

# TS-Space Systems

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## CLOSE MATCH SOLAR SIMULATORS: UNISIM RANGE



TS-Space Systems, Unit A5, Rose Business Estate, Marlow Bottom  
BUCKS, SL7 3ND  
Tel: (+44)1628 474040  
Fax: (+44)1628 488485  
Email: [info@ts-space.co.uk](mailto:info@ts-space.co.uk)

- **Unisim Range: Overview**

TS-Space Systems is the world leader in close-match solar simulators and has been for over 20 years.

In the field of photovoltaic research many of our customers have found other 'Class A' solar simulators to be a very poor approximation of the sunlight spectrum.

This is due to other solar simulators using very crude filters and light sources in order to achieve the 'Class A' specification for solar simulation.

Over the past five years or so, we have been pioneering the use of metal halide lamps for solar simulators intended for photovoltaic measurements. There are a number of advantages in using these lamps, in that they:

- provide high output
- are relatively cheap
- require only air cooling
- allow rapid lamp changes
- (most importantly) provide high stability

We have identified the need for competitively priced, close match solar simulators for general use in small research laboratories. By designing for smaller target areas than those offered by our bespoke simulators, and taking advantage of the relative cheapness of metal halide luminaires, we have found that we can meet the above remit and are, therefore, launching a standard range for the first time.

- Unisim Range Specifications

	Simulated Spectrum	Number of Zones	Spectral Match (ASTM/IEC/JIS)	Temporal Stability (ASTM/IEC/JIS)	Spatial Uniformity (ASTM/IEC/JIS)	Collimation (half-angle)	Illumination (diameter)
<b>Unisim 60 AMO</b>	Am0	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.15%)	A/A/A (+/- 2%)	2-3°	60mm
<b>Unisim 60 Am1.5</b>	AM1, AM2, AM1.5, and AMO	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.15%)	A/A/A (+/- 2%)	2-3°	60mm
<b>Unisim 100 AMO</b>	AMO	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.2%)	A/A/a (+/- 2%)	2-3°	100mm
<b>Unisim 100 AM1.5</b>	AM1, AM2, AM1.5, and AMO	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.2%)	A/A/A (+/- 2%)	2-3°	100mm
<b>Unisim 300 AMO</b>	AMO	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.6%)	A/A/A (+/- 2%)	2-3°	300mm
<b>Unisim 300 AM1.5</b>	AM1, AM2, AM1.5, and AMO	2,3 or 4	A/A/A (CLOSE MATCH)	A/A/A (+/- 0.6%)	A/A/A (+/- 2%)	2-3°	300mm



\*N.B. Custom solar simulators based on this technology are also available and consist of the core specification of our Metal Halide Standard range along with Boost zones (for saturating various junctions)

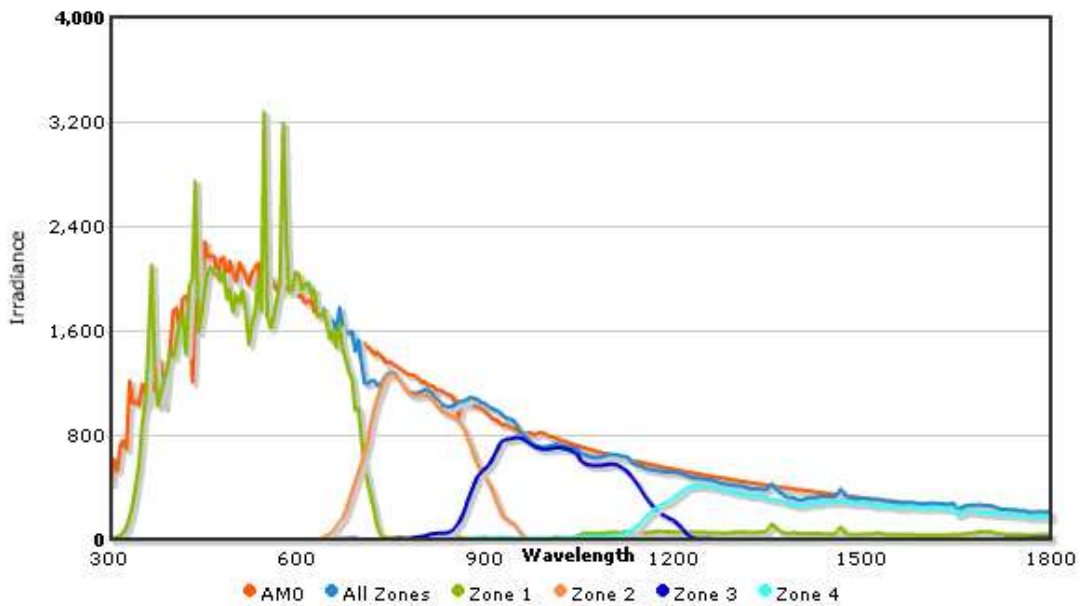
### Multi-zone Spectral Control

TS-Space systems has pioneered the use of metal halide sources for testing solar cells. Using the latest HMI and halogen luminaire technology, the Unisim solar simulator provides a highly stable area of illumination. The simulators also use cutting edge filter technology in order to provide the best spectral match available for AMO and AM1.5. Further to this, the spectrum can be achieved via two, three or four separate spectral wavebands which allows a high degree of spectral control for research and development.

TS-Space Systems is the first and only company to pioneer the use of metal halide sources in solar simulators for photovoltaic testing. The high temporal stability and close spectral match combined with the ability to control the output spectrum via four separate wavebands means the Unisim solar simulator is the only PV research tool designed for the new generation of four junction devices.

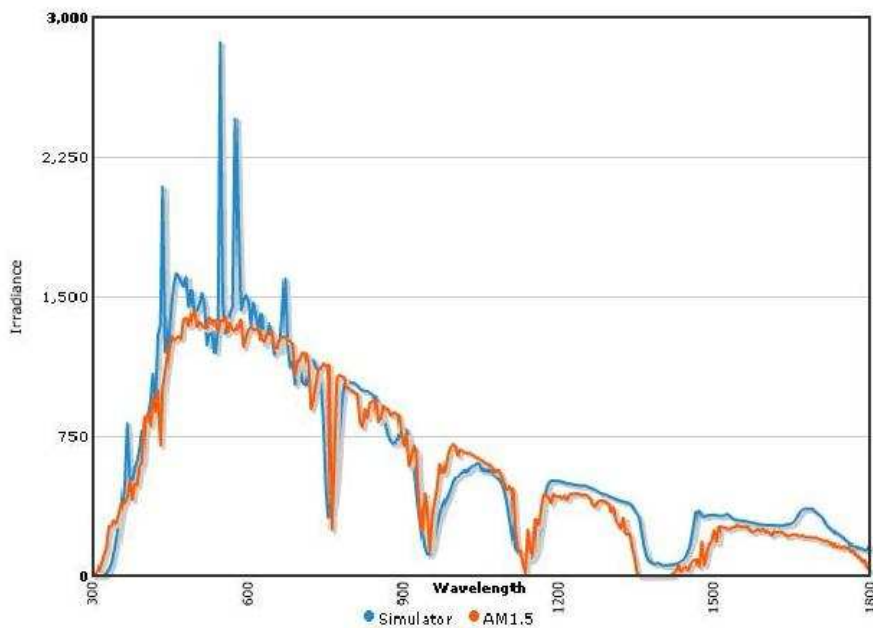
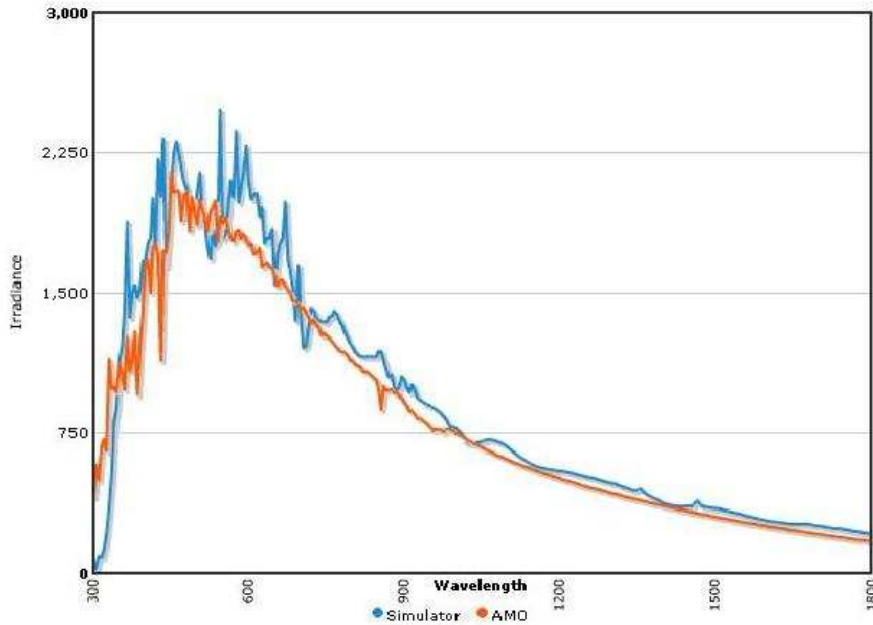
Two and three zone models are also available. Please contact us and we will be happy to help specify your requirements.

**TS-Space Systems 4 Zone Metal Halide Simulator  
Demonstration of Zonal Spectral Control**



- Spectral Match

TS-Space Systems is proud to be the only company in the world to design and build solar simulators of such high quality in spectral match, spatial uniformity and temporal stability.



	required % distribution	TS-Space Systems Unisim Solar Simulator	% distribution	Class Rating	Class A Upper Limit	Class A Lower Limit
400-500	18.4	196053.23	19.58119701	19.58119701	23	13.8
500-600	19.9	197272.76	19.70299993	19.70299993	24.875	14.925
600-700	18.4	191569.52	19.13337777	19.13337777	23	13.8
700-800	14.9	138657.41	13.84867804	13.84867804	18.625	11.175
800-900	12.5	111137.74	11.10009757	11.10009757	15.625	9.375
900-1100	15.9	166541.43	16.63364868	16.63364868	19.875	11.925

- Temporal Stability

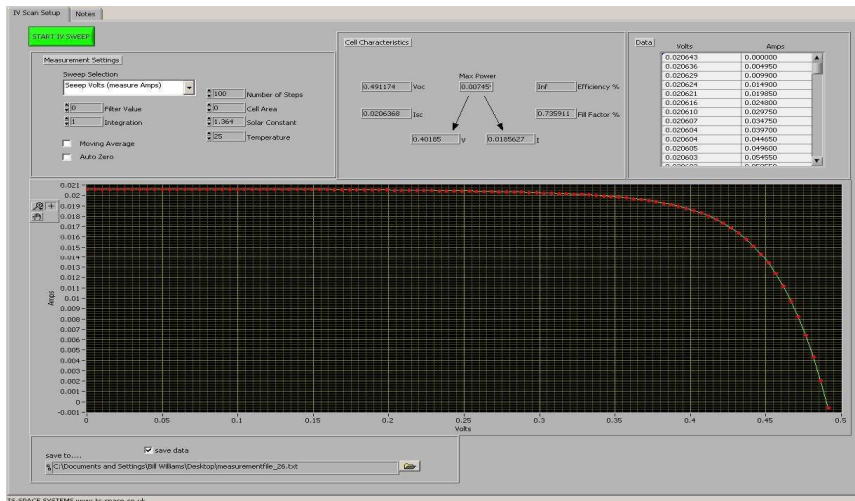
Our method of defining temporal stability is to take a number of IU readings in quick succession, and to look at the reproducibility of the various parameters. Below is shown the typical IU curve achieved with these simulators.

- All readings taken on a Keithley 2420

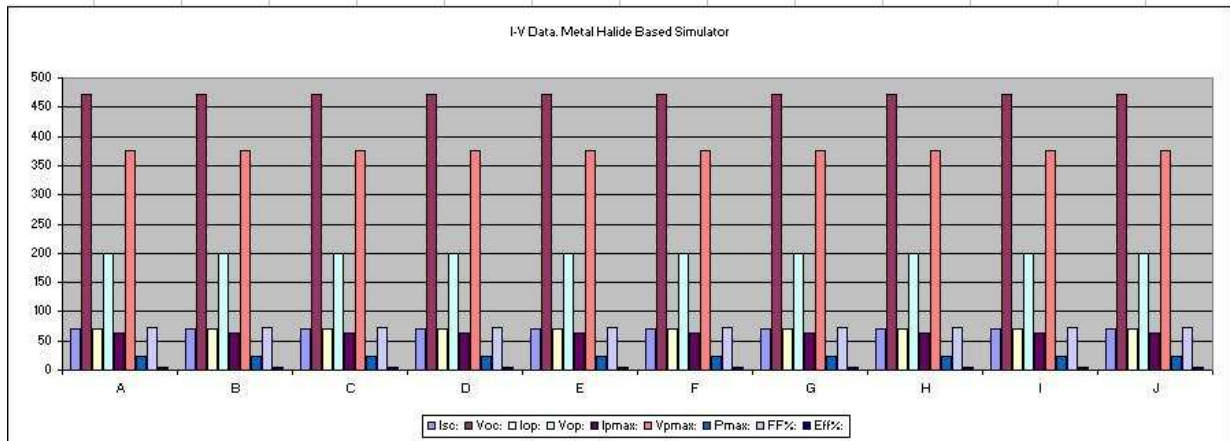
- Integration time 20msec

- Filter 0

- Time for a 100 point plot is a few seconds (with integration reduced to 0.2msec, a 100 point IU sweep will take **1.6 seconds**)



Test	A	B	C	D	E	F	G	H	I	J	Mean	%Min	%Max
Isc:	69.9	69.88	69.86	69.86	69.81	69.9	69.74	69.73	69.88	69.83	69.839	0.15	0.15
Voc:	471.3	471.17	471.3	471.35	471.67	471.59	471.78	471.78	471.8	471.6	471.515	0.073	0.056
Iop:	69.8	69.72	69.7	69.71	69.67	69.71	69.63	69.6	69.71	69.66	69.691	0.13	0.04
Vop:	200	200	200	200	200	200	200	200	200	200	200	0	0
Ipmax:	64.25	64.24	64.28	64.24	64.32	64.23	64.24	64.28	64.26	64.3	64.264	0.037	0.087
Vpmax:	376	376	376	376	376	376	376	376	376	376	376	0	0
Pmax:	24.16	24.15	24.17	24.15	24.18	24.15	24.15	24.17	24.16	24.18	24.162	0.05	0.07
FF%:	73.33	73.36	73.4	73.35	73.44	73.27	73.44	73.47	73.28	73.42	73.376	0.14	0.13
Eff%:	4.46	4.46	4.47	4.46	4.47	4.46	4.46	4.47	4.46	4.47	4.464	0.09	0.1



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