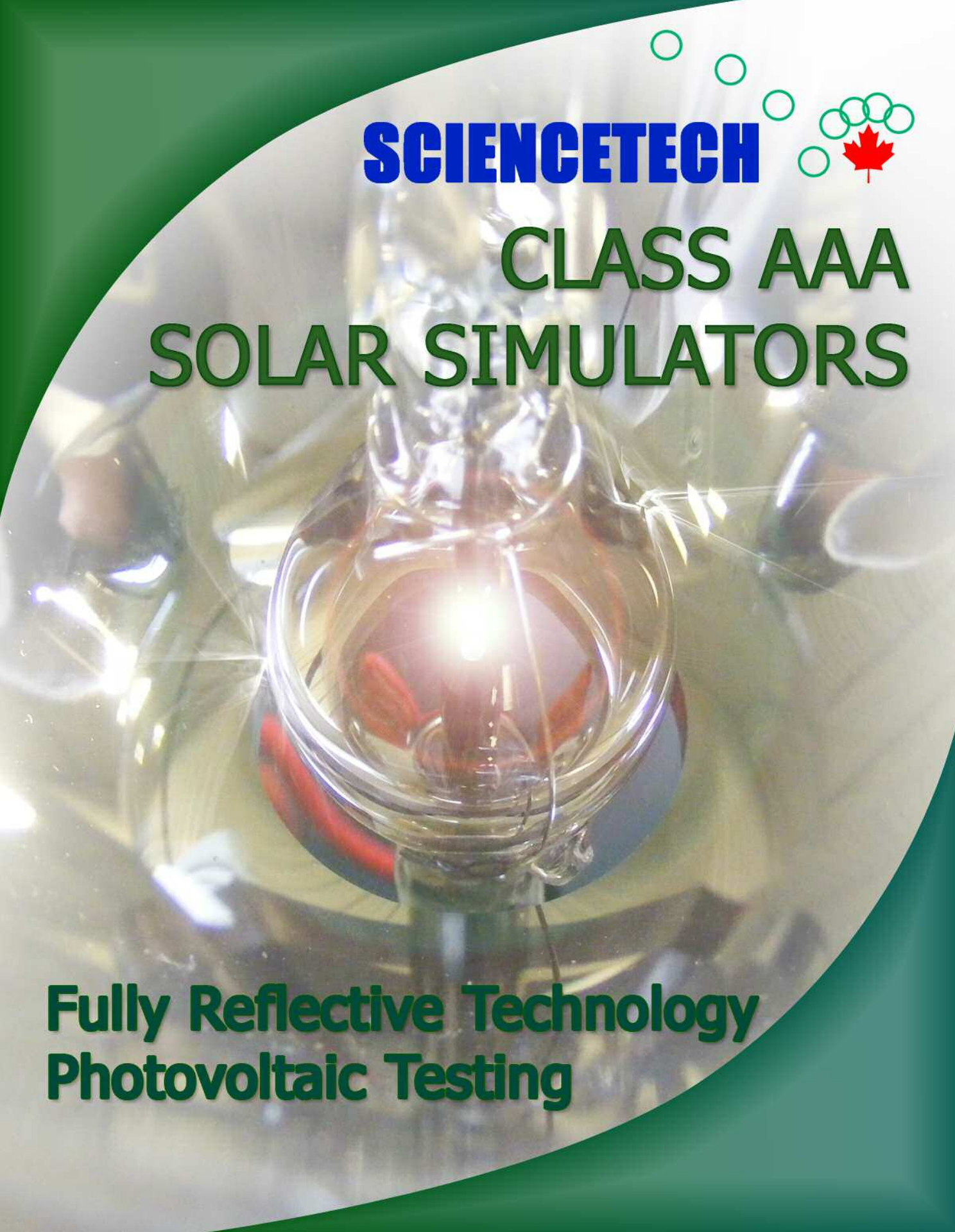
SCIENCETECH

CLASS AAA SOLAR SIMULATORS



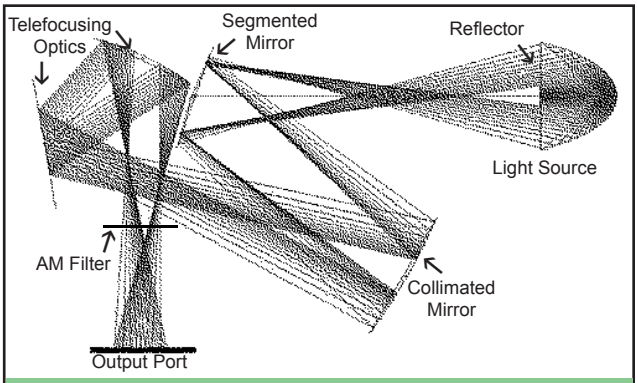
Fully Reflective Technology Photovoltaic Testing

A 10 megawatt solar farm located in Peterborough, Ontario, Canada.
This image is provided by Peterborough Utilities Inc.

Sciencetech solar simulators produce high intensity, uniform illumination on a target area. Typically, high power solar simulators use an ellipsoidal reflector to capture light from an arc lamp source inside the reflector, an arrangement that results in a light pattern with a bright outer region and a dark center. This non-uniformity is unacceptable in many solar simulator applications and as a result, forces many of our solar simulator competitors to use designs involving diffusers to reduce the non-uniformity. This results in a reduction of intensity and a distortion of the spectrum on the target area.

Sciencetech's solution to these problems is to use a unique system of mirrors that 'fold' the light onto the target plane, effectively reducing the light that is lost with little to no spectral distortion and also ensures no chromatic aberration in the output beam.

In addition, each of Sciencetech's solar simulators are customizable to best suit your requirements. The design of the fully reflective solar simulator permits a trade-off between power and uniformity. Higher uniformity can be achieved with lower power; or power can be increased when uniformity is reduced.



Sciencetech's Fully Reflective Solar Simulator Design

The Solar Constant and Solar Simulation

The radiation from the Sun is measured in two ways for a variety of fields of research. The solar constant is the irradiance or intensity of light incident at the surface of the Earth's atmosphere on a plane normal to the angle of incidence. This value has been defined by the World Meteorological Organization to be 1366.7W/m^2 outside the atmosphere. The irradiance of the Sun at the Earth's surface varies under different conditions due to absorption and scattering effects in the atmosphere, and so a number of other constants are important in regards to the irradiance of a solar simulator.

Below the atmosphere the radiation emitted from the Sun can be divided into two components: direct radiation that comes from the Sun itself, and scattered radiation coming from the rest of the sky, including a portion reflected back from the ground. Solar simulators are adjusted to imitate the spectral distribution of sunlight for a variety of environments; to do this the spectral distribution from the xenon arc lamp source is altered and refined using Air Mass (AM) filters.

When discussing filters, the direct radiation spectrum is imitated using a direct (D) filter, and the total including scattered sky and ground radiation is matched by using a global (G) filter that imitates both components together.

The table below gives the 1 SUN irradiance values for both of Sciencetech's filter types at a number of common conditions that can be simulated, as well as the approximate transmission values relative to unfiltered light between 250-2500nm.

Solar Spectrum*	Filter	Power Density (mW/cm²)
In Space	AM0	137
Direct solar spectrum at 0° zenith angle	AM1.0D	104
Global solar spectrum at 0° zenith angle	AM1.0G	100
Direct solar spectrum at 48.2° zenith angle	AM1.5D	93
Global solar spectrum at 48.2° zenith angle	AM1.5G	100
Direct solar spectrum at 60.1° zenith angle	AM2.0D	71

* All Measurements are at sea level, excluding AM0

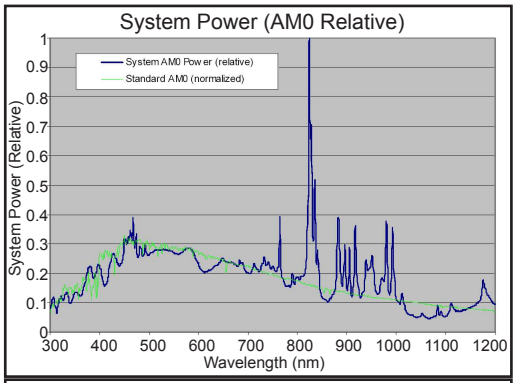
Filter	Transmission Through Filter
AM0	61.3%
AM1.0D	67%
AM1.0G	66.7%
AM1.5D	65%
AM1.5G	58.5%
AM2.0D	57.3%

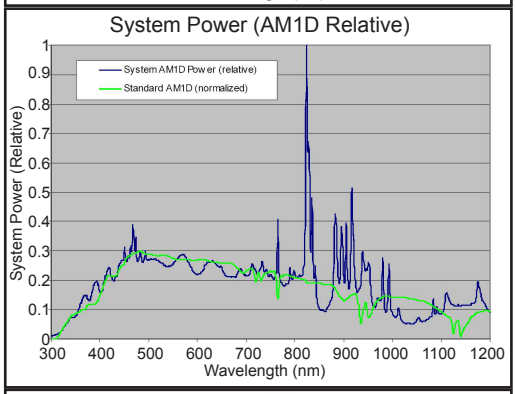
Sciencetech's AM filters are designed to be used individually for standard conditions, although they can also be arranged in series to produce other spectral distributions. Many solar simulator systems used by our competition require filters to be used in series to achieve the same performance as Sciencetech's filters, for example using AM0 and AM1.0 filters in series to achieve a AM1.0 spectral distribution, whereas Sciencetech's AM1.0 filter can be used alone to achieve the same result, reducing power loss and the cost of additional filters.

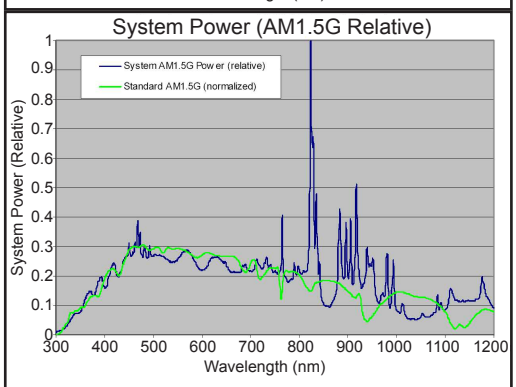
Most Sciencetech solar simulators use xenon arc lamps, which enables the system to produce an intense, collimated beam of light, similar to that of a 5800K blackbody. The biggest difference between the two is the xenon lines are present in the arc spectrum, and atmospheric absorptions in solar spectra, which is especially highlighted in the 800-1100nm range because of the intense line output of the lamp. An AM0 filter can reduce this effect so that the average level in specified bands matches solar levels above the atmosphere to better than ±25%, although complete elimination of the xenon lines while preserving the rest of the spectrum is impossible with a practical filter. AM1.0, 1.5 and 2.0 filters further modify the visible and UV portions of the spectrum for different sea-level conditions, and coupled with the use of high pressure Xenon arc lamps Sciencetech is capable of producing Class A standards for our solar simulators.

The graphs on the right show the typical output spectra of Sciencetech's fully reflective solar simulators. These spectral irradiance curves combine the spectral curves of the xenon arc lamp source, air mass filter, and mirrors used inside the solar simulator beam homogenizer.

Actual output spectra may vary due to the condition of the lamp and manufacturing tolerances of the air mass filters. In order to simplify visual comparison of the spectral curves of our solar simulators with ASTM E927-05 standard curves, the simulator outputs are normalized to the corresponding standard spectrum.







Spectral Irradiance Curves

Performance Measurements

Sciencetech is the only manufacturer that uses this "fully reflective" principle, and can consequently achieve the highest class quality standards for all three performance parameters of photovoltaic cell testing outlined in ASTM E927-05, IEC 60904-9 and JIS-C-8912. These parameters are listed as:

1) **Spectral Match to a Reference Spectral Irradiance**

The output spectrum of a solar simulator is compared to that of natural sunlight. Standards are defined for the range from 400nm to 1100nm divided into 6 intervals. The deviation in radiation of each interval is measured and the worst performing interval determines the solar simulator's class for this parameter. A spectral match of Class A is available for all of Sciencetech's solar simulator models and air mass filters.

2) **Non-uniformity of Spatial Irradiance**

ASTM standards require that at least 36 intensity readings covering a minimum of 25% of the total surface area be taken and averaged in order to determine the non-uniformity. The maximum and minimum values are compared and the uniformity is classified as Class A, B or C.

3) **Temporal Instability of Irradiance**

This parameter represents the fluctuation of the measurement system during the interval required to fully obtain a current-voltage (I-V) curve which depends on the application. Sciencetech's solar simulators typically have a temporal stability of 1% after warmup.

Classification	Spectral Match to all Intervals	Non-Uniformity of Spectral Irradiance	Temporal Instability of Irradiance
Class A	.75 to 1.25	2% (ASTM: 3% for target size ≥30cm)	≤2% (JIS 1%)
Class B	0.6 to 1.4	5% (JIS: 3%)	≤5% (JIS 3%)
Class C	0.4 to 2.0	10%	±10%

While traditional solar panels had few dependencies other than spectral and spatial matching, advances in technology have created additional requirements not covered by international standards. Sciencetech has successfully created simulators to meet these new specifications, and are consistently adding new products to our lineup.

The large distance between the sun and the Earth results in incident sunlight within an extremely high degree of collimation (±0.26° or 0.53° full angle) at the Earth. Replicating this with solar simulators, which do not have the benefit of astronomical distances is challenging, however, Sciencetech has designed a line of highly collimated solar simulators using Fresnel lenses achieve collimation better than 0.7° angle over a 20cm x 20cm target. This allows testing of Concentrated Photovoltaic (CPV) systems and is useful in any application which has a high dependence on collimation.

We have also produced systems that simulate the concentrating optics of a CPV cell by providing extremely high power on small illumination targets; Sciencetech's Flash Solar Simulator Concentrators are uniquely capable of illuminating a 50x50mm square target with up to 4,000 suns at Class AAA.

On the other hand, as traditional solar panels and cells continue to increase in size, systems capable of illuminating larger and larger areas have become necessary. Illuminating large targets with continuous solar simulators can be extremely expensive; however, most panels manufactured do not require constant illumination systems due to the fast rate at which the electronic processes operate. A far more economical solution is to use Sciencetech's line of Flash Solar Simulators, capable of easily illuminating targets as large as 2x2m with Class AAA.

For other requirements not covered by the mentioned systems such as: larger targets, increased power, smaller angles of collimation, or any other specification of being met by an existing system from Sciencetech or one of our competitors, contact our Special Developments Group at sales@sciencetech-inc.com and allow us to design your custom solution.

All of Sciencetech's "Fully Reflective" line of solar simulators feature a design that does not require lenses or diffusers to make the output uniform at the target plane. As a result, the solar simulator is able to reach its optimal throughput efficiency and reach a consistant AAA class rating for every fully reflective solar simulator we provide (see chart on the right), making Sciencetech's line of solar simulators substantially more efficient than our competitor's designs.

The fully reflective design utilizes a series of mirrors, including a special folding mirror that bends the light source without the drawbacks of refractive optics. This allows the simulator to direct the light beam from the arc lamp source to the target plane, producing a higher intensity, uniform illumination at the target plane than a competitor's simulators.

In Sciencetech's line of fully reflective solar simulators the power output will typically be 1.3 times more powerful when compared to simulators that use the same wattage of arc lamp with diffusers to make the light field uniform at the target.

The high pressure xenon lamp used in each simulator projects an excellent basic match for solar simulation. The solar spectral distribution at different Earth conditions can be simulated through use of Air Mass filters.

For more variation of where your test surface is located, several simulators can be mounted on a vertical stand, and if coupled with a beam turning accessory, enable the simulator's ability to project towards a floor, wall, or ceiling, depending on your research requirements.

The air mass filters used with each simulator are 3" x 3" in size and can be easily switched in each model via a built-in access panel. There are two AM filter slots in each simulator; additional slots can be added upon consultation.

Standard Features

- Class AAA capable
- Fully reflective design for optimal effeciency
- Sciencetech 'folding' mirror for optimal performance
- Compatible with all Sciencetech 3" AM filters
- The filter holder can hold up to 2 AM filters at once
- All AM filters can be removed or exchanged through a built-in access panel
- Standard horizontal operation
- Air cooled
- Power supply included (different for each model)

Recommended Optional Features

- Downward facing stand for vertical operation
- Computer controlled electronic shutter
- Optical feedback intensity stabilizer
- Variable Focus

Model	Illuminated Target Size (Diameter)	Illuminated Target Size (Square)	Angle	Working Distance
SS150W	5cm (2")	3.6 x 3.6cm (1.4 x 1.4")	2.5°	76.2cm (30")
SS0.5kW	7.5cm (3")	5.3 x 5.3cm (2.1 x 2.1")	3°	45cm (17.7")
SS1.0kW	12.7cm (5")	8.9 x 8.9cm (3.5 x 3.5")	3°	88cm (34.7")
SS1.6kW	16.5cm (6.5")	11.7 x 11.7cm (4.5 x 4.5")	3°	125cm (49.2")
SS2.5kW	20.3cm (8")	16.0 x 16.0cm (6 x 6")	5°	112cm (44")
SS7.5kW	43.2cm (17")	30.0 x 30.0cm 12 x 12"	7°	254cm (100")

* Measured for 1 SUN

** All readings above meet class AAA requirements

Sciencetech's fully reflective solar simulators are able to measure several types of solar cells:

Crystalline Silicon
- Monocrystalline Silicon (c-Si)
- Poly or Multicrystaline Silicon (poly-Si or mc-Si)

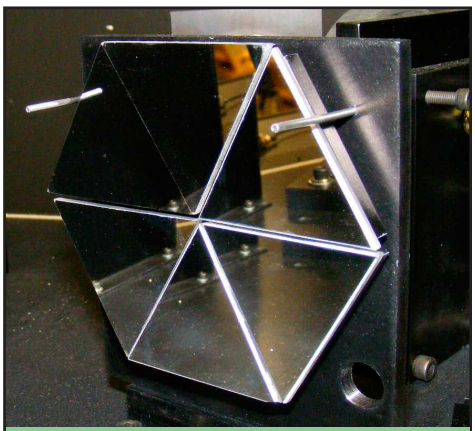
Thin Films
- Cadmium Telluride (CdTe)
- Copper Indium Galium Selenide CIGS
- Amorphous Silicon (A-Si)
- Gallium Arsenide Multijunction GaAs

Light-absorbing Dyes

Organic/Polymer

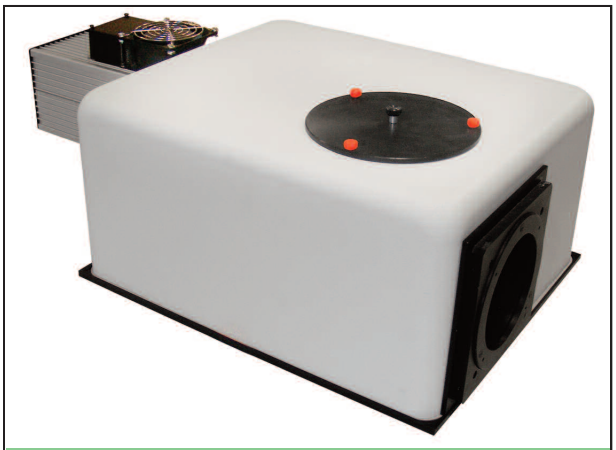
CPV and HCPV

For more information on our fully reflective designs, which solar cells can be successfully tested, or customization options for our simulators contact us at: sales@sciencetech-inc.com



Sciencetech's Folding Mirror Within a Fully Reflective Solar Simulator

SS150W Fully Reflective Solar Simulator



SS150 Fully Reflective Solar Simulator

Technical Specifications

Uniformity:
±2% over central field

Short term power stability:
±1% after 30 minutes

Long term power stability:
-20% after 1000 hours due to aging of the lamp

Wavelength Control:
Solar and Bandpass Filter

Mounting Options:
Horizontal and Vertical

Dimensions:
63.5cm x 30.4cm x 17.7cm (Horizontal)
45 cm x 30.4 cm x 147cm (Vertical)
15kg / 33lbs.

The SS150W is Sciencetech's smallest fully reflective model available is the only 150W solar simulator in the current marketplace, capable of reaching a consistant class AAA rating.

Weighing only 15kg (33lbs) and with dimensions smaller than a typical desktop computer, this makes the SS150 more portable and consumes much less space than the high powered solar simulators, yet the SS150 is still able to deliever the same Class A uniformity at a 1 sun power output that the higher powered models are designed to achieve, within a small target diameter. The SS150 is also compatible with an electronic shutter for controlling exposure time to your target surface and a vertical stand with a beam turner allowing the user to adjust the output beam on a 90 axis angle.

The tables below signifiy output power readings with or without a filter and at variable distances. For more specific inquires please consult with a sales representative.

SS150 Output Powers with Class A Uniformity

Distance to Target	15" 38cm	24" 61cm	35" 89cm
Beam Diameter	1.2" 3.0cm	1.8" 4.6cm	2.4" 6.1cm
Area (cm^2)	12.2	27.4	48.7
Power Density without filters (mW/cm^2)	462	220	115
Power Density with AM0 filter (mW/cm^2)	283	135	71
Power Density with AM0 filter solar constants (SUN)	2.1	1.0	0.5
Power Density with AM1.5G filter (mW/cm^2)	270	129	67
Power Density with AM1.5G filter solar constants (SUN)	2.8	1.4	0.7

SS150 Output Powers with Class B Uniformity

Distance to Target	15" 38cm	24" 61cm	35" 89cm
Beam Diameter	2" 5.1cm	3" 7.6cm	4" 10.2cm
Area (cm^2)	20.3	45.6	81.1
Power Density without filters (mW/cm^2)	502	239	125
Power Density with AM0 filter (mW/cm^2)	308	147	77
Power Density with AM0 filter solar constants (SUN)	2.3	1.1	0.6
Power Density with AM1.5G filter (mW/cm^2)	294	140	73
Power Density with AM1.5G filter solar constants (SUN)	3.1	1.5	0.8

High Power Fully Reflective Solar Simulators

High Powered Fully Reflective Solar Simulator

In addition to the small but effective SS150, Sciencetech manufactures four high power versions of Class AAA fully reflective solar simulator. The high powered simulators produce similar results to the smaller SS150; however, the variable power capabilities allow the system to have a larger diameter of uniformity at various power outputs.

The tables on the right give typical levels derived from measurements made with a variety of different setups, and so numbers may seem inconsistent. Generally, to achieve Class A from Class B uniformity, the diameter of the target area should be reduced 40%.

Specific AM filters require:
Global - 10% less
Direct - 30% less
AM0 - 25% more

Spatial Non-Uniformity Target Diameter with a 1 SUN level		
Model #	Class A	Class B
SS0.5kW	7.5cm / 3.0”	9.0cm / 3.6”
SS1kW	12.7cm / 5.0”	15.0cm / 6.0”
SS1.6kW	16.5cm / 6.5”	20.0cm / 7.8”
SS2.5kW	20.3cm / 8.0”	24.0cm / 9.6”

Spatial Non-Uniformity Target Diameter with a 0.5 SUN level		
Model #	Class A	Class B
SS0.5kW	12.4cm / 4.9”	15.0cm / 6.0”
SS1kW	18.0cm / 7.1”	21.5cm / 8.5”
SS1.6kW	22.6cm / 8.9”	27.0cm / 10.7”
SS2.5kW	28.7cm / 11.3”	34.0cm / 13.5”

Spatial Non-Uniformity Target Diameter with a 2 SUN level		
Model #	Class A	Class B
SS0.5kW	6.3cm / 2.5”	7.5cm / 3.0”
SS1kW	8.9cm / 3.5”	10.5cm / 4.2”
SS1.6kW	11.2cm / 4.4”	13.5cm / 5.3”
SS2.5kW	14.2cm / 5.6”	17.0cm / 6.7”

Technical Specifications

Uniformity:
±2% over central field

Short term power stability:
±1% after 30 minutes

Long term power stability:
-20% after 1000 hours due to aging of the lamp

Mounting Options:
Horizontal and Vertical

Dimensions:
122cm x 76cm x 36cm (Horizontal)
52cm x 76cm x 154cm (Vertical)
55kg / 121lbs.

High Power Simulator UV Upgrade

The benefits of Sciencetech’s Fully Reflective design are especially pronounced in the UV region of the spectrum. Typical diffuser based solar simulators have heavy losses in the UV region, making Sciencetech’s UV solar simulators unequaled in the UV region.

7.5kW Fully Reflective Solar Simulator

7.5kW Fully Reflective Solar Simulator

The SS-7.5kW Solar Simulator uses three Sciencetech SS 2.5kW fully reflective Solar Simulators to provide up to 1 Sun of highly uniform illumination on a large area (30 x 30cm) target.

The spectral distribution can be tailored to the user's needs with easily removable transmission and reflection filters, which provide combinations of solar spectra, UV or IR illumination, or other spectra for special applications.

Our 7.5kW SS is useful for applications which require both relatively large illumination areas and a constant light source, unlike our larger flash solar simulators (see page 14).

This is important for solar cells or processes with slow response or reaction times that prohibit the use of millisecond flashes. These systems are also useful for applications that require very long exposures such as biological or aging measurements.

Technical Specifications

Total Output Power on Target:
1 Sun (1000W/m^2) AM1.5G
1 Sun (1366.7W/m^2) AM0

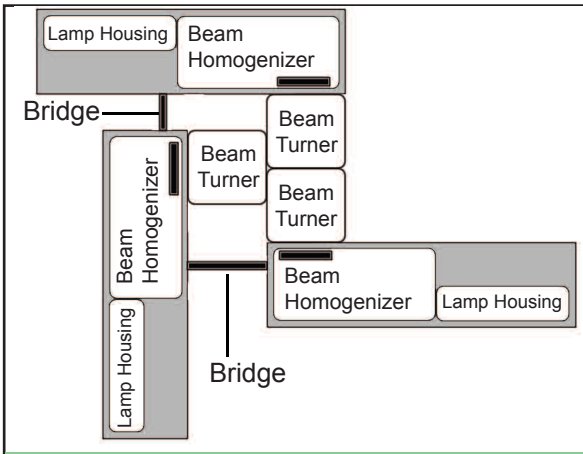
Uniformity:
Constant within 2% over 30 x 30cm (12" x 12")

Stability of power on target (Short term):
±1% after 30 minutes

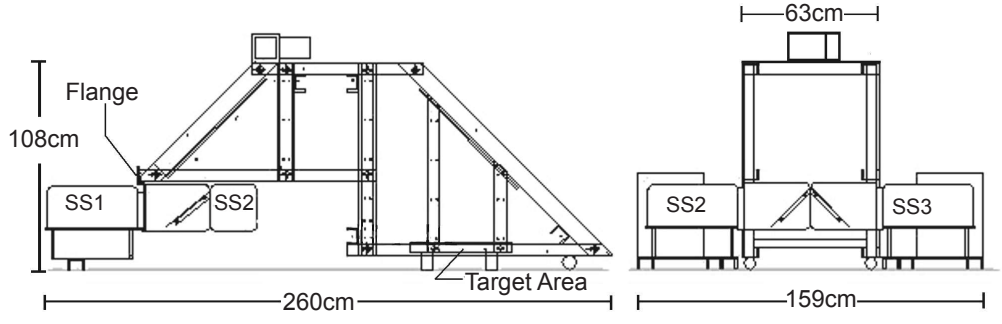
Stability of power on target (Long term):
-20% after 1000 hours due to aging of the lamp

Wavelength Control:
Solar and Bandpass Filter

Dimensions:
260.35 x 158.75 x 107.95cm / 102.5 x 62.5 x 42.5"
220kg (approximate)



7.5kW Solar Simulator Optical Layout



Three Solar Simulator Units + Beam Folding Unit

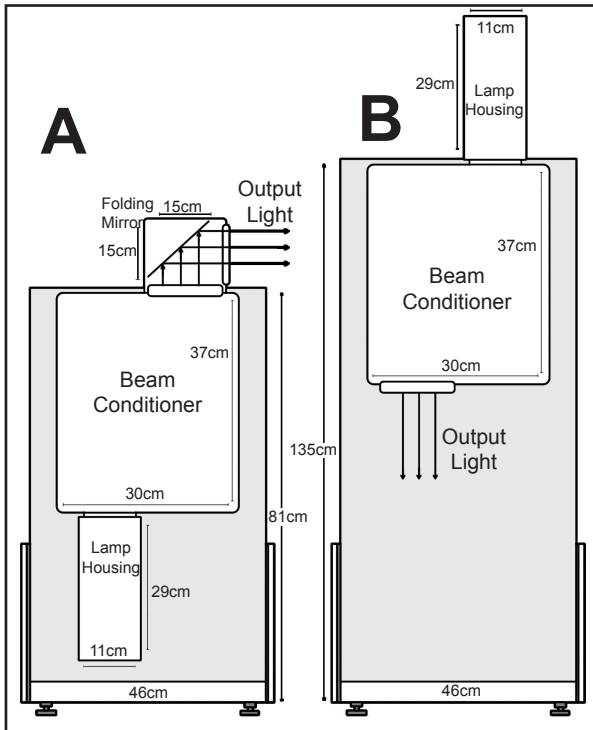
Vertical Stand for Fully Reflective Solar Simulators

When a simulator is in the standard horizontal position, the output beam exits from a side panel and illuminates an area on the wall (or other target surface); an optional beam turner can be mounted at the output window to direct the beam, downward, left or right.

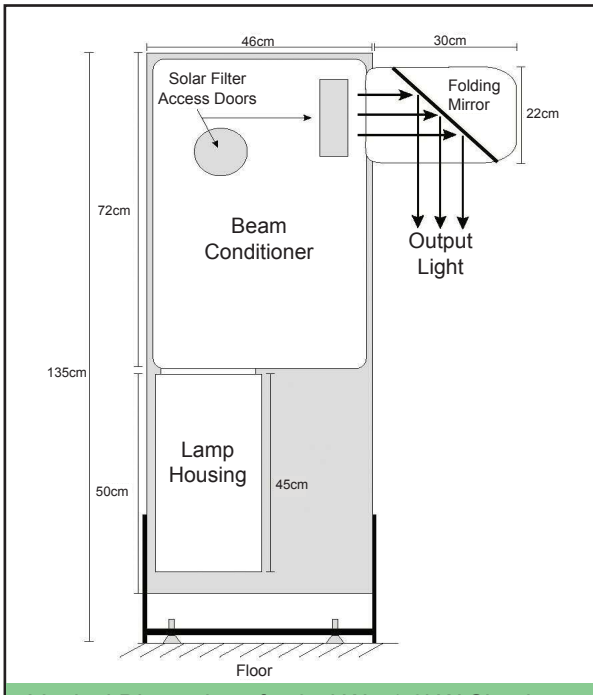
When a vertical stand is used the output beam also exits horizonally, and is adjusted by the beam turner for vertical operation or any 90° angle to direct the light beam up, down or to either side. However, the vertical stand assures the distance between the output port of the solar simulator to the sample platform produces exactly 1 Sun intensity (100mW/cm^2 using an AM1.5G filter or 136mW/cm^2 using an AM0 filter) onto: a 3" diameter area for an SS-500W, 6" diameter for an SS-1000W, and 7" diameter for an SS-1600W.

A 2.5kW solar simulator can be mounted vertically on a stand; however, a different custom mount is required specifically for this system. This mount allows the simulator to be elevated enough to project the light beam towards the ground with sufficent room for a consistant 1 Sun intensity.

A 1kW Solar Simulator on a Vertical Stand



Vertical Configurations for SS150 Solar Simulators
A: Target spot on wall / B: Target spot on floor



Vertical Dimensions for 0.5kW - 1.6kW Simulators

Variable Focus

Sciencetech's fully reflective solar simulators are imaging systems where the plane of uniformity is produced by overlapping images of Sciencetech's proprietary folding mirror assembly.

The solar simulator's imaging system can be adjusted to meet user specifications for target size, power level and uniformity.

Sciencetech's variable focus assembly allows additional flexibility for changing target size while maintaining uniformity.

Variable Focus Mechanism on a 1kW Solar Simulator

Target Distance from Beam Turner / Output Flange	Variable Focus Adjustment	Target Diameter (Inches)	Power w/1.5G filter
9.5" / 20"	Fully C.W.	3.5"	1.3
15.5" / 26"	Inbetween	5"	1.0
27" / 37.5"	Fully C.C.W.	6.5"	0.6

* Measured for With a 1kW fully reflective solar simulator
** All readings above meet class AAA requirements

Without the variable focus assembly the user will have to re-focus the mirrors inside of the solar simulators beam homogenizer each time the target size is changed. This procedure involves shutting down the solar simulator and adjusting the position of each internal mirror in the solar simulators imaging system in order to support a different focal spot size.

Although possible, this procedure is a time consuming should the user need to change the target size regularly. The variable focus assembly allows re-adjustment of the solar simulator's imaging system with a single knob and without shutting down the system. Some users may also wish to use the variable focus assembly to vary illumination intensity on the target (see table above).

Manual and Electronic Shutters for Fully Reflective Simulators

Computer Controlled Electronic Shutter

An arc lamp is not designed to be frequently turned off and on, as doing so will dramatically lower its service life. In addition, each time an arc lamp is turned on, the power supply needs to ignite the bulb with a spark of over 20,000V. This surge causes minor damage to the bulb itself, which is generally insignificant, but is cumulative over time, resulting in a decrease in power output and an increased risk of the bulb catastrophically failing. In addition, since bulbs do not stabilize instantly after ignition, each time the system is turned on requires a period of stabilization, usually 10-15 minutes, before useful measurements can be taken with the source stabilized and consistent. For more powerful systems, this time may be considerably longer, and so the need to avoid turning off the system to do quick tasks, such as replacing samples, becomes more critical.

Sciencetech has developed an electronic shutter system for use inside the beam homogenizer to control exposure times on target without requiring the system to be turned off. This has the benefits of increasing the lifetime of the arc lamp bulb, and potentially reducing the down-time between measurements. The shutter has options for either manual or computer control and has an activation time of less than 150 ms. Due to the design of the system, it may be left closed for extended periods if necessary without risk to other the operators from UV radiation, or to the system itself.

SF Series Collimated Solar Simulator

Sciencetech is proud to offer our low cost SF-series solar simulator systems. The SF300 is the most inexpensive system on the market to provide Class AAA illumination.

Systems components include: Arc Lamp Housing, Arc Lamp Bulb, Adjustable Power Supply with Ignitor, Filter Holder, and UV Fused Silica Lenses. These systems are ideal for testing small samples or larger samples which do not have a strict uniformity requirement.

The beam can also be configured for different power densities and spot sizes as required. Up to 3 Solar Constants (w/o AM filter) can be achieved in some configurations. The beam output can be made, collimated, convergent or divergent. 2" diameter optics are available as an option. An option for fibre optic illumination is available, but requires an additional condenser and fibre mount.

The filter holder allows the user to selectively trim the xenon spectrum to provide the desired Air Mass spectrum using any of our full range of AM filters. Other filters such as dichroic filters and bandpass filters are available for further modification of the spectrum. (Sold separately)

Sciencetech's SF-series collimated small beam solar simulator can be configured to a variety of specifications including using higher power lamps for increased power output and increasing the size of the output beam. For more information on custom configurations please contact our custom developments group at sales@sciencetech-inc.com.

SF Series Collimated Solar Simulator with Beam Turner

Model	Illuminated Target Size (Diameter)*	Illuminated Target Size (Square)*	Collimation	AM Spectral Match**	Spatial Uniformity**	Temporal Stability**	Working Distance+
SF300-A	2.3cm (0.9")	1.65 x 1.65cm (0.65 x 0.65")	1°	A	A	A	10-13cm (4-5")
SF300-B	4.8cm (1.9")	3.4 x 3.4cm (1.34 x 1.34")	1°	A	B	A	10-13cm (4-5")
SF150-B	2.3cm (0.9")	1.65 x 1.65cm (0.65 x 0.65")	1°	A	B	A	10-13cm (4-5")
SF300-C	5cm (2.0")	3.6 x 3.6cm (1.4 x 1.4")	1°	A	C	A	10-13cm (4-5")
SF150-C	4.8cm (1.9")	3.4 x 3.4cm (1.34 x 1.34")	1°	A	C	A	10-13cm (4-5")

* Air Mass Filter AM1.5G
** All readings above meet ASTM E927-05 requirements
+ When a beam turner is used the working distance is reduced to 2.5cm (1") for all systems

Technical Specifications

Lamp Housing:
Sciencetech 201-100 air-cooled research arc lamp housing

Center beam line height:
136.88mm (5.389")
(not including adjustable feet)
One collimating lens 25mm (1") or 50mm (2") diameter UV Fused Silica at the housing exit port

Lamp:
300W or 150W ozone free, xenon lamp

Coupling & Filters:
Standard filter holder mounts one filter, an additional filter holder or lens can be added

Power Supply & Igniter:
Sciencetech 500-300 highly regulated, linear, adjustable power supply for arc lamps up to 300W for 201 series arc lamp housing.

Input:
110-115v/60Hz or 220-240v/50Hz
(please specify)

Display:
Digital LCD

Power:
150 - 300W
Operating Voltage - 0-30V
Operating Current - 0-10A
Pre-ignition Voltage >80V
Ripple at Maximum Current <1%
Stability After Warm-up - 0.05%

Line Voltage Regulation:
0.02% current variation for 5V line change

Cooling Fan:
120VAC cooling fan

Spatial Non-uniformity:
(SF300)
2% non uniformity at specified target diameter and a working distance of 50~76mm (2~3")
(SF150-B)
5% non uniformity at specified target diameter and a working distance of 152mm (6")

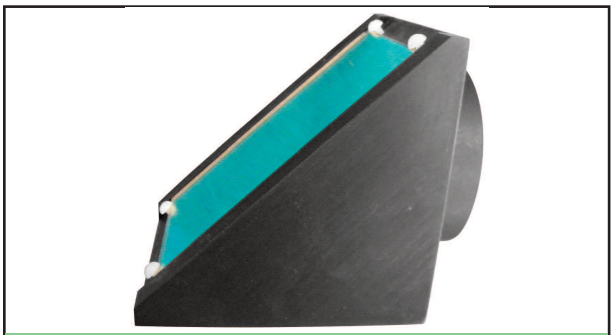
Dimensions and Weight:
51cm x 46cm x 39cm (20" x 18" x 15")
14kg (30lbs)

Beam Turning Assembly

The output of Sciencetech's SF solar simulators is a collimated, horizontal beam. A beam turning assembly can be mounted to the output port to redirect the light downwards onto a horizontal table top. This beam turning assembly is placed after the filter holder.

It consists of a flat UV enhanced mirror mounted on a 45° angle and is located after the lamp housing's collection lens at the output port.

An optional cold mirror version is available to eliminate IR light and thermal heat on the sample.



Beam Turner for SF Series Solar Simulators

SF Series Electronic Shutter

The external version of the 600-VS25 shutter can be used with all of Sciencetech's SF series of Solar Simulators and is computer controlled via Sciencetech's PCI A/D data acquisition board.

The shutter has its own power supply, electronics module, and cable that connects it with the Sciencetech PCI A/D data acquisition board. It has a 25mm diameter aperture, minimum exposure time is 6ms (40Hz), and maximum exposure time is several minutes.

The SF series electronic shutter is compatible with 1" models only.

Highly Collimated Fresnel Lens Solar Simulator

Sciencetech has designed a highly collimated solar simulator for the purpose of photovoltaic cell testing. This solar simulator, Model SS3.0KW-Xe-Fr, has the ability to illuminate a 30cm (12") diameter target size.

In a 1.6kW version of the simulator the output power is approximately 1 Sun with an AM1.5D filter onto a 22.5cm (9") diameter spot at the exit window plane with a collimation of ±0.7°, providing a broadband spectral range of 250-2500 nm without filters.

The main component of the solar simulator is a fresnel lens, which can collimate the light beam from the arc lamp source to infinity, and results in a highly collimated illumination at the target spot.

An ozone-free xenon arc lamp is used as the light source. The spectral distribution of the xenon light source, along with the use of Sciencetech's specially calibrated Air Mass filters, closely simulates the sun's true spectral distribution in various conditions on Earth. For solar cell testing, the AM1.5D filter is recommended to simulate terrestrial conditions and the AM0 filter is recommended to simulate conditions in Space.

Sciencetech's highly collimated solar simulator is air cooled with electric blowers and has adjustment pins to align the focal point of the lamp. The arc lamp is powered through an external adjustable DC power supply. The power supply has a manually operated controller with LED display for current and power adjustments.

Fresnel Lens Solar Simulator

Standard Features

- Adjustable DC power supply with LCD display screen, includes igniter
- 12" diameter frensel optical quality acrylic, UV transmitting lens
- Low f/# for maximum power throughput
- Built-in filter holder for 152 x 152mm (6" x 6") filter
- Standard horizontal operation
- Custom designed aluminum air cooled lamp housing
- Ozone free operation
- Compatible with all of Sciencetech's AM filters

Fresnel Solar Simulator Power Supply

* Air Mass Filter AM1.0D

** All readings are based on ASTM E927-05 requirements

Model	Illuminated Target Size (Diameter)*	Illuminated Target Size (Square)*	Collimation	AM Spectral Match**	Spatial Uniformity**	Temporal Stability**
SS1.6KXeFR (Class B)	23cm (9.0")	16 x 16cm 6.4 x 6.4"	0.7°	A	B	A
SS1.6KXeFR (Class A)	23cm (9.0")	16 x 16cm 6.4 x 6.4"	0.7°	A	B	A
SS3.0KXeFR	30.5cm (12.0")	21 x 21cm 8.4 x 8.4"	0.7°	A	B	A

Triple Optical Path Solar (TOPS) System

(Left) Triple Optical Path Solar [TOPS] System
(Right) The TOPS Testing Chamber

The Sciencetech TOPS system is a revolutionary new design in solar simulation, coupling a powerful lamp with novel optics unrivalled in the current simulator market. This system is capable of illumination areas up to 30cm in diameter at 1 sun of power with an optical design optimized for maximum spatial uniformity at a fraction of the cost of other systems.

The core of the Sciencetech TOPS system is the 3kW Xenon arc lamp, surrounded by a sophisticated collection and alignment system to fold the illumination onto the target without the use of diffusing media, ensuring no spectral degradation, illuminating the target, and without absorption or scattering losses.

The compact design includes three 3" x 3" air mass filters and all the necessary fans, plugs, and Sciencetech's proprietary power supply.

The system can be built to specifications, illuminating anywhere between 43cm diameter targets with 0.5 sun or up to 30cm diameter with 1 sun (Class A).

Larger diameters are possible with the same irradiance levels at Class B or C. In addition, higher power yet smaller area illumination options are also available. Ask one of our technical sales representatives how we can modify your system to your exact specifications.

Technical Specifications

Arc Lamp Power:
3.0kW

Uniformity:
Better than ±3%

Uniform Area Diameter:
43.2cm (17") at 0.5 Sun at a working distance of 50cm (19.7")
30cm (12") at 1 Sun at a working distance of 36cm (14.1")

Stability of power on target (Short term):
≤0.5%

Stability of power on target (Long term):
≤2.0%

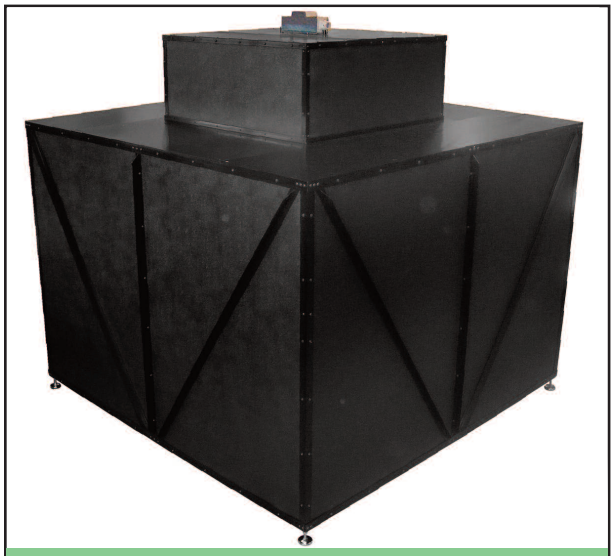
Mounting Options:
Vertical (Default)
Optional horizontal configuration available

Filter Holders:
3 Separate filters loaded with identical solar filters

Cooling Fans:
4x DC Air recirculators

Dimensions:
69cm x 61cm x 61cm
27" x 24" x 24"
40kg (88lbs)

Flash Solar Simulators for Large Photovoltaic Module Testing



2m x 2m Flash Solar Simulator

Sciencetech's flash solar simulators are designed to test large photovoltaic devices. The flash solar simulator utilizes a heavy duty xenon flash lamp and an AM1.5G calibrated solar filter to approximate the sun's true spectral distribution following ASTM E927-05 Class A standards. The flash solar simulator fires short flashes of light to measure the performance of a photovoltaic device without heating it.

The system can operate as a single flash/point which will produce an I-V data point of the photovoltaic device. The data can be captured by connecting the device to an optional current-voltage measurement system.

A computer controller then sequences the light flashes with the current-voltage measurement system to capture and store a multi-point I-V curve for the photovoltaic device.

All of Sciencetech's flash solar simulators can be used on many types of photovoltaic devices including thin films, amorphous silicon, and traditional crystalline silicon materials. The optional current-voltage measurement system has an active load and wattage range that can be tailored to each type of PV material.

The simulator utilizes a heavy-duty/low-duty cycle xenon flashtube powered by a digitally controlled power supply. This provides a stable and repeatable flash in a multi-exposure I-V test sequence. The power supply also provides a wide operation range from 70-2400 Joules to accommodate different sizes of photovoltaic panels ranging from 20 x 20cm (8" x 8") to 2 x 2m and at various intensities from 70-150 mW/cm^2.

Technical Specifications

(2m x 2m)

Uniformity / Class:
±3% or better (Class A)

Uniform Area Dimensions:
Standard 2m x 2m (1m x 1m version available)

Flash Lamp:
Power Range: 75 - 2400J
Stability of Power on Target +/- 3%

Intensity Range (AM 1.5G):
70 - 1600mW/cm^2 (I-V testing to 150mW/cm^2).

Flash Duration:
500µs @ 90% peak intensity, 2.5ms @ 50%
Upgraded to 3ms - 5ms at an additional cost

Distance to Target:
3"

Power Requirements (120V):
100-140 VAC / 200-245 VAC **(230V)** @ 50/60Hz
25 Amp surge on fast charge / 16 Amp **(230V)**
10 Amp surge slow charge / 6 Amp **(230V)**

Dimensions:
205cm x 205cm x 195cm (79" x 79" x 76")
408kg (900lbs)

To withstand heat stress in a continuous use production operation, the heavy duty xenon flashtube has over dimensioned tungsten electrodes tested to 60,000 Joules.

The ASTM E927-05 standard states that a solar simulator must match the spectral distribution of the reference spectral irradiance to within ± 25% to be classified as a Class A solar simulator. For large area solar simulators (greater than 30 x 30cm) the spatial uniformity for Class A shall be ±3% or better. Class A Temporal stability for a flash intensity must not vary by more than ±2% from an average value over the total test time.

In addition, Sciencetech offers an optional full featured workstation with illumination table and Current-Voltage (I-V) measurement system for use in both in-line low volume production and off-line quality control environments is available (PSS 1x1 only).

Flash Solar Simulator Concentrator

Sciencetech's Flash Solar Simulator Concentrator (FSSC) is a well designed, compact and robust source of very high intensity solar irradiance with high uniformity for testing and characterizing solar cells and other devices up to 5cm x 5cm in size.

It may be operated vertically with the normal (61cm x 61cm) mounting base and included sample holder requiring a total height of 82cm or, optionally, with the base removed and the smaller dimensions of 36cm x 36cm x 78cm to permit the FSSC to be easily mounted to other equipment.

A 75mm x 75mm removable Air Mass Filter and a spectrally neutral 8.3:1 mesh attenuator are included with the FSSC. Additional spectrally neutral attenuators up to 100:1 are available from Sciencetech at additional cost.

Irradiance may be set by power control in 50 steps of approximately +/- 7% of the current level from 225 Suns minimum without the mesh attenuator or 27 Suns minimum with the attenuator in place under the air mass filter. Note that irradiance is specified at the flash peak.

The spatial uniformity is better than 2% at the exit plane. Acceptable uniformity may be obtained at working distances of 1mm to 5mm from the FSSC exit plane with uniformity measured and specified at 3mm distance. Sciencetech also provides the electronics to generate an IV curve for your cell (Sold separately).

FSSC-4000
(Flash Solar Simulator Concentrator)

Technical Specifications

Target size:	5cm x 5cm	**Flash interval:**	5 sec (<600 Suns) , 2 sec minimum
Working Dist.:	3mm	**Energy Setting:**	75 - 2400 joules (2^3.5 - 2^8.5 in 50 steps)
Angle of Exit:	47.5 degrees max 30 degrees typical (50%)	**Duty Cycle:**	6750/Sun FPM avg (Flashes/Minute average)
Uniformity:	+/- 3% +/- 2% typical		
Irradiance:	225 - 4000 Suns (Less than 225 suns possible with attenuator)	**Lamp Life:**	20,000 shots @ 2000 Suns est. 100,000 @ 400 Suns
		Ref. Output:	5.377uA/Sun 11.0mA typical peak @ 2000 Suns
Repeatability:	± 5%, ± 3% typical		

Power Requirements

120V version:	100-140 VAC 50/60 Hz 25 Amp surge on fast charge 10 Amp surge slow charge	**230V version:**	200-245 VAC 50/60 Hz 16 Amp surge on fast charge 6 Amp surge slow charge

Photovoltaic Testing System (PTS)

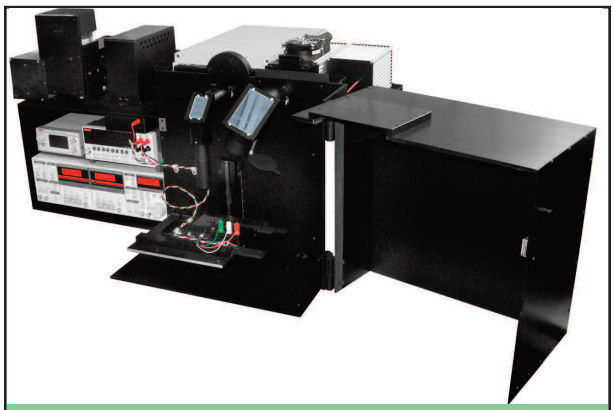
This system includes either a 150W Xenon or 200W QTH lamp and a monochromator to tune the light source. A source meter used as an active load permits operating the test cell at various load conditions, including short-circuit, compensating for a series resistor required to sense the current produced by the modulated monochromatic light. This sensed current plus a reference signal at the frequency of the light modulation are both fed into the precision lock-in amplifier to allow measurement of the photocurrent generated by the modulated monochromatic light.

The PTS-1 features all the software required for I-V Curves and Spectral Response measurements. Main parameters of these measurements are displayed by the software, including the most important graphs typically required by researchers and the industry. Optionally, our software development group offers to develop whatever is required to meet your demands.

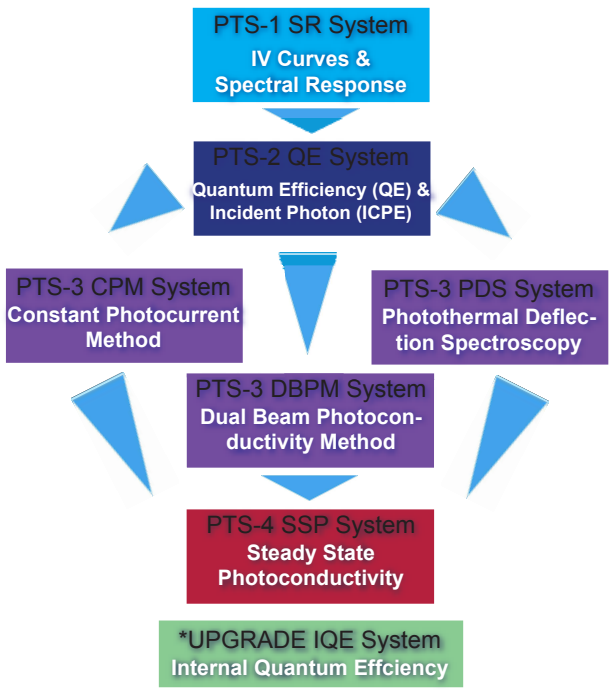
Unless a different request is made, the geometry of the light from the Monochromator is controlled to illuminate only a small section of the solar cell (typically 3mm diameter), ensuring that 100% of the monochromatic irradiance contributes to the output signal. NOTE: Spot size must be smaller than the 5mm diameter reference detector.

The PTS-1 system includes a SCIRUNSR I-V-Test measurement system, precision lock-in amplifier and system software. The software controls the Monochromator, source meter and lock-in amplifier to automatically measure the I-V characteristics and SR versus wavelength, plotting the result(s) on screen and outputting calculated values, including Voc, Isc, Pmax, Fill Factor, and the raw measurements to a standard file format.

Additionally, the PTS-1 can be upgraded with an optional light tight sample chamber, vertical adjustment components, sliding sample holder, and thermal control (either cooling or heating) for the sample holder. While these additions are not required, including them will ease your operation of the system. While the basic PTS-1 system offers researchers a good starting package for I-V and SR measurements, the true power of the system is in its ability to seamlessly upgrade to a more versatile system. The PTS-2 includes all the capabilities of the PTS-1, plus the additional ability to measure Quantum Efficiency and Incident Photon to Charge Carrier Efficiency (ICPE). This improved system also includes a bias solar light and the necessary power supplies and controllers.



PTS Cell Testing System



*Available for PTS systems 2, 3 & 4 only

The Spectral Response and Quantum Efficiency measurement systems provide an overall “external” QE value that doesn’t consider that some of the light is reflected or transmitted by the photosensitive sample. From the point of view of cell efficiency this is the most important factor. However, to measure the QE of the cell material itself apart from these losses - the internal quantum efficiency or IQE - the reflected and transmitted light must be measured and mathematically deducted so that only the light absorbed by the solar cell is considered in the QE calculations. This optional upgrade can be applied to the PTS-2 or the PTS-3 systems.

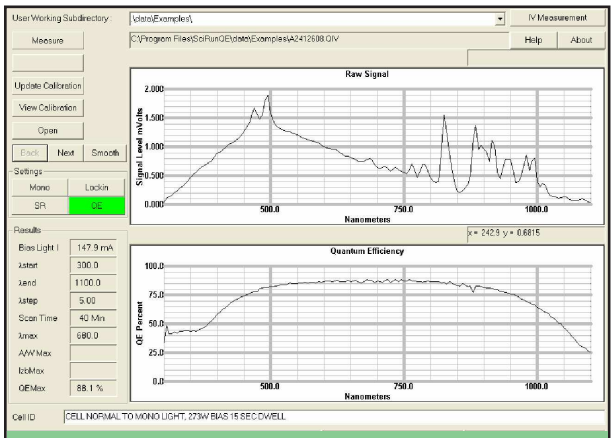
The ICPE method gives a good approximation of internal Quantum Efficiency and is included by default with all PTS-2 and higher systems. While true IQE will be more accurate, the ICPE is a powerful tool for solar cell characterization.

The PTS-3 allows the user the same ability to measure IV, SR, and QE as the PTS-1 and PTS-2 systems, but adds the powerful techniques of Constant Photocurrent Method (CPM, PTS-3-CPM), Dual Beam Photoconductivity Method (DBPM, PTS-3-DBPM), or Photothermal Deflection Spectroscopy (PDS, PTS-3-PDS).

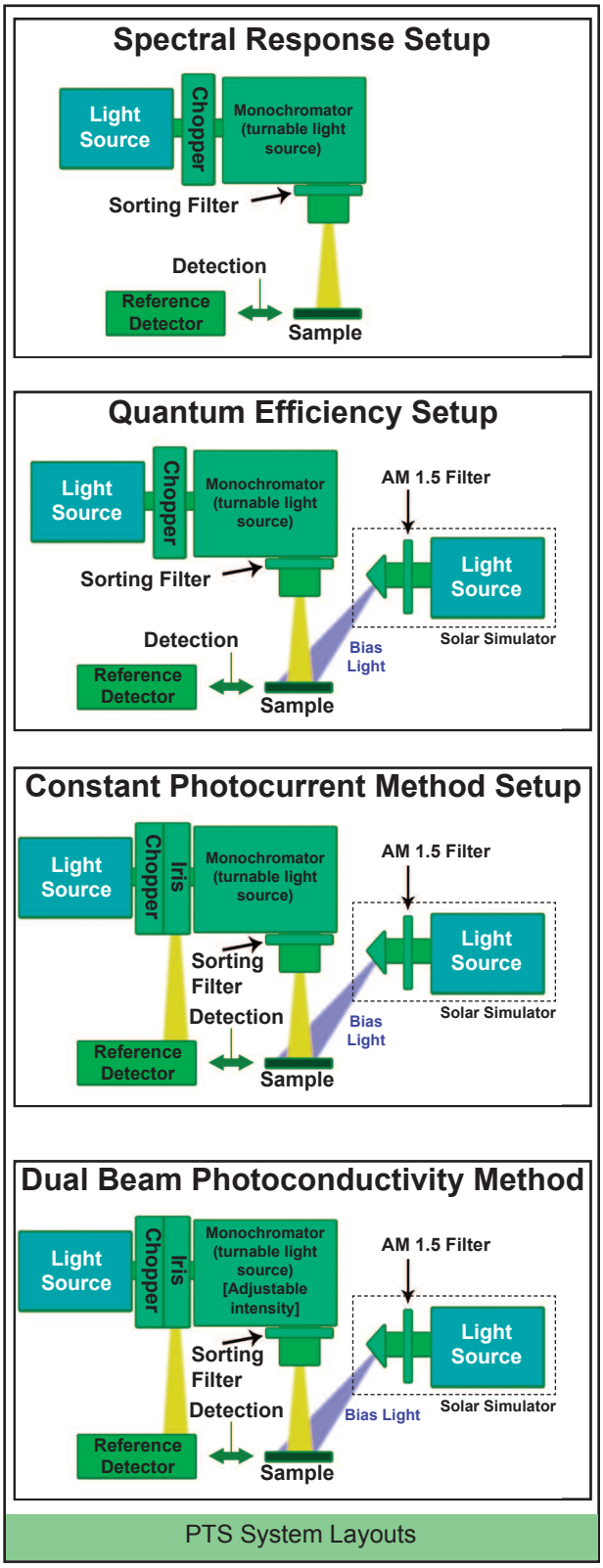
In the CPM technique, the photocurrent is maintained constant over the range of photon energy to get constant quasi-Fermi levels. Constant photocurrent implies that the steady state concentration and the lifetime of photogenerated electrons are constant, and thus the recombination mechanism is unchanged.

The CPM system illuminates the sample solar cell with a bias solar light source while a separate light source is modulated to cover a specific spectrum. The bias source ensures that the signal is not dominated by the non-linear response at low-level illumination of the cell, but rather gives a baseline response dependent on the wavelength of the modulated source (after the bias light signal is removed). This allows a highly precise measure of defect density of the cell, and as such gives researchers and manufacturers extremely sensitive information for their work.

The DBPM system is based on the same setup as CPM, but has additional capability to vary the bias light source intensity. This changes the electron and hole quasi-Fermi levels to yield additional information about defect states. While CPM measures bulk defect states below the dark Fermi level, DBPM can probe defects both below and above the Fermi level.



PTS Screenshot



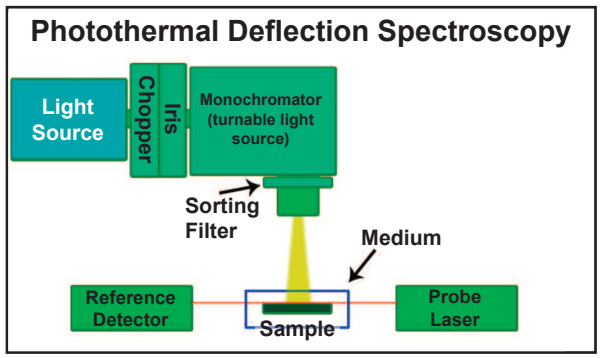
PTS System Layouts

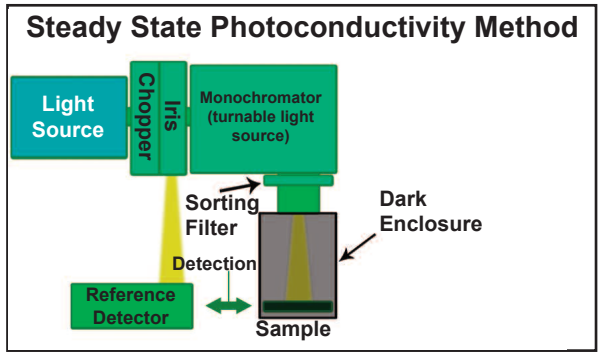
The PDS system can measure additional transitions not observed in photoconductivity measurements, since it is not dependent on the Fermi level position. This technique is sensitive to surface, interface and bulk states. The modulated, monochromatic light periodically heats the medium in which the sample is embedded. This in turn modulates the index of refraction near the film surface. The laser probe grazing the sample surface subsequently experiences a periodic deflection synchronized with the modulation of the intensity. The amplitude and phase of the deflection are measured and fed into a lock-in amplifier and thus, as the wavelength is varied, the deflection of the probe laser is a measure of the optical absorption spectrum of the sample.

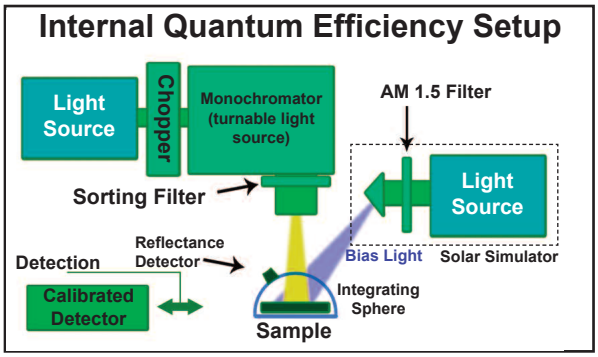
The PTS-3 comes with a fully integrated software package, capable of controlling every aspect of the system. Graphical and data output can be in a wide range of file types, and as Sciencetech may supply source code to customers that wish to further modify the system or integrate it into existing computer framework.

The PTS-4 provides the same capabilities of the PTS-1, PTS-2, and one of the PTS-3 systems for IV, SR, QE, and a choice of CPM, DBPM or PDS measurements, and adds the Steady State Photoconductivity (SSP) method. The steady state photoconductivity measurements give information about the nature of defects, mobility-lifetime products, and the transport and recombination kinetics of photogenerated carriers. Since the states between quasi-Fermi levels act predominantly as recombination centres, steady state photoconductivity is sensitive to both the density and the nature of these states.

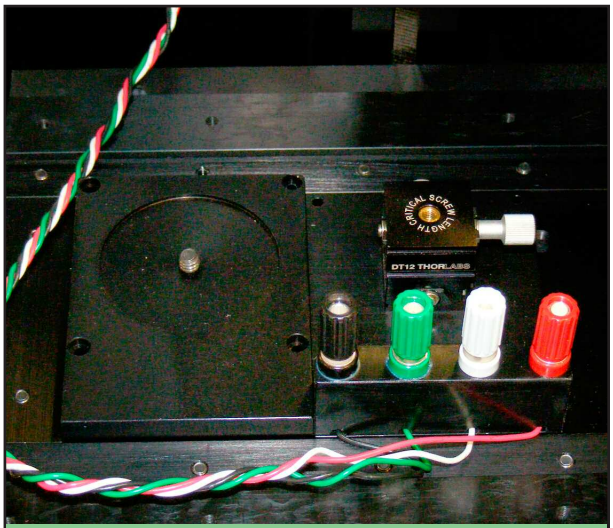
The addition of the SSP method to the PTS-3 requires an upgrade to the existing software, as well as several modifications to the measurement components of the existing system. The iris, used in the PTS-3, combined with the beam-splitter for intensity control, allows tighter manipulation of the flux values. A calibration photodiode is used to regulate the incident white light for the respective photon energies.







PTS System Layouts (Continued)



PTS Dual Chuck Target Table

Key Features

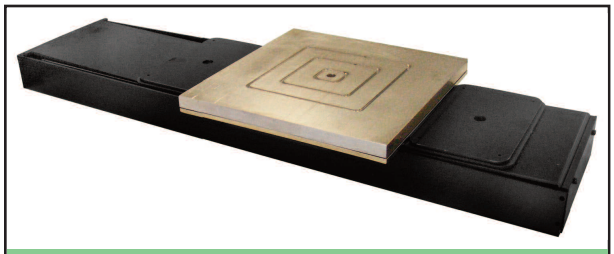
- Monochromator with automated order sorting filters
- Monochromatic probe light area adjustable from 2mm to 5mm diameter with an option to concentrate in a 1mm x 4mm rectangle for rectangular samples.
- Monochromatic probe light power of 125 mW total (white light).
- Low noise bias light source with 1.5G Air Mass filter is included for QE and I-V measurements.
- Complete SR, QE and I-V measurement system with software is included.
- Keithley 2400 Series Source meter
- Bias voltage range from 0 to 200 Volts.
- Calibrated Reference Detector
- (PTS-3 and up) Control of Iris and stabilization of photocurrent via lock-in amplifier.
- (PTS-3 and up) Illumination intensity (and therefore photocurrent) is maintained constant within 5% over a range of 10,000:1 absorption or conversion efficiency.
- (PTS-3 and up) Monitoring of illumination throughput of Iris with 18 bit resolution.
- Optical chopper and drive
- Stanford SR800 series lock-in amplifier
- Photocurrents measurable from 1 picoampere to 1 microampere.
- Automated switching of lock-in input signals from reference detector to sample current measurement.
- All components assembled on Sciencetech's integrated optical and electronic mounting system with a 45x90 cm desktop footprint, not including light tight sample enclosure.
- Sample enclosure with adjustable dual cell holder
- Target table with dual cell holder has 150 mm height adjustment.

Design Specifications	
Monochromatic Light Source	- 150 W Xe arc lamp or 200W QTH Tuneable sources (SR or QE) - 250W QTH Tuneable source (CPM) - < 0.5% Stability - Adjustable Spot Size - Full spectrum coverage 300-2500 nm
Bias Light	- 150W Ultra-stabilized Xe arc lamp <0.1% instability - Adjustable Spot Size - Low-power lamp greatly increases signal to noise ratio
Monochromator	- Motorized triple grating - 250 - 2500 nm range - Czerny-Turner design
Reference Detector	- 5mm diameter - Broadband pyroelectric - Calibrated
Data Acquisition	- Stanford Lock-in Amplifier - MS Windows based software
System Dimensions	- 36” x 20” x 22” - 91.5cm x 50.8cm x 55.9cm
Standards	- ASTM 927-05 standard for Photovoltaic cell testing - Will meet IEC and JIS standards on request

Solar Cell Chuck

Sciencetech's solar cell chucks are designed to be electrically isolated from all other sources to be low noise. Manufactured out of brass plated with tin, each solar cell chuck can be upgraded to copper with optional gold or nickel coating. The chuck has 4 standard sizes of vacuum grooves that can be regulated to hold the solar cell firmly to allow a variety of different sizes of cells to be tested.

The chuck plate consists of spring loaded gold pins to make the standard 4 wire IV test connection. One connection is in the center isolated from the plate to make the negative voltage measurement, the plate is the positive connection, one 3 axes arm consists of multiple spring loaded gold pins to take the current, and another 3 axis arm with a single gold pin to make the positive voltage measurement. Both arms are independently pneumatic controlled and pressure can be regulated to control the force the pin puts on the cell.

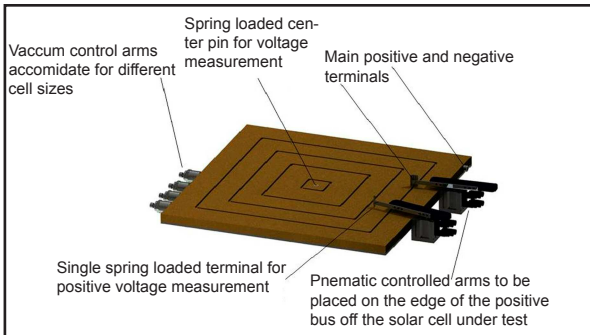


SCC4 Solar Cell Chuck (All Optional Features)

Version/Model	Description	Price
SCC4	Solar Cell Chuck	Starting at $9,900

Recommended Options

- Temperature and Control Device
- Water and TE Cooling
- Vacuum Pump
- Copper plate upgrade
- Gold to nickel coating
- Sample and reference cell switching mount
- X-Y movement mount



Solar Cell Chuck Diagram

Temperature Control and Vacuum Pumps for Solar Cell Chucks

Technical Specifications

(Temperature Control Device)

Cooling Capacity:
at 20°C - 250W

Power:
VAC 230 / 50Hz

Temperature Range and Stability:
From -10°C to 80°C Stability of ±0.1°C

(Vacuum and Pressure Pump)

Maximum Pressure:
60psi

Port Size:
1/4" NPT(F) 3/8" hose barb on gauges

Noise Level:
68 dB(A)

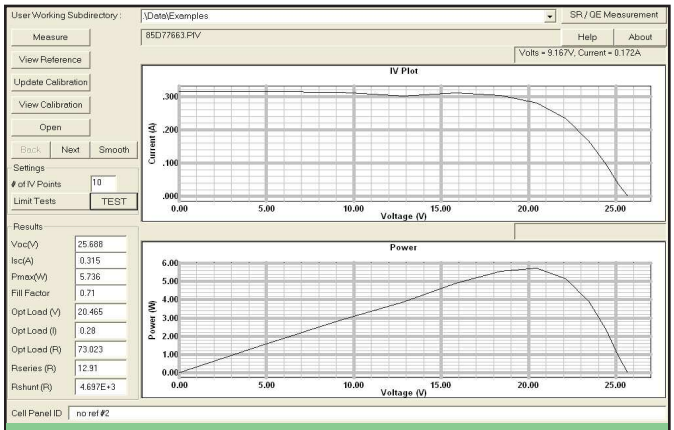
Maximum Temperature:
38°C (100°F)

Duty Cycle:
Continuous

Temperature Control Device (left)
Vacuum and Pressure Pump (right)

Version/Model	Description	Price
TC-2000	Temperature Control Device	$3,900
VP-600	Vacuum and Pressure Pump	$800

Current-Voltage Measurement System (IV Tester)



IV Tester Software Screenshot

2400 Keithley Source Meter (IV Tester Hardware)

The Sciencetech Model SSIVT is an electrical current-voltage measurement system used to characterize photovoltaic cell performance. This "IV Tester" works by setting the voltage and measuring the current while keeping the light source constant. The integrated software is used to operate the flash system, measures the reference cell and temperature during IV measurements, generates and operates the solar cell IV measurement procedure and allows the customer calibration of a reference cell. It allows the tester to create either a multiple sequential pulses (typically 10~100 points selectable) or a single continuous measurement to complete the IV curve. Universal input 100V~240VAC, 50/60Hz.

SCISPIV.exe is the primary module to other components, SCIRUNIV, provide screen output for monitoring I-V operations, available separately or bundled with SCISPIV.

These interface and control programs are designed for operation with Keithley 2400 series source meters. Software for the SSIVT measurement system can also be purchased separately.

Key Features

- Does not require Windows operating system
- Has its own user interface (HAL)
- Requires RS-232 port (COMM 1-4)
- Software runs in the background during testing
- Remotely operates flash systems
- Measure the reference cell and temperature during I-V measurements
- Generates and operates the I-V measurement procedure
- Allows customer calibration of a reference cell
- Collects and writes data to files readable by the interface programs
- Designed for use with continuous or flash solar simulators

Technical Specifications

20W Continuous Model Range:
20W / 20V / 1A

60W Continuous Model Range:
60W / 60V / 3A

1kW Flash Range Model (Flash Systems Only):
1kW / 100V / 10A

Data Storage Capabilities:
Saves each IV curve dataset in separate ASCII text files

Sample Limitations:
Several sample points are selectable at once

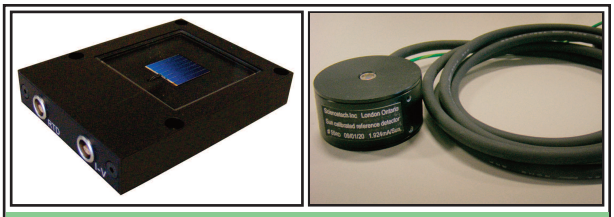
Parameters Measured by IV Software:
V_{oc}, I_{sc}, V_{max}, I_{max}, P_{max}, V_{oc} slope, R_p, FF

Reference Cells and Detectors

The calibrated reference cell consists of a 20 x 20 mm monocrystalline silicon photovoltaic cell encased in a 92 x 70 x 16 mm metal enclosure with a protective quartz window and a temperature sensor. The temperature sensor is a 100 ohm platinum Resistance Temperature Detector (RTD). The calibrated solar reference cells includes a certificate of calibration, compatible set of connecting cables, and is certified in the following parameters:Isc, Imax, Voc, Vmax, Pmax, Area, Fill Factor and Efficiency.

The certification is accredited by NIST to the ISO-17025 standard and is traceable both to the National Renewable Energy Laboratory (NREL), and to the International System of Units (SI). A compatible cable set is also supplied with each Solar Reference Cell.

The reference detector is effective in sensing wavelengths between 190 nm and 1100 nm and is calibrated with the sun. However, the reference detector does not include a temperature sensor.



Calibrated Reference Cell (left)
SSIVT Reference Detector (right)

Load Meters

With characteristics quite different from the line of Keithley source meters, Sciencetech offers a series of load meters that address the need for testing higher currents and voltage cells or panels while also collecting data much faster than the typical single point per flash. Simultaniously measuring both I-V curve generation in a single flash.

Intended mainly for use in pulsed load requirements where the full voltage and current ratings may be used simultaniously instead of being limited to either maximum voltage OR maximum current like existing sourcemeters, the loadmeters may also be operated in continuous mode at levels far higher than competing sourcemeters. A subset of the control command set is recognized, making these loadmeters 100% compatible with Sciencetech's existing IV software.

Sciencetech loadmeters come in three general voltage classifications which are internally expandable as per the following table:

Low Voltage	Rated 32 Volts, Capable 48 Volts @ Zero Amps	
Single Module	8 Amps pulse (256W)	1 Amps continuous (32W)
Dual Module	16 Amps pulse (512W)	2 Amps continuous (64W)
Quad Module	32 Amps pulse (1024W)	4 Amps continuous (128W)
Full Box	64 Amps pulse (2048W)	8 Amps continuous (256W)
Medium Voltage	**Rated 128 Volts, Capable 192 Volts @ Zero Amps**	
Single Module	2 Amps pulse (256W)	0.25 Amps continuous (32W)
Dual Module	4 Amps pulse (512W)	0.5 Amps continuous (64W)
Quad Module	8 Amps pulse (1024W)	1 Amps continuous (128W)
Full Box	16 Amps pulse (2048W)	2 Amps continuous (256W)
High Voltage	**Rated 512 Volts, Capable 768 Volts @ Zero Amps**	
Single Module	0.5 Amps pulse (256W)	0.0625 Amps continuous (32W)
Dual Module	1 Amps pulse (512W)	0.125 Amps continuous (64W)
Quad Module	2 Amps pulse (1024W)	0.25 Amps continuous (128W)
Full Box	4 Amps pulse (2048W)	0.5 Amps continuous (256W)

Air Mass Filters

Air Mass filters are designed to imitate solar conditions for a variety of solar angles and atmospheric depths. The spectrum of solar radiation is expressed in different ways, depending on the location of measurement. Total ground radiation is called global radiation. The direction of the target surface must be defined for global irradiance. The target surface faces the incoming beam for direct radiation.

The ASTM E927-05 standards cover the wavelength range between 400-1100nm. According to these standards the spectral match must be within 0.75 - 1.25 for each interval of the spectrum which is divided in increments of 100nm between 400-1100nm. For Sciencetech AM0 filter these standards are applicable in the wavelength range from 300-1400nm. Accuracy in the UV spectrum is not mandated by the standards.

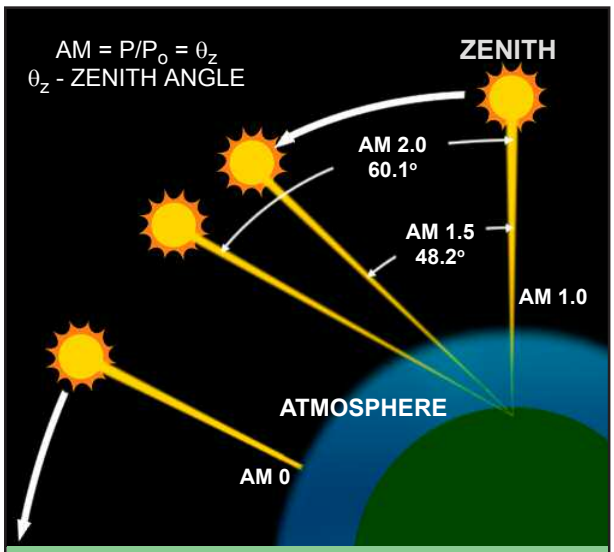
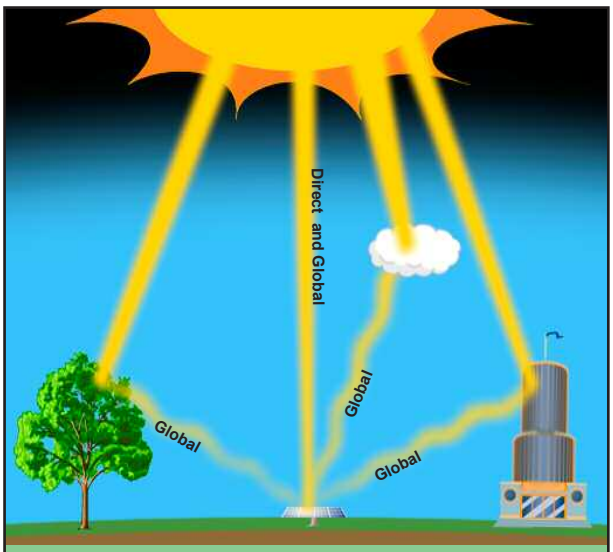


Diagram for Direct Solar Air Masses



Comparing Direct and Global Sunlight

The following removable filters are available; they are inserted into the filter holder inside the beam conditioner through the access panel to simulate various light conditions on earth and in space. Sciencetech also offers a line of extended range filters to extend the working region to 1800nm.

Speciality Filters

UV Blocking Filter

This 3 x 3" filter eliminates over 99% of all UV wavelengths below 400nm, but allows Visible and IR light (up to 2000nm) through. Its transmission efficiency in the Visible range is 85%.

This filter can be purchased with the correct mounting frame for use in Sciencetech SF150, SS150 and SS (500,1K,1.6K) solar simulators as well as inside the 3" filter holder.

IR Absorbing Water Filter

IR absorbing water filters protect downstream optical components from IR thermal damage by absorbing all infrared light between 1000-3000nm. When filled with distilled water, it absorbs nearly 100% of all IR light in this spectral range while allowing approximately 98% of all visible light between 350-700nm through. It also absorbs little UV light between 200-350nm as 80% of all UV light is transmitted through. All Sciencetech IR absorbing water filter models have a re-circulated water jacket to cool the filter itself making it excellent for high power applications. Sciencetech offers IR filters in both aluminum and stainless steel models. Aluminum filters are used with only distilled water: stainless steel filters are used when the absorbing media is water, copper sulfate or nickel sulfate.

Band Pass UVA+B Filter

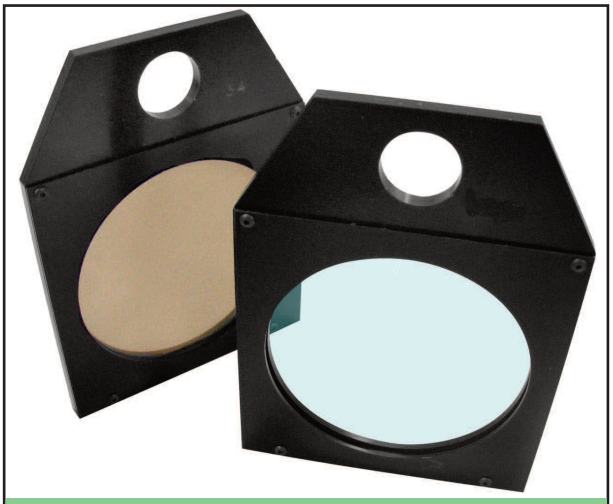
Only the 290-400nm UVA and UVB portion of the ultraviolet spectrum is required for SPF (Sun Protection Factor) sun screen testing. Isolating UVA+B rays is achieved by using a UVC blocking filter in series with a visible and infrared blocking filter. These two filters eliminate all other wavelengths.

This is the industry's accepted method (COLIPA compliant) for isolating UVA+B wavelengths in SPF sun screen testing. Sciencetech's Band Pass UVA+B Filter is essentially these two filters arranged in series.

The cost includes the 3" frames for use with Sciencetech SS series fully reflective solar simulators or 1" frames for use with the Sciencetech SF-150 solar simulator.

Hot Mirror for UV applications (3" x 3")

This 76x76mm (3 x 3") hot mirror filters out IR light to remove thermal heat on the target. However, standard hot mirrors also remove UV light as a side-effect which means it cannot be used in UV applications. This special hot mirror removes IR light between 730-1100nm while preserving UVA and UVB light (280-400nm) in addition to visible light. This filter is ideal for Sciencetech UV solar simulators where the filtering of thermal heat on the target is desired and preservation of UVA and UVB light is required.



A UV Blocking and Band Pass filter from Sciencetech

Broadband Thermopile Detectors

These broadband thermopile detectors measure the total broadband radiation emitted by a light source and light power density on a surface (in W/cm^2) which is particularly useful for power measurements and checking solar simulator performance.

Both UP19K detectors have a 19mm diameter sensor and is sensitive to all wavelengths between 190nm-10µm (UV-VIS-IR). The 30W model has a heat sink so that it can tolerate a higher power output. The XLP detector features a smaller sensor diameter, however the detector has a higher sensitivity to lower power readings and is capable of picking up up all wavelengths between 190nm-20µm (UV-VIS-IR) giving it a wider range than its UP19K counterpart.

Each detector head comes with a NIST calibration certificate that states that broadband power readings are accurate to NIST standards. This certification is performed on each individual detector unit and hence each unit has a unique parameter value on the certificate that relates its output voltage (in mV) to the actual power measured (in W).

Each detector will require either an external display controller or computer interface to visualize the detector's measurements. Sciencetech offers pre-programmed PC interfaces with USB and RS-232 options available with software that shows total broadband power (W) and power density (W/cm^2).

Broadband Thermopile Detectors available from Sciencetech

Detector Power Monitors

Sciencetech offers two handheld power meters for use with our broadband thermopile detectors, which can automatically recognize the detector head and ensures accurate auto-calibration.

The UNO model provides power measurement in W or dBm. The Maestro Power & Energy Meter has many more features and will do more, in less time, and with less effort than any other meter on the market. With an extra-large 5.6" color LCD display, fully touch screen controls, a completely revised user interface and faster electronics, easy to navigate interface and with many display features including:

- Single or Dual Graph Display
- Instant access to the main functions
- Function Search tool
- USB Key Access
- Real-Time Statistical Functions: Max, Min, Average, Standard Deviation, RMS and more.

Uno Power Monitor (left)
Maestro Power Monitor (right)

Alignment Kit

Sciencetech's solar simulator alignment kit is compatible with all of Sciencetech's solar simulators and allows the user to align their simulator to their own specifications at any given time.

Included in the kit is a 1 SUN calibrated alignment silicon detector, laser and holder, UV protection glasses, and a Sciencetech multimeter.

Contents of the Alignment Kit

Light Intensity Stabilizer

A microprocessor based, stand alone unit, the Light Intensity Stabilizer is able to monitor the light intensity of any Sciencetech solar simulator by correcting intensity fluctuations caused by a change in environmental or power conditions by automatically adjusting the power supply output in real time to maintain the same light intensity level.

Both easy to install and operate, it comes with a light sensor, coupled to the light source with a fiber optic cable for electrical isolation. The optical feedback unit also uses relative intensity comparison to maintain light levels.

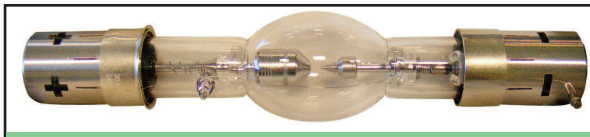
Output Fiber Bundle Attachments

Sciencetech offers a wide variety of fiber bundles for your scientific needs. For more information or for pricing on specific fibers, contact us at:
sales@sciencetech-inc.com

Replacement QTH and Xenon Arc Lamps

QTH bulbs generally have two different types depending on your scientific requirements; 'long life' bulbs last much longer than their counterparts, however the 'high intensity' bulbs are able to draw more power at once, sacrificing part of the bulb's life span.

A xenon arc lamp has an average hour life of 1,500 hours for a 150W bulb and up to 2,000 hours for 0.5 to 2.5 kW bulbs before burning out, requiring replacement of the bulb from time to time.



1 kW Xenon Arc Lamp

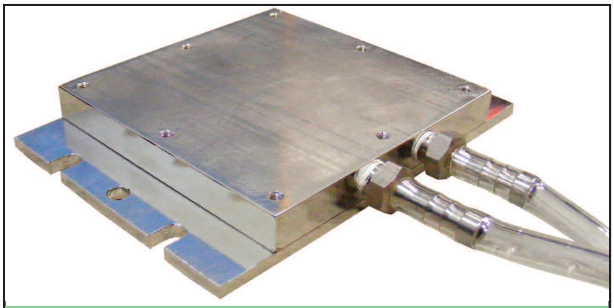
Water Recirculating Cooler and Sample Cooling Pad

This adjustable temperature cooler is designed to keep a sample from overheating under intense light by placing a water cooling pad underneath it. This water cooling pad not only cools the sample to ambient room temperature, but also monitors its exact temperature.

This cooling system is an external unit designed to dissipate up to 700W of heat through a fan cooled radiator system, which is enough to cool samples illuminated by 1600W solar simulators. The cooler displays the sample's current temperature in either celsius or Fahrenheit. The temperature of the sample can be adjusted by setting the cooler's internal radiator fan speed which is also displayed on the cooler.

If the current temperature wanders above a "warning" preset value, an alarm will go off. The cooling pad temperature is monitored by a thermo sensor wire which can be embedded between the cooling pad and the sample itself.

130-REC-STD Water Recirculating Cooler

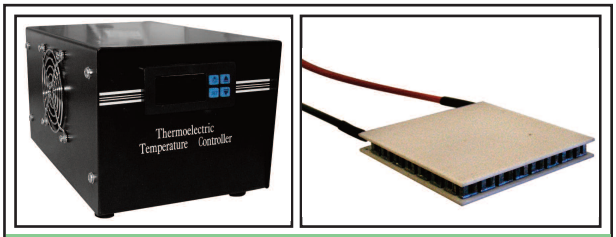


Flat Cooling Pad

Thermoelectric Temperature Controller for a PV Cell Holder Assembly

For an accurate thermoelectric temperature reading and control, Sciencetech's Temperature Controller Assembly is a low cost, high power unit with an excellent temperature stabilty range (±0.1°C).

With a PWM control and a 1kOhm RTD sensor the module's power output is also adjustable at output voltages of 3, 7, 12 and 14V with a maximum current of 10A. In addition, a temperature range of 0°C to 100°C and terms adjustable to read proportional, integral and derivative data are also standard features of Sciencetech's model.



Thermoelectric Temperature Control Unit (left)
Thermoelectric Cell (right)

Step-Up Voltage Transformer

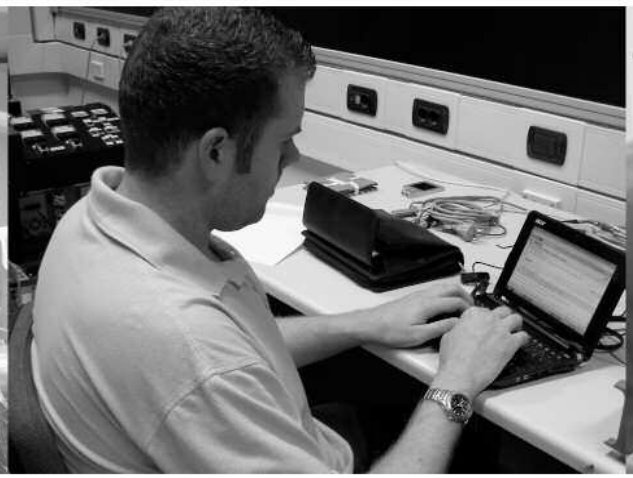
Sciencetech 1000W, 1600W arc lamp sources and solar simulators require 230-240VAC electrical service.

If your lab does not have a 240VAC electrical outlet as in many North American laboratories, you can use a 120VAC-240VAC step-up voltage transformer to power 240VAC devices with a 120VAC electrical outlet.

This step-up transformer will require a 30 Amp 120VAC circuit.

Manufacturing Capabilities

Solar Simulation Equipment
Spectrophotometry
Fluoresence Spectroscopy
Fourier Transform Interferometry
Time Resolved Spectroscopy
Infrared Spectroscopy
Raman Spectroscopy Radiometry
Original Equipment Manufacturing



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