Biospherical Instruments Inc

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 07/03/13 **Job No.:** R11671
Model Number: QSP200L
Serial Number: 4242
Operator: TPC
Standard Lamp: V-032(3/7/12)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200 uses a log amplifier to measure the detector signal current with V = log I (Amps) / IRef
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**5.77E+12**	**quanta/cm²·sec/"amps"**	**9.58E-06**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**1.02E+13**	**quanta/cm²·sec/"amps"**	**1.69E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	71.4	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	9.26E+15	quanta/cm²·sec	0.01538	µEinsteins/cm²sec	
SC3 Immersion Coefficient:	0.5664	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.		Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm²·sec)
No Filter	100.00%	3.206	100.00%		1.61E-07	1.61E-07	3.206	0.000	0.0	9.26E+15
0.3	36.10%	2.765	36.13%		5.81E-08	5.80E-08	2.765	0.000	-0.1	3.35E+15
0.5	27.60%	2.652	27.83%		4.47E-08	4.44E-08	2.648	-0.003	-0.8	2.58E+15
1	9.27%	2.188	9.50%		1.53E-08	1.49E-08	2.177	-0.010	-2.4	8.80E+14
2	1.11%	1.300	1.15%		1.85E-09	1.78E-09	1.286	-0.014	-3.4	1.06E+14
3	0.05%	0.439	0.08%		1.25E-10	8.58E-11	0.373	-0.066	-31.1	7.18E+12

Dark Before: 0.177 Volts
Light - No Filter Hldr.: 3.206 Volts
Dark After - NFH: 0.177 Volts
Average Dark 0.177 Volts

I_{Ref} = 1.00E-10 Amps
I_{Dark} = 1.50E-10 Amps
10^{VDark} = 1.503142 Amps

RG780 **0.889**

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.

Biospherical Instruments Inc

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 08/05/13 **Job No.:** R11692
Model Number: QSP200L
Serial Number: 4603
Operator: TPC
Standard Lamp: V-032(3/7/12)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200L uses a log amplifier to measure the detector signal current with V = log I (Amps) / IRef
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**1.47E+13**	**quanta/cm²·sec/"amps"**	**2.44E-05**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**2.60E+13**	**quanta/cm²·sec/"amps"**	**4.31E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	68.7	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	9.26E+15	quanta/cm²·sec	0.01538	µEinsteins/cm²sec	
SC3 Immersion Coefficient:	0.5664	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.		Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm²·sec)
No Filter	100.00%	2.800	100.00%		6.31E-08	6.31E-08	2.801	0.001	0.0	9.26E+15
0.3	36.10%	2.361	36.24%		2.29E-08	2.28E-08	2.360	-0.001	-0.4	3.36E+15
0.5	27.60%	2.244	27.63%		1.74E-08	1.74E-08	2.245	0.001	-0.1	2.56E+15
1	9.27%	1.775	9.23%		5.82E-09	5.85E-09	1.778	0.003	0.5	8.55E+14
2	1.11%	0.916	1.08%		6.80E-10	7.00E-10	0.927	0.011	3.0	9.99E+13
3	0.05%	0.278	0.07%		4.42E-11	3.37E-11	0.253	-0.025	-23.8	6.49E+12

Dark Before:	0.163	Volts				
Light - No Filter Hldr.:	2.800	Volts	I_{Ref} =	1.00E-10	Amps	
Dark After - NFH:	0.163	Volts	I_{Dark} =	1.46E-10	Amps	RG780 0.217
Average Dark	0.163	Volts	10^{VDark} =	1.455459	Amps	

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.