I. INTRODUCTION

The QSP-200L Logarithmic Output Oceanographic Light Transducer is designed to allow the oceanographer to measure the widely variant light fields found in the ocean in conjunction with STD (salinity-temperature-depth), CTD (conductivity-temperture-depth), current meters, or other fixed range data acquisition systems.

The only irradiance sensor designed expressly for oceanographic data acquisition systems, the QSP-200L's logarithmic output is consistent with the inherently depth dependent exponential decay of light in the ocean. This exponential decay of light level places special demands on light sensing systems, especially where accurate measurements are required at light levels ranging from 0.01 to 100% of full sunlight. This logarithmic output allows four decades of accurate measurement of light intensity with a 10-12 bit fixed range data acquisition system, normally limited to two decades.

The QSP-200L uses the patented (US Patent 4,178,101) Biospherical Instruments scalar optical collector to measure light from all directions, an important attribute in optical and oceanographic research. The spectral response is designed to measure PAR - Photosynthetically Available Radiation between 400 and 700 nanometers with an equal quanta response. The QSP-200L comes calibrated with constants for microEinsteins/cm2" or quanta/second/cm2. Power requirements are compatible with most CTDs and data acquisition systems. Standard pressure housing is tested to 1000 meters.

Available options include the QSR-240 solar reference hemispherical sensor for simultaneous monitoring of incident irradiance during the vertical profile, and the QSP-210 lowering frame. Biospherical Instruments also has computer hardware and software packages suitable for data logging and analysis using
these sensors.

Biospherical Instruments logarithmic irradiance sensors are available in several configurations. One area of configuration deals with power options for the sensor. Input power can be selected from the three input ranges:

1. 15 volts DC at 7 mA.
2. +7 to +12 volts DC at typically 35mA
3. +10.8 to +28.8 volts DC at typically 16.5mA

The QSP-200L standard configuration uses a scalar ("omnidirectional") irradiance optical collector while the alternate configuration uses a cosine ("flat plate") irradiance optical collector. In this manual the standard configuration is assumed, but electronic details will equally apply to cosine collector option. Depending on the power supply option selected or upon user request, the underwater connector will be either a 3 or 4 pin connector. If the15 volt supply option is selected the the connector supplied will be a LSG-4-BGL. If a single supply voltage option is selected, then the connector will be either an LSG-3-BGL or an LSG-4-BCL.

It is important that this operating manual be read carefully since there are several precautions that should be taken to extend the inherent accuracy of the instrument itself to the desired measurement. These precautions include paying careful attention to the position of the lowering platform relative to the sun to avoid shading, checking battery voltage regularly, and voiding temperature extremes.

II. INITIAL INSPECTION

This instrument was carefully inspected mechanically and electrically and was optically calibrated before shipment. It should be free of mars or scratches and in perfect operating condition upon receipt. To confirm this, the instrument should be inspected for physical damage incurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check the instrument for proper operation as outlined in the following sections. If there is damage or deficiency, see the warranty in this manual.

WARNING: Disassembly of the Sensor will Void the Calibration. Read Section V on Operation before attempting to operate or disassemble the instrument.

Retain original packing material for shipment to factory. Instrument must be carefully wrapped and cushioned with appropriate packing material before shipping.

III. SPECIFICATIONS

IRRADIANCE COLLECTOR: 1.9 cm (3/4") diameter solid Teflon (Teflon is a registered trademark of the Dupont Corp.) sphere optically connected to the main housing by a 2.5 cm (1") stainless steel
encased quartz light pipe. O-ring seal to main housing.

COSINE COLLECTOR OPTION: 1.15 cm (.45") diameter x .5 cm (.2") high cylindrical solid translucent acrylic collector fused to transparent Plexiglas support. O-ring seal to main housing.

PHOTODETECTOR: Blue-enhanced high stability silicon photovoltaic detector with dielectric and absorbing glass filter assembly.

SPECTRAL RESPONSE: Equal (better than 10%) quantum response from 400 to 700 nm with response sharply attenuated above 700 and below 400 nm. Spectral response induced errors will cause less than 5% errors in naturally occurring light fields.

DIRECTIONAL RESPONSE: Each instrument's directional response is optimized before final calibration. Front to bottom side response (0 to approximately 135 either side of front) response is equal (7%) with falloff until collector is obscured by instrument housing. Individual detector response plots are optionally available. QSP-200L (COSINE OPTION) directional response designed to produce cosine response curve when fully immersed in water.

CALIBRATION: The QSP-200L sensor is calibrated using a National Institute of Standards and Technology traceable 1000 watt type FEL Standard of Spectral Irradiance. The recalibration is recommended yearly.

DEPTH: Not to exceed 1000 meters

ENVIRONMENTAL: The QSP-200L sensor is O-ring sealed and uses high quality oceanographic type connector. It is recommended that the QSP-200L housing be rinsed in fresh water after using. The operating temperature range is -2 to 35 C.

POWER REQUIREMENTS: Three power option exist for the QSP-200L (these are listed with typical current drains).

1. 15 volts DC at 7 mA.
2. 2 +7 to +12 volts DC at typically 35mA
3. +10.8 to +28.8 volts DC at typically 16.5mA

CONNECTORS: Three connector options exist for the QSP-200L.

A. Single power supply voltage: Standard Option: LSG-3-BCL
   Pin 1 = Power/Signal Common
   Pin 2 = Signal Output
   Pin 3 = Power Input

B. Alternate Single Supply Connector: LSG-4-BCL
   Pin 1 = Power Common
   Pin 2 = Signal Output
   Pin 3 = Power Common
   Pin 4 = Power Input

C. Dual Power Supply Option: LSG-4-BCL
   Pin 1 = Power Common
   Pin 2 = Signal Output
   Pin 3 = Negative Supply Voltage
   Pin 4 = Positive Supply Voltage

Transfer Function: Light = CALFACTOR * 10(VOLTS)

IV. OPERATING INSTRUCTIONS

A. RESTRICTIONS

DEPTH: Not to exceed 1000 meters

TEMPERATURE: 0 to 35 C

INPUT POWER: Refer to CALIBRATION SHEET for the exact input voltage and current requirements for the sensor you have ordered.

HANDLING: CAUTION, the Teflon ball and mount are critical optical components. They have been aligned at the factory before calibration. It is possible to remove the ball, but this voids the calibration. The stainless steel mount contains a quartz light pipe and is FRAGILE. If you suspect damage, or if the ball has been removed, consult the factory. Similarly, the acrylic cosine collector is also a critical optical component, and care must be exercised to avoid striking or scratching the surface.

It should not be necessary to disassemble the sensor housing. Read maintenance section to avoid damage during disassembly procedure.

B. NORMAL OPERATION

The normal output of the QSP-200L is a positive voltage ranging between +6 volts at the maximum irradiance level and a minimum voltage near zero where the sensor has insufficient irradiance to generate a proper signal to bias the internal log amplifier (consult the calibration sheet for the voltage output in full sunlight). As the irradiance drops below the minimum sighal level the output will swing to a slightly negative value. This value has no meaning and should be regarded as the LOG(0), undefined in this application. As the irradiance is then increased, the reading will stay near this negative value until the irradiance reaches a level where the output will suddenly appear to "jump" back to a normal range.

The QSP-200L should be connected to a data acquisition system that will correctly digitize the voltage output. When data is analyzed from this data acquisition system, the transfer function should be applied and the correct irradiance reading recovered.

After a vertical profile, the QSP-200L should be washed off with fresh water. The protective cap should be installed after the irradiance collector has dried.

V. OPERATION

It is very important that the instrument package be lowered so that the sensor does not pass through the ship's shadow. A boom from the bow with the ship backing very slowly in a direction that points the bow to the sun is the best option. This will trail the meter away from the ship and its shadow. Pointing the bow away from the sun and lowering from the stern is next best. Some investigators have even devised small floats from which to lower the instrument to avoid shadow effects.

> *CAUTION should be exercised in very strong currents. The boat operator or Captain must be notified when lowering any instrument where it may become caught in the ships propeller.*

Proper operation of an underwater irradiance sensor depends on the way in which it is used. In addition to keeping the sensor out of the shadow of the ship, a vertical profile for irradiance can only be used in the computation of the diffuse attenuation coefficient "K" if the surface irradiance is constant when the two observations are made, and when the depths are known. It is assumed that the QSP-200L will be used in conjunction with a system that will provide a correct reading of depth. If the instrument is used in an application where the surface irradiance is changing significantly during the profile, then analysis will be complicated. Changes in irradiances can occur during periods of cloudiness, or in slow vertical profiles when the sun is near the horizon and raising or setting rapidly. One solution is to monitor surface irradiance during the vertical profile. These data can then be used to provide an approximate correction to the underwater irradiance field. A sensor well suited to this purpose is the QSR-240. To make best use of this sensor, a power supply (+6 volts DC, also provided with either the QSP-170 digital readout or the QSR-250 digital integrator) will be needed for the QSR-240 and a means of digitizing and recording the resulting voltage data will also be needed. Consult Biospherical Instruments Inc. for suggestions of proper Data Acquisition Devices for this purpose.

The QSP-200L output voltage may be decoded into the measurement of quanta/(sec*cm2) incident on the collecting sphere. The normal calibration factors will be provided with an immersion correction that will provide for the "immersion effect" (which causes different collection efficiencies for wet and dry optical diffusers due to a combination of refractive indicies and scattering coefficients) so that the sensor gives correct readings in water. It is important to note that this will cause an QSP-200L sensor to give a higher (and incorrect) reading when placed alongside a QSR-240 sensor with both sensors in air. This is normal and the ratio should be fixed provided the field of view is the same. It is critical that the QSP-200L sensor not view reflected light from below, as is normally the case with the QSR-240.

PAR UNDERWATER UNIT PIN OUT

1 GROUND.

2 SIGNAL

3 +15 Vdc

Hook-up to A/D CHANNEL ON CTD