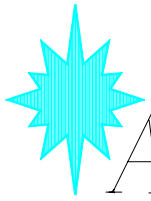
SCIENTECH®



Astral **SERIES**
CALORIMETERS

Setup and Operating Procedures

PN9458P

Thank you for choosing a Scientech Astral calorimeter. Scientech, an ISO 9001 registered company, and our employees are pleased to provide you with a product designed for years of reliable service. Please read this manual completely before using your indicator. This information will enable you to fully utilize the equipment and should be located nearby for reference. The calorimeter is intended to be used only in the manner outlined in this manual. Misuse of the equipment may cause product failure.

The words "calorimeter" and "detector" are synonymous as used in this manual.

Table of Contents:

CALORIMETER OPERATING PARAMETERS:

Calorimeter 1:		Calorimeter 2:	
Model No:	_____	Model No:	_____
Serial No:	_____	Serial No:	_____
Calibration Wavelength	_____nm	Calibration Wavelength:	_____nm
Output Sensitivity (S):	_____V/W	Output Sensitivity (S):	_____V/W
Time Constant (1/e):	_____sec.	Time Constant (1/e):	_____sec.
Calibration Temp:	_____°C	Calibration Temp:	_____°C
Sub. Heater Resistance (R_c):	_____ohms	Sub. Heater Resistance (R_c):	_____ohms
Sub. Heater Voltage (V_h):	_____volts	Sub. Heater Voltage (V_h):	_____volts
Sub. Heater Wattage (W_h)	_____watts	Sub. Heater Wattage (W_h):	_____watts

ASTRAL™ CALORIMETER SPECIFICATIONS:

Model	**AC2500**	**AC25HD**	**ACX25HD**	**AC2501**	**ACX2501**	**AC25UV**	**AC2504**
Type of Absorber	Surface	Surface	Surface	Volume	Volume	Volume	Volume
Aperture Diameter	25.4 mm	25.4 mm	8 mm	25.4 mm	8 mm	25.4 mm	25.4 mm
Spectral Response	.25-35 µm	.193-12 µm	.4-2 µm	.266-1.2 µm	.4-1.2 µm	.193-.36 µm	.85-4.2 µm
Average Power Maximum	10 W						
Average Power Minimum	1 mW when installed in an Isoperibol Enclosure						
Noise Level	10 µW or µJ						
Maximum Power Density	200 W/cm²	1.5 kW/cm²	12 kW/cm²	Note 1	Note 2	Note 3	Note 4
Maximum Peak Power Density	1 MW/cm²	100 MW/cm²	800 MW/cm²	Note 5	8.5 GW/cm²	Note 6	Note 7
Maximum Single Pulse Energy	10 J						
Maximum Energy Density	Note 8	Note 9	Note 10	Note 11	Note 12	Note 13	Note 14
Precision	< 1 %						
Accuracy	± 3 %						
Response Time	3 sec when connected to a Scientech Indicator in Watts Mode						
Dimensions DxL - inches	3.75 x 2.2	3.75 x 2.2	3.75 x 3.82	3.75 x 2.2	3.75 x 3.82	3.75 x 2.2	3.75 x 2.2
cm	9.53 x 5.6	9.53 x 5.6	9.53 x 9.7	9.53 x 5.6	9.53 x 9.7	9.53 x 5.6	9.53 x 5.6
Weight - pounds/kg	1.5/0.68	1.5/0.68	1.7/0.77	1.5/0.68	1.7/0.77	1.5/0.68	1.5/0.68
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200C						

Model	**AC5000**	**AC50HD**	**ACX50HD**	**AC5001**	**ACX5001**	**AC50UV**	**AC5004**
Type Absorber	Surface	Surface	Surface	Volume	Volume	Volume	Volume
Aperture Diameter	50.8 mm	50.8 mm	16 mm	50.8 mm	16 mm	50.8 mm	50.8 mm
Spectral Response	.25-35 µm	.193-12 µm	.4-2 µm	.266-1.2 µm	.4-1.2 µm	.193-.36 µm	.85-4.2 µm
Average Power Maximum	30 W						
Average Power Minimum	40 mW						
Noise Level	400 µW or µJ						
Maximum Power Density	200 W/cm²	1.5 kW/cm²	12 kW/cm²	Note 1	Note 2	Note 3	Note 4
Maximum Peak Power Density	1 MW/cm²	100 MW/cm²	800 MW/cm²	Note 5	8.5 GW/cm²	Note 6	Note 7
Maximum Single Pulse Energy	30 J						
Maximum Energy Density	Note 8	Note 9	Note 10	Note 11	Note 12	Note 13	Note 14
Precision	< 1 %						
Accuracy	± 3 %						
Response Time	3 sec when connected to a Scientech Indicator in Watts Mode						
Dimensions DxL - inches	4.75 x 2.3	4.75 x 2.3	4.75 x 3.92	4.75 x 2.3	4.75 x 3.92	4.75 x 2.3	4.75 x 2.3
cm	12.07 x 5.8	12.07 x 5.8	12.07 x 9.96	12.07 x 5.8	12.07 x 9.96	12.07 x 5.8	12.07 x 5.8
Weight pounds/kgs	2.9/1.3	2.9/1.3	3.1/1.4	2.9/1.3	3.1/1.4	2.9/1.3	2.9/1.3
Indicator Compatibility	H410, H410D, S310, S310D, D200PC, D200C						

Note 1: AC2501, AC5001 — 30W/cm^2 @ 1064nm, 23W/cm^2 @ 532nm, 8.5W/cm^2 @ 355nm, 175mW/cm^2 @ 266nm

Note 2: ACX2501, ACX5001 — Note 1 specs x 8 for 400nm to 1.2µm

Note 3: AC25UV, AC50UV — 50W/cm^2 @ 355nm

Note 4: AC2504, AC5004 — 35W/cm^2 @1064nm

Note 5: AC2501, AC5001 — 100GW/cm^2 @ 1064nm, 78GW/cm^2 @532nm, 29GW/cm^2 @ 355nm, 580MW/cm^2 @266nm

Note 6: AC25UV, AC50UV — Repetitive pulses: 101MW/cm^2 @ 355nm
Single pulses: 3.5GW/cm2 @ 355nm

Note 7: AC2504, AC5004 — 125GW/cm^2 @ 1064nm

Note 8: AC2500, AC5000 — Max J/cm^2 = 1,000 x (pulse width)$^{1/2}$ to a maximum of 200J/cm^2.

Note 9: AC25HD, AC50HD — Max J/cm^2 = 4,500 x (pulse width)$^{1/2}$ to a maximum of 14J/cm^2.

Note 10: ACX25HD, ACX50HD — Max J/cm^2 = 36,000 x (pulse width)$^{1/2}$ to a maximum of 42.5J/cm^2.

Note 11: AC2501, AC5001 — Repetitive pulses: 4.1J/cm^2@1064nm, 3.2J/cm^2@532nm, 1.2J/cm^2@355nm, 24mJ/cm^2@266nm
Single pulses: 8J/cm^2@1064nm, 6.2J/cm^2@532nm, 2.3J/cm^2@355nm, 46mJ/cm^2@266nm

Note 12: ACX2501, ACX5001 — Note 11 specs x 8 for 400nm to 1.2µm

Note 13: AC25UV, AC50UV — Repetitive pulses: 1.1J/cm^2 @ 355nm
Single pulses: 40J/cm2 @ 355nm

Note 14: AC2504, AC5004 — Repetitive pulses: 4.8J/cm^2 @ 1064nm
Single pulses: 10J/cm2 @ 1064nm

ABSORPTION OF HD ABSORBING MATERIAL:

Warning: You must exercise caution when using HD detectors. They exhibit spectral reflection of between 7% and 18%, of the input power, back out of the aperture. Please refer to Figure 1 to determine the reflectance for the wavelength you are measuring. These detectors should be treated as a partial mirror or any other type of reflective optic and the appropriate caution level observed, especially at the CO_2 wavelength.

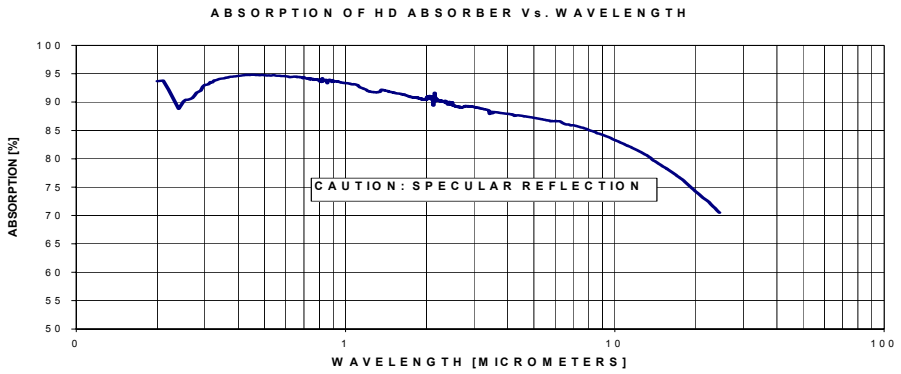


Figure 1

Note: HD calorimeters might show "beam" marks on the absorbing surface. These marks are characteristic of the material and do not affect the performance of the calorimeter. Do not rub off or remove the marks. Polishing or cleaning the absorbing surface might change the performance of the calorimeter.

Please see the table at the end of this manual for specific absorption vs. wavelength information.

CE MARK CERTIFICATION:

All of the calorimeters listed in this manual have been certified for the European CE mark.

ENVIRONMENTAL REQUIREMENTS:

This product is intended for indoor use at altitudes up to 2000 meters, Pollution Degree 2 in accordance with IEC 664 and transient overvoltages according to Installation Categories (Overvoltage Categories) II. Note that each of the above detectors will not pass the IEC 801 Publication, Part 3, Radiated Electromagnetic Field Requirements. The system, meter and detector, is designed to measure radiation within the test's radiation band. The detectors were held outside the radiated electromagnetic field during this test. It is up to the user to be aware of RF fields present during measurements and their effects if any on those measurements.

UNPACKING AND SET UP:

The calorimeter and accessories are shipped in custom packing materials. All packing materials should be saved for future damage free shipments.

A ½" diameter mounting post is included. Screw the post into one of the mounting holes in the body of the calorimeter. Mount the post to your optical bench or working surface. An optional mounting base, Scientech Model 301-019, is available for this purpose.

A 3 meter mini DIN interconnect cable is also included. If you are using a Scientech indicator, connect the calorimeter to the indicator with the interconnect cable. Follow the detailed set up instructions that are in the indicator's instruction manual. If you are not using a Scientech indicator operating requirements are contained in this manual.

Note: Astral calorimeters are sensitive to all types of thermal input. Due to the handling of the calorimeter during setup and possible environmental temperature differences, thermal gradients may exist in the calorimeter. Allow the calorimeter to sit undisturbed for several minutes to, reach thermal equilibrium, before using.

Note: When using a 25mm Astral calorimeter for measuring average power levels below 30mW and single pulse energy levels below 30mJ, a Scientech Model 36-0203A, Isoperibol Enclosure, is highly recommended. The isoperibol enclosure should not be used at average power levels above 30mW, and single pulse energy levels above 100mJ because heat build up will occur.

CORRECTING ASTRAL™ SERIES HD CALORIMETERS OPERATING PARAMETERS FOR USE AT DIFFERENT WAVELENGTHS:

Scientech Astral calorimeters in general have a flat response to all wavelengths within their specified spectral response. HD and HDX calorimeters are an exception to that rule and are calibrated at a specific wavelength by adjusting the calorimeter's gain circuitry for that wavelength. The calibration wavelength is recorded in the Operating Parameters section at the front of the manual and on the detector's serial tag. When a HD or HDX calorimeter is used at a wavelength other than the calibration wavelength, the calorimeter's output sensitivity can be adjusted to compensate for the absorption rate at the new wavelength as follows:

1. Find the absorption rate from the chart at the end of this manual for the calibration wavelength of your calorimeter.
2. Find the absorption rate for the wavelength where you will be working.
3. Determine the new output sensitivity using the following formula:

$$\frac{\text{absorption rate of calibration wavelength}}{\text{absorption rate of new wavelength}} \times \text{output sensitivity from serial tag} = \text{output sensitivity for new wavelength}$$

NOTE: Due to variability in the manufacturing process the absorption characteristics of the HD model calorimeters can vary in the UV region (190 to 400nm). Scientech recommends optical calibration at 266nm if the detector is to be used in the UV region instead of relying on an absorption rate in the chart at the end of this manual.

CALORIMETER OPERATION WITHOUT AN INDICATOR:

Cable Requirements:

Astral calorimeters are powered up by the indicators. To use an Astral calorimeter without a Scientech indicator, but with a volt meter or chart recorder, you must apply +/-8VDC to the mini DIN connector as shown in Figure 2. The voltage output of the calorimeter, from pin 8, should be connected to the positive side of the DVM or chart recorder. All 3 of the grounds should be tied together at the negative side. Pins 2 and 3 are not used.

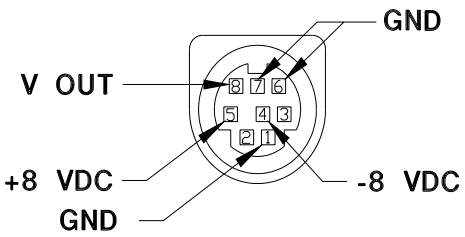


Figure 2

Operation of Astral™ Calorimeters with a Digital Volt Meter:

The calorimeters may be used with any digital volt meter (DVM) capable of reading 5 volts full scale.

Connect the output of the calorimeter to the DVM.

Select the DC volts mode.

Direct the laser beam on to the absorbing surface of the calorimeter.

When the display of the DVM has stabilized (about 2 minutes), calculate the laser power using the formula:
W = V/S
where:
W = Laser power in watts
V = Voltage reading of the DVM in volts
S = Sensitivity of the calorimeter from page 2.

Operation of Astral™ Calorimeters with an Analog Chart Recorder:

Calorimeter Response:

The response of a calorimeter to a single pulse input as displayed by a chart recorder appears below.

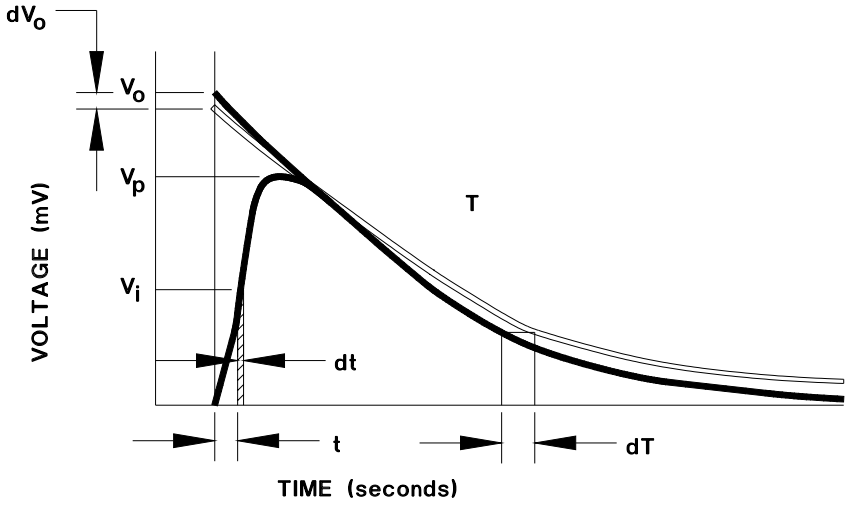


Figure 3

The output voltage from a chart recorder can be converted to wattage at any time by:

$W = V/S$, $W_i = V_i/S$

V = Chart recorder voltage level in mV
S = Calorimeter sensitivity in mV/W

The total energy (E) in the pulse can be found by integrating the instantaneous wattage over time:

$$E = \int_0^\infty W(t)\, dt$$

The following methods may be used to compute the total integrated energy:

Numerical Integration:

Finding the area under the curve in figure 7 is the equivalent procedure for determining pulse energy. Choose an appropriate time interval, dt, and perform the summation:

$$E = \sum_{I=1}^{N} W_i x dt = (dt/S) \sum_{i=1}^{N} V_i$$

The error caused by this procedure is:

$$dE = (dt/S) \sum_{i=1}^{N} dV_i$$

The error, in theory, is only dependent upon the value of $\sum dV_i$, that is the cumulative random error of V_i. This number should approach zero if data is carefully taken. The accuracy is also increased if the time interval, dt, is minimized. Numerical integration can yield accurate results, but is a tedious task.

Initial Voltage Interpolation:

A method used to eliminate the tedious numerical integration task is to project the thermal decay envelope on to the voltage axis, determine the 1/e decay time constant T, and estimate the total energy value (E):

$$E = (V_o/S) \times T$$

The change from thermal absorption to thermal transport phenomena near the peak causes difficulty in accurately projecting the envelope on to the voltage axis introducing an error, dV_o. Further, the determination of the time constant T, introduces another error, dT. The total error is the sum of the two errors.

$$dE = (V_o/S)dT + (T/S)dV_o$$

The difficulty in eliminating the potential error makes this method typically less accurate than numerical integration, but much faster in application.

Peak Voltage Estimate:

The peak voltage method requires using an independent determination of total energy and referencing it back to the peak voltage value, V_p.

For a given pulse, use the numerical integration method to obtain E. Note the peak voltage, V_p. Compute the value, F

$$F = E/V_p$$

For the next pulse compute the total energy: $E = F \times V_p$

The error in using this method yields: $dE = FdV_p + V_p dF$

The accuracy of this measurement depends upon the error in the original calibration, dF, and the error in the peak voltage dV_p. A careful numerical integration yields a value for dF near zero. The value of dV_p can be minimized by maintaining the geometry of the system (i.e. beam intensity, beam profile, wavelength and environment) during operation to be the same as during calibration. Under controlled circumstances, the peak method accuracy usually falls between the numerical integration and initial voltage interpolation methods.

CALIBRATION OF ASTRAL™ CALORIMETERS USING ELECTRIC SUBSTITUTION HEATING:

For Astral calorimeters the electric substitution heating option must be ordered and installed at the factory when the calorimeter is purchased. It can not be retrofitted to a calorimeter at a later time. To calibrate using electric substitution heating proceed as follows.

A. Remove the screws holding the calorimeter's ID tag and remove the plate to expose the circuit board.

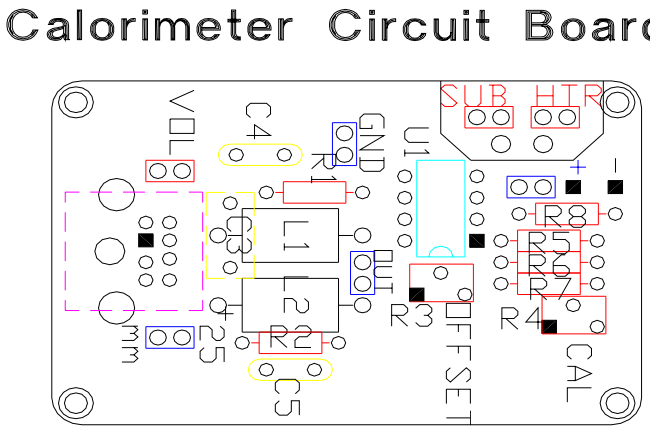


Figure 4

B. Connect a DVM to the test points labeled SUB and HTR on the calorimeter circuit board.

C. Measure the resistance of the substitution heater making sure to subtract the resistance of the patch cables from the total resistance measurement. Compare this resistance to R_c in the calibration data in the front of the manual. The two should agree within 2%. If not contact Scientech.

D. Remove the DVM. Connect a power supply to the SUB and HTR test points and connect the DVM to monitor the power supply.

E. Connect a second DVM to the output and ground of the Astral calorimeter.

F. Apply V_h volts, stated in the calibration data you received with the calorimeter, to the substitution heater.

G. Verify that the output voltage is one of the following values depending on the type of calorimeter being tested:

0.750 volts for 25 mm calorimeters
0.333 volts for 50 mm calorimeters

H. If needed, adjust the calibration trim pot, R4 on the calorimeter circuit board, until the voltage measured in step G is from the calibration data, is displayed by the indicator.

FACTORY RECALIBRATION:

Scientech recommends that a complete calibration be performed annually to verify system accuracy. Please contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientech-inc.com to arrange for a NIST traceable, factory calibration.

LIMITED WARRANTY:

All Scientech Laser Power and Energy Measurement Systems are warranted against defects in materials and workmanship for two (2) years from date of delivery. During the warranty period, Scientech will repair, or at its option replace at no charge, components that prove to be defective. The equipment must be returned, shipping prepaid, to Scientech's product service facility. This limited warranty does not apply if the equipment is damaged by accident or misuse or as a result of service or modification by other than a Scientech service facility. The foregoing warranty is in lieu of all other warranties expressed or implied including but not limited to any implied warranty of merchantability, fitness, or adequacy for any special incidental or consequential damages whether in contract, tort, or otherwise.

RETURNED GOODS PROCEDURE:

Should it become necessary to return any item to Scientech for any reason, please contact our Product Service Department at (800)525-0522 or (303)444-1361 or Fax (303)444-9229 or email inst@scientech-inc.com. When you call, please be ready to provide model number, serial number, and a description of the problem. Frequently we can provide self-help information which will eliminate the need for returning the unit(s).

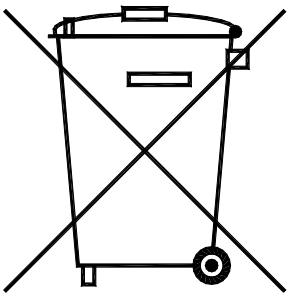
If equipment return is required, please pack the items in the original box and packing material. As an alternate, place the equipment in a snug-fitting box, and then pack that box in a larger box with at least four inches of packing material. Scientech does not assume responsibility for under packed items. Please include the name and phone number of the person we should contact regarding repair questions. Normally, products are repaired and shipped within 5 working days after their arrival at the product service facility. This is an average time and could vary depending on the workload.

Shipping address: Scientech, Inc.
Product Service Department
5649 Arapahoe Ave.
Boulder, Colorado 80303 U.S.A.

DISPOSAL OF ELECTRICAL AND ELECTRONIC EQUIPMENT:

Scientech, Inc. recommends the following for disposal of electrical and electronic equipment:

1. The best option is to reuse the equipment in its entirety.
2. Where the equipment can not be reused in its entirety, priority should be given to reuse of its subassemblies and components.
3. Where reuse is not appropriate, electrical and electronic equipment, including batteries, should be recycled according to local ordinances.
4. Waste electrical and electronic equipment should never be mixed with municipal waste.



HD ABSORPTION VS. WAVELENGTH:

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
0.200	93.66	0.480	94.71	0.735	93.99	0.990	93.34
0.210	93.78	0.485	94.75	0.740	94.21	0.995	93.35
0.220	92.18	0.490	94.80	0.745	93.98	1.000	93.34
0.230	90.44	0.495	94.76	0.750	93.98	1.005	93.33
0.240	88.79	0.500	94.73	0.755	94.08	1.010	93.33
0.250	90.07	0.505	94.70	0.760	94.04	1.015	93.33
0.255	90.42	0.510	94.67	0.765	93.89	1.020	93.29
0.260	90.41	0.515	94.68	0.770	93.94	1.025	93.28
0.265	90.56	0.520	94.70	0.775	94.01	1.030	93.28
0.270	90.71	0.525	94.66	0.780	93.91	1.035	93.25
0.275	91.13	0.530	94.66	0.785	94.03	1.040	93.23
0.280	91.63	0.535	94.70	0.790	93.96	1.045	93.17
0.285	91.85	0.540	94.75	0.795	93.89	1.050	93.14
0.290	92.01	0.545	94.73	0.800	93.64	1.055	93.12
0.295	92.73	0.550	94.66	0.805	93.65	1.060	93.12
0.300	93.02	0.555	94.63	0.810	93.67	1.065	93.14
0.305	93.04	0.560	94.64	0.815	93.53	1.070	93.17
0.310	93.15	0.565	94.64	0.820	94.21	1.075	93.16
0.315	93.53	0.570	94.62	0.825	93.61	1.080	93.13
0.320	93.45	0.575	94.56	0.830	93.81	1.085	93.12
0.325	93.82	0.580	94.59	0.835	93.83	1.090	93.09
0.330	93.83	0.585	94.56	0.840	93.83	1.095	93.06
0.335	93.96	0.590	94.56	0.845	93.93	1.100	93.03
0.340	94.07	0.595	94.61	0.850	93.84	1.105	93.01
0.345	94.14	0.600	94.55	0.855	93.31	1.110	93.00
0.350	94.15	0.605	94.51	0.860	93.65	1.115	92.83
0.355	94.19	0.610	94.50	0.865	93.90	1.120	92.76
0.360	94.31	0.615	94.45	0.870	93.84	1.125	92.67
0.365	94.30	0.620	94.38	0.875	93.92	1.130	92.60
0.370	94.44	0.625	94.44	0.880	93.81	1.135	92.57
0.375	94.48	0.630	94.42	0.885	93.85	1.140	92.56
0.380	94.46	0.635	94.44	0.890	93.54	1.145	92.51
0.385	94.53	0.640	94.48	0.895	93.88	1.150	92.47
0.390	94.53	0.645	94.50	0.900	93.60	1.155	92.43
0.395	94.57	0.650	94.46	0.905	93.70	1.160	92.42
0.400	94.62	0.655	94.49	0.910	93.62	1.165	92.37
0.405	94.63	0.660	94.39	0.915	93.68	1.170	92.32
0.410	94.65	0.665	94.43	0.920	93.66	1.175	92.30
0.415	94.72	0.670	94.41	0.925	93.64	1.180	92.24
0.420	94.70	0.675	94.44	0.930	93.60	1.185	92.23
0.425	94.78	0.680	94.36	0.935	93.67	1.190	92.21
0.430	94.74	0.685	94.37	0.940	93.59	1.195	92.16
0.435	94.80	0.690	94.36	0.945	93.60	1.200	92.08
0.440	94.76	0.695	94.19	0.950	93.50	1.205	92.02
0.445	94.80	0.700	94.37	0.955	93.49	1.210	91.94
0.450	94.79	0.705	94.25	0.960	93.51	1.215	91.91
0.455	94.79	0.710	94.20	0.965	93.45	1.220	91.92
0.460	94.79	0.715	94.16	0.970	93.42	1.225	91.88
0.465	94.76	0.720	94.08	0.975	93.40	1.230	91.87
0.470	94.78	0.725	94.11	0.980	93.35	1.235	91.82
0.475	94.75	0.730	94.21	0.985	93.37	1.240	91.81

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
1.245	91.78	1.510	91.70	1.775	90.84	2.016	90.87
1.250	91.79	1.515	91.66	1.780	90.86	2.019	91.03
1.255	91.76	1.520	91.58	1.785	90.83	2.020	90.69
1.260	91.75	1.525	91.59	1.790	90.78	2.022	90.68
1.265	91.76	1.530	91.59	1.795	90.77	2.025	90.67
1.270	91.79	1.535	91.58	1.800	90.80	2.026	90.99
1.275	91.75	1.540	91.57	1.805	90.79	2.029	90.92
1.280	91.74	1.545	91.53	1.810	90.77	2.030	90.60
1.285	91.74	1.550	91.52	1.815	90.76	2.032	90.61
1.290	91.74	1.555	91.50	1.820	90.75	2.035	90.63
1.295	91.71	1.560	91.49	1.825	90.76	2.038	90.66
1.300	91.72	1.565	91.51	1.830	90.81	2.040	90.69
1.305	91.70	1.570	91.50	1.835	90.71	2.041	90.70
1.310	91.70	1.575	91.49	1.840	90.74	2.045	90.70
1.315	91.73	1.580	91.49	1.845	90.71	2.048	90.69
1.320	91.78	1.585	91.50	1.850	90.77	2.050	90.68
1.325	91.78	1.590	91.47	1.855	90.71	2.051	91.03
1.330	91.79	1.595	91.45	1.860	90.74	2.054	91.07
1.335	91.76	1.600	91.44	1.865	90.70	2.055	90.70
1.340	91.77	1.605	91.44	1.870	90.73	2.058	90.67
1.345	91.82	1.610	91.43	1.875	90.67	2.060	90.63
1.350	91.94	1.615	91.36	1.880	90.67	2.061	91.02
1.355	92.17	1.620	91.32	1.885	90.64	2.064	91.03
1.360	92.17	1.625	91.33	1.890	90.64	2.065	90.64
1.365	92.17	1.630	91.34	1.895	90.61	2.068	90.64
1.370	92.15	1.635	91.34	1.900	90.59	2.070	90.63
1.375	92.12	1.640	91.31	1.905	90.53	2.071	91.01
1.380	92.12	1.645	91.29	1.910	90.48	2.074	90.96
1.385	92.12	1.650	91.24	1.915	90.63	2.075	90.55
1.390	92.10	1.655	91.26	1.920	90.45	2.077	90.55
1.395	92.04	1.660	91.30	1.925	90.48	2.080	90.54
1.400	91.99	1.665	91.24	1.930	90.48	2.081	90.91
1.405	92.00	1.670	91.24	1.935	90.48	2.084	90.76
1.410	92.02	1.675	91.20	1.940	90.52	2.085	90.43
1.415	91.98	1.680	91.15	1.945	90.45	2.088	90.47
1.420	91.95	1.685	91.16	1.950	90.41	2.090	90.51
1.425	91.95	1.690	91.18	1.955	90.47	2.091	90.87
1.430	91.96	1.695	91.13	1.960	90.50	2.094	90.90
1.435	91.94	1.700	91.09	1.965	90.56	2.095	90.53
1.440	91.91	1.705	91.04	1.970	90.47	2.098	90.57
1.445	91.86	1.710	91.03	1.975	90.49	2.100	90.61
1.450	91.77	1.715	90.97	1.980	90.46	2.101	90.99
1.455	91.77	1.720	90.99	1.985	90.36	2.104	90.90
1.460	91.80	1.725	90.96	1.990	90.39	2.105	90.50
1.465	91.79	1.730	90.92	1.995	90.36	2.108	90.45
1.470	91.79	1.735	90.89	2.000	90.39	2.110	90.40
1.475	91.77	1.740	90.92	2.001	90.68	2.111	90.41
1.480	91.75	1.745	90.92	2.004	90.79	2.115	90.43
1.485	91.73	1.750	90.89	2.005	90.49	2.118	90.80
1.490	91.69	1.755	90.89	2.007	90.53	2.120	89.36
1.495	91.69	1.760	90.89	2.010	90.56	2.125	90.44
1.500	91.68	1.765	90.86	2.013	90.54	2.122	90.44
1.505	91.71	1.770	90.87	2.015	90.52	2.125	90.60

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
2.129	90.76	2.255	90.17	2.390	89.92	2.557	89.30
2.130	90.41	2.258	90.14	2.392	89.92	2.562	89.25
2.132	90.05	2.260	90.11	2.395	89.91	2.567	89.23
2.135	90.41	2.262	90.12	2.396	89.72	2.572	89.29
2.136	90.43	2.265	90.13	2.400	89.53	2.577	89.25
2.139	90.84	2.270	90.24	2.401	89.57	2.582	89.28
2.140	90.48	2.274	90.20	2.405	89.61	2.588	89.26
2.143	90.46	2.275	90.17	2.410	89.84	2.593	89.20
2.145	91.65	2.278	90.17	2.414	89.79	2.598	89.18
2.146	90.04	2.280	90.17	2.415	89.73	2.603	89.18
2.150	90.45	2.282	90.14	2.419	89.85	2.608	89.13
2.153	90.44	2.285	90.11	2.420	89.96	2.614	89.11
2.155	90.42	2.286	90.15	2.423	89.88	2.619	89.12
2.157	90.39	2.290	90.19	2.425	89.79	2.624	89.16
2.160	90.36	2.294	90.11	2.428	89.91	2.630	89.10
2.161	90.69	2.295	90.03	2.430	90.03	2.635	89.10
2.164	90.76	2.298	90.10	2.432	89.89	2.640	89.13
2.165	90.43	2.300	90.18	2.435	89.75	2.646	89.20
2.168	90.44	2.303	90.14	2.437	89.68	2.651	89.21
2.170	90.44	2.305	90.10	2.440	89.61	2.656	89.11
2.171	90.41	2.307	90.08	2.441	89.78	2.662	89.06
2.175	90.38	2.310	90.07	2.445	89.95	2.667	89.03
2.179	90.38	2.311	90.09	2.446	89.90	2.673	88.98
2.180	90.37	2.315	90.10	2.450	89.86	2.678	89.03
2.182	90.40	2.319	90.07	2.451	89.73	2.684	89.06
2.185	90.44	2.320	90.04	2.455	89.59	2.690	89.10
2.186	90.42	2.323	90.03	2.460	89.75	2.695	89.05
2.190	90.41	2.325	90.02	2.465	89.83	2.701	89.09
2.193	90.39	2.327	90.00	2.469	89.81	2.706	89.10
2.195	90.37	2.330	89.98	2.470	89.80	2.712	89.05
2.197	90.38	2.332	89.97	2.474	89.66	2.718	89.06
2.200	90.39	2.335	89.95	2.475	89.51	2.723	89.05
2.201	90.34	2.336	89.94	2.479	89.72	2.729	89.09
2.205	90.29	2.340	89.93	2.480	89.92	2.735	89.09
2.208	90.33	2.344	90.08	2.483	89.79	2.741	89.13
2.210	90.36	2.345	90.23	2.485	89.66	2.747	89.19
2.212	90.33	2.348	90.08	2.488	89.82	2.752	89.19
2.215	90.29	2.350	89.93	2.490	89.98	2.758	89.16
2.216	90.27	2.353	89.96	2.493	89.79	2.764	89.20
2.220	90.26	2.355	89.99	2.495	89.59	2.770	89.23
2.224	90.21	2.357	89.98	2.498	89.49	2.776	89.23
2.225	90.16	2.360	89.98	2.500	89.38	2.782	89.24
2.227	90.20	2.361	89.88	2.503	89.38	2.788	89.30
2.230	90.24	2.365	89.79	2.507	89.38	2.794	89.32
2.231	90.24	2.366	89.82	2.512	89.35	2.800	89.27
2.235	90.25	2.370	89.85	2.517	89.37	2.806	89.27
2.239	90.22	2.374	89.98	2.522	89.39	2.812	89.26
2.240	90.19	2.375	90.10	2.527	89.41	2.818	89.25
2.243	90.14	2.379	89.97	2.532	89.43	2.824	89.27
2.245	90.08	2.380	89.84	2.537	89.36	2.830	89.26
2.247	90.17	2.383	89.82	2.542	89.34	2.837	89.24
2.250	90.25	2.385	89.79	2.547	89.27	2.843	89.29
2.251	90.21	2.387	89.86	2.552	89.24	2.849	89.31

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
2.855	89.26	3.233	88.79	3.725	88.11	4.394	87.66
2.862	89.24	3.241	88.75	3.736	88.10	4.409	87.64
2.868	89.25	3.249	88.75	3.747	88.09	4.424	87.63
2.874	89.23	3.257	88.76	3.758	88.07	4.440	87.62
2.881	89.24	3.265	88.75	3.768	88.07	4.455	87.61
2.887	89.26	3.274	88.74	3.779	88.07	4.470	87.61
2.894	89.24	3.282	88.73	3.790	88.06	4.486	87.59
2.900	89.19	3.290	88.72	3.802	88.05	4.501	87.58
2.907	89.22	3.299	88.71	3.813	88.04	4.517	87.56
2.913	89.20	3.307	88.69	3.824	88.02	4.533	87.55
2.920	89.22	3.315	88.68	3.835	88.03	4.549	87.55
2.926	89.24	3.324	88.67	3.847	88.02	4.565	87.54
2.933	89.20	3.333	88.65	3.858	88.00	4.581	87.51
2.940	89.21	3.341	88.65	3.870	87.99	4.597	87.49
2.946	89.17	3.350	88.63	3.881	87.99	4.613	87.50
2.953	89.17	3.358	88.62	3.893	87.98	4.630	87.49
2.960	89.17	3.367	88.61	3.905	87.97	4.646	87.48
2.966	89.17	3.376	88.59	3.916	87.96	4.663	87.46
2.973	89.15	3.385	88.57	3.928	87.96	4.680	87.45
2.980	89.12	3.394	88.55	3.940	87.96	4.697	87.44
2.987	89.14	3.402	88.51	3.952	87.95	4.714	87.43
2.994	89.17	3.411	88.35	3.964	87.94	4.731	87.41
3.001	89.14	3.420	88.05	3.977	87.93	4.749	87.40
3.008	89.11	3.429	87.89	3.989	87.90	4.766	87.39
3.015	89.09	3.439	88.03	4.001	87.90	4.784	87.38
3.022	89.08	3.448	88.18	4.013	87.90	4.801	87.37
3.029	89.08	3.457	88.23	4.026	87.88	4.819	87.36
3.036	89.06	3.466	88.26	4.038	87.89	4.837	87.35
3.043	89.07	3.475	88.29	4.051	87.89	4.855	87.34
3.050	89.06	3.485	88.30	4.064	87.90	4.873	87.32
3.057	89.04	3.494	88.28	4.077	87.88	4.892	87.31
3.065	89.03	3.504	88.11	4.089	87.85	4.910	87.30
3.072	89.02	3.513	88.01	4.102	87.85	4.929	87.29
3.079	89.01	3.523	88.11	4.115	87.85	4.948	87.27
3.087	89.00	3.532	88.19	4.129	87.83	4.967	87.25
3.094	89.01	3.542	88.23	4.142	87.82	4.986	87.24
3.101	89.00	3.552	88.26	4.155	87.82	5.005	87.22
3.109	88.99	3.561	88.24	4.168	87.82	5.025	87.20
3.116	88.99	3.571	88.21	4.182	87.80	5.044	87.20
3.124	88.95	3.581	88.22	4.195	87.77	5.064	87.18
3.131	88.93	3.591	88.22	4.209	87.70	5.084	87.16
3.139	88.97	3.601	88.22	4.223	87.60	5.104	87.14
3.146	88.96	3.611	88.21	4.236	87.56	5.124	87.13
3.154	88.92	3.621	88.21	4.250	87.60	5.144	87.10
3.162	88.89	3.631	88.20	4.264	87.60	5.165	87.10
3.170	88.88	3.641	88.20	4.278	87.57	5.185	87.09
3.177	88.86	3.652	88.19	4.293	87.58	5.206	87.08
3.185	88.85	3.662	88.18	4.307	87.61	5.227	87.07
3.193	88.86	3.672	88.17	4.321	87.64	5.248	87.05
3.201	88.85	3.683	88.15	4.336	87.65	5.270	87.03
3.209	88.83	3.693	88.14	4.350	87.66	5.291	87.01
3.217	88.82	3.704	88.13	4.365	87.67	5.313	87.00
3.225	88.80	3.714	88.11	4.380	87.67	5.335	86.98

Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %	Wavelength µm	Absorption %
5.357	86.95	6.682	86.05	8.879	84.32	13.09	80.67
5.379	86.95	6.717	86.06	8.940	84.27	13.23	80.54
5.401	86.94	6.752	86.07	9.002	84.22	13.36	80.36
5.424	86.90	6.787	86.00	9.065	84.17	13.50	80.24
5.447	86.89	6.823	85.91	9.129	84.11	13.65	80.08
5.470	86.86	6.859	85.86	9.194	84.06	13.79	79.83
5.493	86.86	6.895	85.91	9.260	84.00	13.94	79.67
5.516	86.86	6.932	85.93	9.326	83.95	14.09	79.57
5.540	86.83	6.970	85.92	9.394	83.90	14.25	79.42
5.564	86.80	7.007	85.91	9.462	83.83	14.40	79.29
5.588	86.78	7.045	85.87	9.532	83.78	14.57	79.14
5.612	86.79	7.084	85.86	9.603	83.72	14.73	78.98
5.636	86.77	7.123	85.84	9.674	83.64	14.90	78.81
5.661	86.76	7.162	85.79	9.747	83.55	15.07	78.66
5.686	86.76	7.202	85.77	9.821	83.46	15.25	78.54
5.711	86.74	7.242	85.74	9.896	83.38	15.43	78.39
5.736	86.68	7.283	85.70	9.972	83.32	15.62	78.23
5.762	86.59	7.324	85.66	10.05	83.26	15.81	78.05
5.787	86.62	7.366	85.63	10.13	83.19	16.00	77.89
5.813	86.66	7.408	85.61	10.21	83.13	16.20	77.73
5.839	86.66	7.450	85.56	10.29	83.06	16.41	77.54
5.866	86.64	7.493	85.52	10.37	82.99	16.62	77.36
5.893	86.61	7.537	85.50	10.45	82.90	16.84	77.17
5.919	86.63	7.581	85.48	10.54	82.82	17.06	76.95
5.947	86.63	7.626	85.46	10.60	82.79	17.29	76.77
5.974	86.64	7.671	85.42	10.63	82.76	17.52	76.57
6.002	86.67	7.716	85.36	10.71	82.69	17.76	76.38
6.030	86.66	7.763	85.32	10.80	82.61	18.01	76.15
6.058	86.60	7.809	85.28	10.89	82.51	18.26	75.87
6.086	86.62	7.857	85.24	10.99	82.42	18.52	75.62
6.115	86.64	7.905	85.18	11.08	82.35	18.79	75.36
6.144	86.63	7.953	85.13	11.18	82.29	19.06	75.07
6.173	86.62	8.002	85.09	11.27	82.21	19.35	74.81
6.203	86.62	8.052	85.02	11.37	82.13	19.64	74.56
6.232	86.61	8.102	84.97	11.47	82.06	19.94	74.25
6.263	86.58	8.153	84.94	11.58	81.94	20.26	73.99
6.293	86.54	8.205	84.91	11.68	81.86	20.58	73.73
6.324	86.47	8.257	84.86	11.79	81.79	20.91	73.41
6.355	86.39	8.310	84.82	11.89	81.69	21.25	73.14
6.386	86.34	8.364	84.77	12.00	81.60	21.61	72.90
6.418	86.26	8.418	84.73	12.12	81.50	21.97	72.65
6.450	86.23	8.473	84.69	12.23	81.40	22.35	72.37
6.482	86.15	8.529	84.60	12.35	81.29	22.74	71.98
6.514	86.12	8.585	84.50	12.47	81.21	23.15	71.60
6.547	86.10	8.642	84.47	12.59	81.10	23.57	71.31
6.580	86.05	8.700	84.45	12.71	80.98	24.01	70.85
6.614	86.03	8.759	84.41	12.84	80.85	24.46	70.50
6.648	86.03	8.819	84.37	12.96	80.74		

Note: Due to variability in the manufacturing process the absorption in the UV region varies.
Calibration at 266nm is recommended if the detector is to be used in the UV region.