QSR-240

Quantum Scalar Reference Sensor

User's Manual

Biospherical Instruments Inc.
5340 Riley Street
San Diego, CA 92110
(619) 686-1888
FAX (619) 686-1887

Version 002896UA.DOC

Date Printed: 03/02/00

NOTICE

Document 002896UA.doc

First Edition 1993
Second Edition November, 1994

LIMITED WARRANTY

BIOSPHERICAL INSTRUMENTS INC. warrants this instrument system or software (the Product) to be in good working order for a period of one (1) year parts and good for a period of ninety (90) days labor from the date of purchase. Should this Product fail to be in good working order at any time during the above stated warranty period, Biospherical Instruments Inc. will, at its option, repair or replace this Product at no additional charge except as set forth below. Repair parts and replacement Products will be furnished on an exchange basis and will be either reconditioned or new. All replacement parts and Products become the property of Biospherical Instruments Inc. This limited warranty does not include service to repair damage to the Product resulting from accident, disaster, misuse, abuse or non-Biospherical Instruments Inc. modification of the product.

Limited warranty service may be obtained by delivering the Product during the warranty period to Biospherical Instruments Inc. at its San Diego, California, Service Center, showing proof of purchase. If this Product is delivered by mail, you agree to insure the Product or assume risk of loss or damage in transit; to prepay shipping charges to the San Diego, California, Service Center; to use the original shipping container or equivalent; and to pay for return shipping charges.

ALL EXPRESS AND IMPLIED WARRANTIES FOR THIS PRODUCT INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE WARRANTY PERIOD, AND NO WARRANTIES, WHETHER EXPRESSED OR IMPLIED, WILL APPLY AFTER THIS PERIOD. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

IF THIS PRODUCT IS NOT IN GOOD WORKING ORDER AS WARRANTED ABOVE, YOUR SOLE REMEDY SHALL BE REPAIR OR REPLACEMENT AS PROVIDED ABOVE. IN NO EVENT WILL BIOSPHERICAL INSTRUMENTS INC. BE LIABLE TO YOU FOR ANY DAMAGES, INCLUDING ANY LOST PROFITS, LOST SAVINGS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT, EVEN IF BIOSPHERICAL INSTRUMENTS INC. HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. NOR WILL BIOSPHERICAL INSTRUMENTS INC. BE LIABLE FOR ANY CLAIM BY ANY OTHER PARTY.

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR CONSUMER PRODUCTS, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.

TABLE OF CONTENTS

INITIAL INSPECTION AND SHIPPING PROCEDURES

This instrument was carefully inspected mechanically and electrically, and was 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 Section 3.0. If there is damage or deficiency, see the Warranty in the preface of this manual.

WARNING: Read Section 3.0 on Operation before attempting to operate or disassemble the instrument.

Retain original packing material for shipment to the factory. The instrument must be carefully wrapped and cushioned with appropriate packing material before it is shipped.

PRECAUTIONS

PROTECT THE CABLE AND CONNECTOR. Avoid any sharp bends in the interconnect cable. To ensure cable safety, secure the cable in place during instrument usage. The connector is the most vulnerable part of the system. Protect the connector contacts from moisture, both during use and while in storage. Do not step on the connector, or strike it while it is plugged into the instrument.

PROTECT THE INTEGRATED CIRCUITS. A person walking across a carpet on a dry day can generate a static charge of over 10,000 volts. The resulting discharge can destroy an integrated circuit. Therefore, use standard anti-static equipment any time the instrument is opened and the components are removed.

AVOID THE SHADOW. The QSR-240 should be mounted so that it will not be shaded by or subjected to the reflections of the upper parts of a ship or any other objects.

MAINTAIN PROPER CALIBRATION. The proper conversion of the voltages for the sensors to engineering units is determined by data contained on the calibration certificate issued with the instrument, which is updated on subsequent recalibrations.

CARRY SPARE CABLE. For extended operations, it is prudent to carry spare cables.

1.0 INTRODUCTION

Biospherical Instruments' Quantum Scalar Reference Sensor (QSR-240) is designed as a surface (non-submersible) instrument for monitoring total incident photosynthetically active radiation (between 400 nm and 700 nm) from the sun and sky. It is designed to be used primarily with the QSR-250 (Digital Integrator) to provide independent irradiance measurements, the QSP-170 (Digital Readout System), or the QSP-186 (Battery-Powered Eight-Channel Digitizer) to provide a measurement of surface irradiance during underwater vertical profiles. These products act as power supplies and digital readouts. For long-term data storage, the user can attach a data recorder to the QSP-186, QSP-170 or QSR-250, or directly to the QSR-240.

The QSR-240 is a hemispherical reference sensor. It shares the scalar directional response of Biospherical Instruments' QSP-200 series of sensors, but it includes a field-of-view cutoff plate that transforms its response to a hemispherical one. In essence, the instrument is a transducer which produces an analog voltage output that is directly proportional to the irradiance incident upon the collector's sensing plane. As illustrated in Figure 1.1, this sensing plane lies halfway between the equator and upper pole of the spherical collector.

In order to fully understand the capabilities of the QSR-240, the user should read this manual carefully and thoroughly. The manual includes operating instructions, precautions and compatibility notes that can help the user adapt the instrument to a specific application.

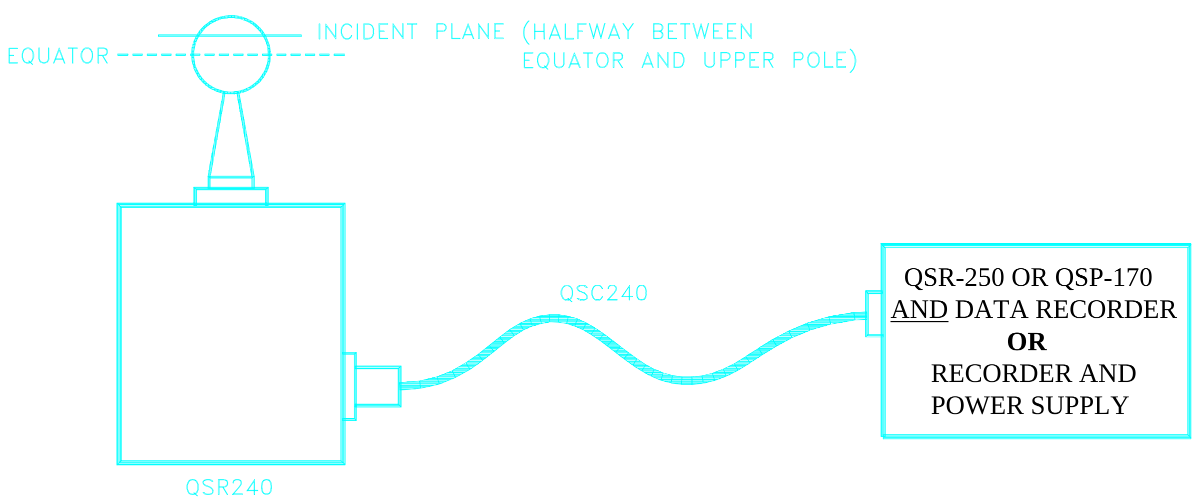


Figure 1.1 The QSR-240 irradiance monitoring system. A complete system includes a QSR-240 Quantum Scalar Reference Sensor, interconnecting cable and a data recorder with power supply. The QSP-170, QSP-186 and QSR-250 act as power supplies and provide digital readout. Each has data outputs which may be connected to a data recorder to provide data storage.

2.0 SPECIFICATIONS

IRRADIANCE COLLECTOR: 1.9 cm (3/4") diameter solid Teflon sphere optically connected to the main housing by a 2.5 cm (1") aluminum encased quartz light pipe.

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

SPECTRAL RESPONSE: Within ±10% of an ideal quantum response from 400 nm to 700 nm. The response is sharply attenuated above 700 nm and below 400 nm.

DIRECTIONAL RESPONSE: Each instrument's directional response is optimized before final calibration. From zenith angles of 0° to 85°, the instrument's directional response is uniform to ±6%. The response is attenuated to 0 at a zenith angle of 95° due to the 20 cm diameter cutoff shield. Individual sensor response plots are optionally available.

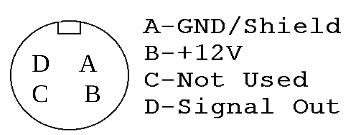
SENSITIVITY: When purchased alone, the sensor is calibrated in µEinsteins/(cm^2sec). Nominal sensitivity is 1 Volt = 1 x 10^{17} µEinsteins/(cm^2sec) (slightly less than full sunlight). Noise level is typically 1 mV (standard deviation), temperature coefficient of the dark signal is 10 µV/°C, and response temperature coefficient is approximately 0.15%/°C.

OUTPUT IMPEDANCE: 100 ohms.

ENVIRONMENTAL: The QSR-240 sensor is fully sealed and water resistant, and it has a special weather-proof connector. Its operating temperature range is -15 to 35°C.

POWER REQUIREMENTS: 6-15 Volts DC and 0.9 to 2 mA is required. Typically, power is supplied by either the QSR-250 (Digital Integrator) or the QSP-170B (two channel digital readout system), which is used with the QSP profiling irradiance system.

CABLE: QSC-240 shielded, weather resistant cable (ordered separately) is supplied with appropriate connectors. The cable contains the following pin assignments:



QSR240 Pin Assignment
(Looking at Connector)

3.0 INSTALLATION, OPERATION AND MAINTENANCE PROCEDURES

3.1 INSTALLATION

The sensor should be installed in a place that is free of obstacles which might block its field of view. The QSR-240 has a large mounting base with several holes so that it may be secured to a variety of mounting platforms. When it is operated in high seas, it may be necessary to gimbal mount the sensor to prevent the data from changing rapidly, making them difficult to read and analyze. Use of the QSR-240 with the QSR-250 (Digital Integrator) makes gimbal mounting less important because the QSR-250 will integrate over the data set and, therefore, compensate for individual changes in solar angle due to tilt and roll of the ship. However, if the sun will be very low in the sky (such as in polar regions) for a significant portion of the integration period, the QSR-240 should still be gimbal mounted.

Note that the QSR-240 features a circular irradiance shield or "cut-off plate" that blocks irradiance from the lower hemisphere of the collector so as to permit monitoring of only total irradiance from the sun and sky. The plane of the shield must be level with the horizon and there should be no physical obstructions (buildings, masts, etc.) above this plane. For special applications this shield may be removed without otherwise affecting operation.

NOTE: Do not attempt to remove the irradiance collector sphere.

3.2 OPERATION

If you are using a QSC-240 cable and the QSR-250, QSP-186 or QSP-170, simply plug the cable into the proper outlet at the rear panel of the QSR-250 (large multi-pin outlet) or QSP-170/QSP-186 (REF-JACK). When these systems are powered on, they will automatically power the attached QSR-240. These digital systems may then be used to control the sensor and collect data, as described in their respective user's manuals.

If you are using a different method for collecting data, remember that the sensor requires 6-15 VDC at 0.9-2 mA. The sensor normally outputs a voltage analog signal between -1 and -2 volts for full sunlight. However, positive output is available for use with the Sea-Bird CTD. Make sure that your data acquisition system meets these requirements. If needed, a QSC-240 custom, weather-resistant deck cable may be ordered.

It is recommended that the user check the instrument system, and all optical instruments in general, for gross error every two to three months depending on the amount of use. Weather conditions aside, perhaps the most dependable reference light source is the sun on a clear day. Solar irradiance at local noon, measured against a black surface, is typically 1.5×10^{17} to 2×10^{17} quanta/(cm^2 sec) on a clear day. Check your instrument system accordingly to make sure it measures correctly.

We strongly recommend that, whenever the instrument's calibration is in question for any reason, the instrument should be returned to Biospherical Instruments for recalibration and examination at a nominal charge.

3.3 MAINTENANCE

When the sensor is mounted outside for long periods of time, it is important to periodically clean both the flat surface of the irradiance shield and the collector sphere itself. While cleaning the sphere and shield, **do not attempt to rotate or remove the collector sphere or the sensor calibration will be altered.** To clean the spherical collector, simply wipe it gently using a soft tissue or towel and warm water, soap or alcohol. Do not use any other solvents such as acetone, MEK or Trichlor because these can dissolve the coatings on the shield. Also, do not use acids, abrasive cleaners or brushes as this will mar the surface of the sphere and void the instrument's calibration. Should the sphere become damaged or heavily soiled, return the instrument to the factory for service and recalibration.

If the surface of the irradiance shield becomes soiled and its reflectance changes, the calibration of the instrument will be altered. Therefore, the user should keep the irradiance shield as clean as possible by periodically wiping it with a damp cloth. Remember to avoid moving or scratching the Teflon sphere.

The only other maintenance procedures required by the instrument are annual optical recalibrations and biannual preventive maintenance checks. Consult your factory for details.

APPENDIX: THEORY OF OPERATION AND TECHNICAL DRAWINGS

THEORY OF OPERATION

The Teflon sphere on the instrument serves as the irradiance collector. Light penetrating the surface of the sphere is diffused as it passes toward the center. A quartz optical conductor is inserted into the sphere to collect the diffuse light from the sphere and guide it to the filter and detector assembly. The light travels through a special filter assembly and onto a low noise silicon photodiode. The combination of detector spectral response and collector spectral transmission properties are corrected by the filter assembly to give the instrument an equal quantum response between 400 and 700 nm and negligible response outside this region.

The current from the photodiode is amplified and converted to a voltage by a high stability electrometer amplifier in the sensor housing. The instrument also contains power conditioning circuitry for generating the positive and negative amplifier supply voltages.

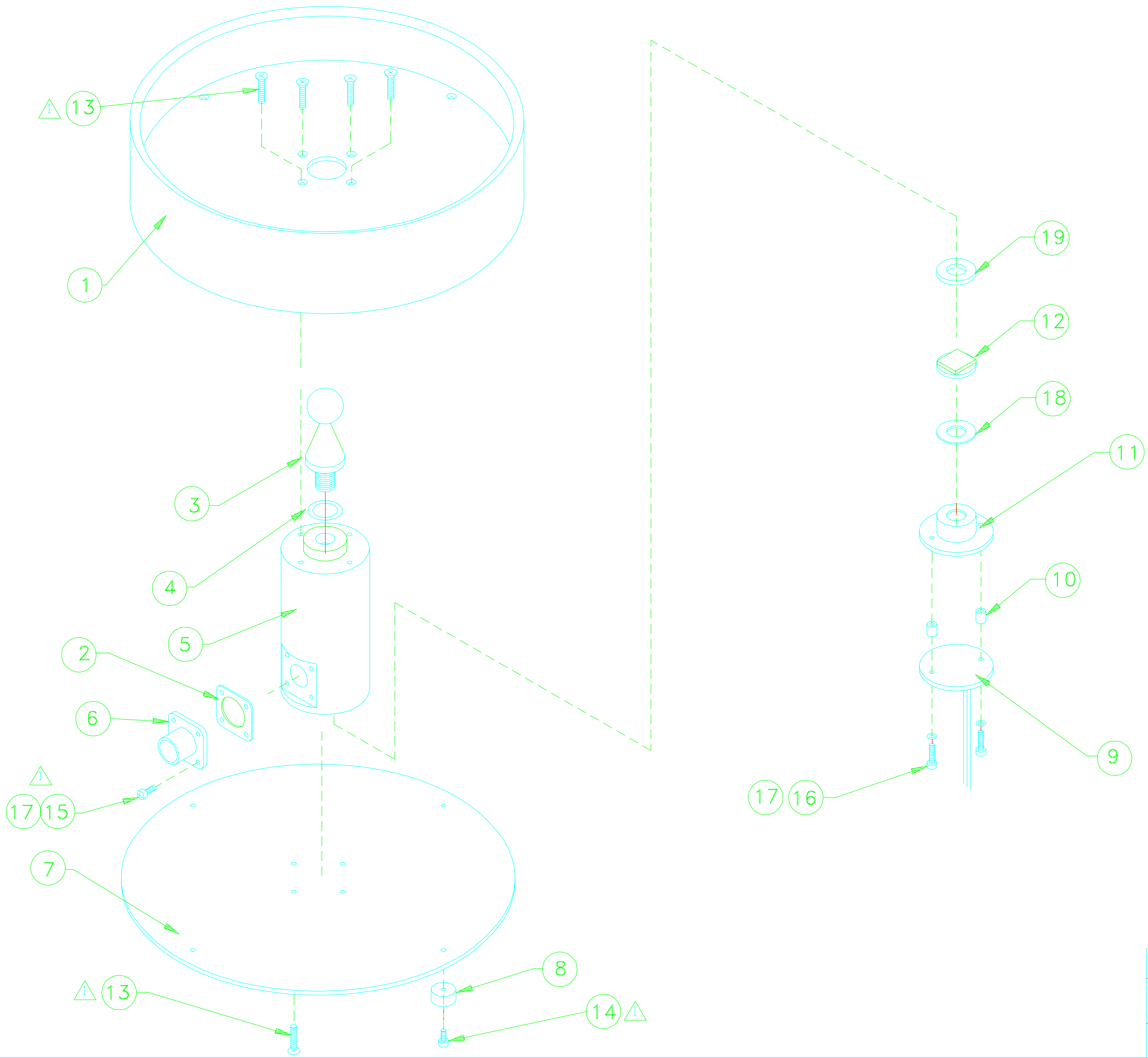
TECHNICAL DRAWINGS

These drawings are included on the following pages:

TITLE	NUMBER/TYPE
QSR-240 Assembly Diagram	001394A
QSR-240 Preamplifier PCA Electronic Schematic	001541E

*****A note regarding Biospherical Instruments' drawing and part numbering scheme. BSI uses a system which integrates part and drawing numbers for those parts or assemblies that we specify or build. End items have a slightly different numbering scheme. A standard BSI part number has a 9-digit alpha-numerical code. It consists of a two digit class code prefix, a six digit sequence number suffix, and a single letter revision code. An example would be: 05.123456C. The drawings associated with this part consist of the same six digit suffix number but have two appended letters. The first indicates the drawing type (electronic schematic (E), assembly diagram (A), mechanical drawing, etc.), and the second letter is the revision level. For example, if the sub-assembly 05.123456C was a printed circuit assembly, it should have at least two drawings associated with it, 123456AC and 123456EC, which are the assembly diagram and electronic schematic, respectively, for revision level C (i.e., third revision). In drawings which include components numbered in this way, the revision level for the components is omitted so that the drawing does not need to be changed when a component is revised (the definition of a revision is that the new part is functionally and mechanically interchangeable with the original part).

REV	DESCRIPTION	DATE	BY
A	PROD. RELEASE	8/16/94	McGUIRE



ITEM NO.	DESCRIPTION	QTY.
20	RTV FOR SCREWS ⚠1	6
19	FILTER SPACER (25.00004)	1
18	FILTER SPACER (25.00002)	1
17	WASHER, SPLIT LOCK, S/S (85.04412)	6
16	SCREW, 4-50x1/2 P.H. PHILLIPS (85.04401)	2
15	SCREW, 4-40x1/4 P.H. PHILLIPS (85.04407)	4
14	SCREW, 6-32x1/4 P.H. PHILLIPS (85.06007)	4
13	SCREW, 6-32x3/8 F.H. PHILLIPS (85.06321)	8
12	LB FILTER/ HOT MIRROR ASSY (06.002151A)	1
11	PHOTODETECTOR & HOLDER ASSY (05.002192)	1
10	SPACER, 1/8" L, #4 ROUND NYLON (88.09997)	2
9	PREAMPLIFIER PCA (05.001541)	1
8	RUBBER FEET (88.00240)	4
7	HOUSING BASEPLATE (90.001490)	1
6	CONNECTOR 4 PIN, FEM. (80.10600)	1
5	MAIN HOUSING (90.000257)	1
4	O-RING (91.00150)	1
3	LIGHT PIPE ASSEMBLY (05.002144)	1
2	GASKET (80.106001)	1
1	COLLECTOR SHIELD (90.001347)	1

MATERIAL: –
–

FINISH: –
–
–

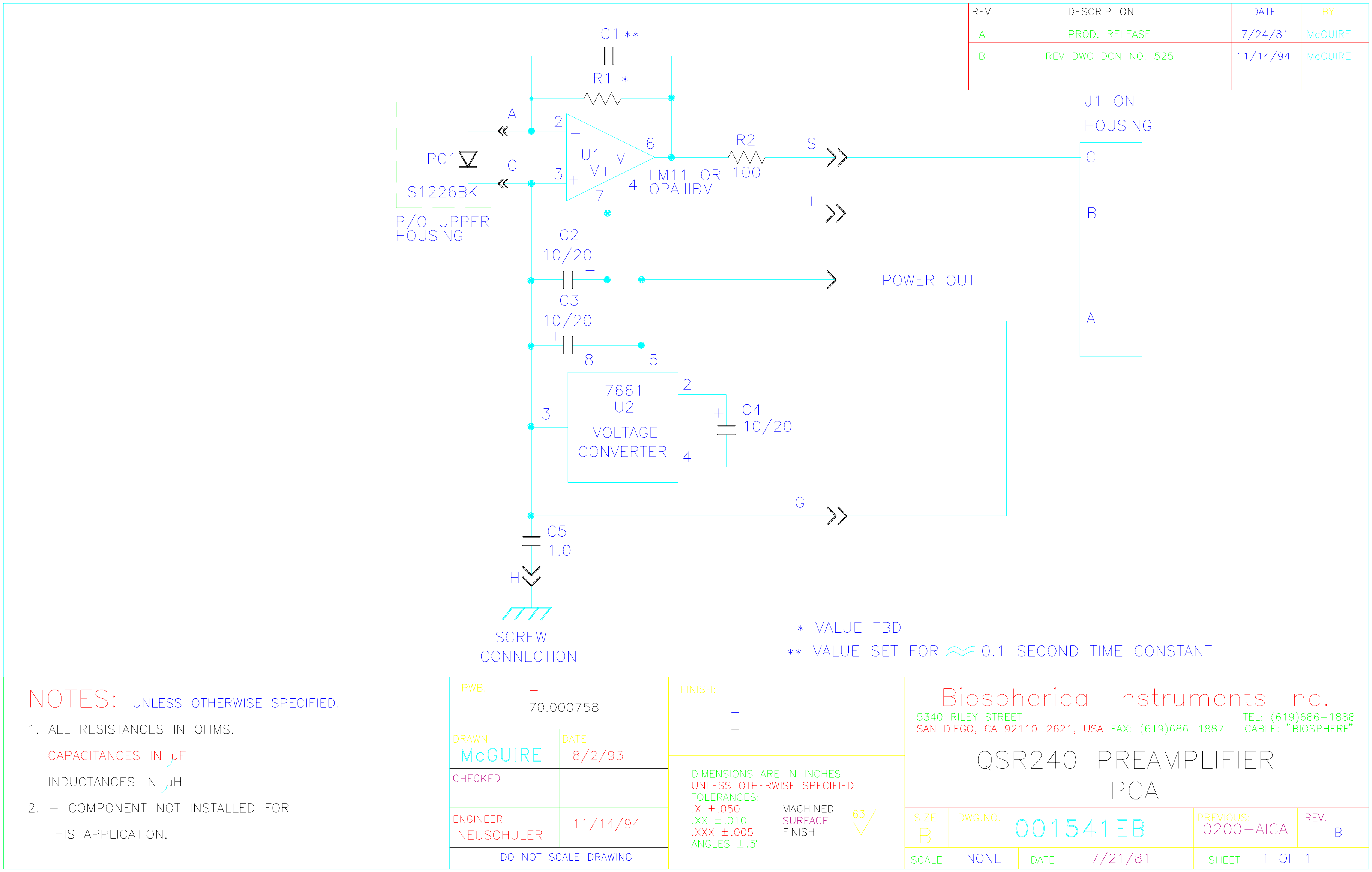
DRAWN: McGUIRE DATE: 8/16/94
CHECKED
APPROVED
DO NOT SCALE DRAWING

DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES:
.X %P.050
.XX ±.010
.XXX ±.005
ANGLES ±.5°
MACHINED SURFACE FINISH 63

Biospherical Instruments Inc.
5340 RILEY STREET
SAN DIEGO, CA 92110-2621, USA
TEL: (619)686-1888
FAX: (619)686-1887
CABLE: "BIOSPHERE"

QSR240
ASSEMBLY

SIZE	DWG.NO.	PREVIOUS:	REV.
E	001394AA	XXX	A
SCALE 1:1	DATE 8/16/94	SHEET 1 OF 1	


REV | DESCRIPTION | DATE | BY
A | PROD. RELEASE | 7/24/81 | McGUIRE
B | REV DWG DCN NO. 525 | 11/14/94 | McGUIRE
C1 **
R1 *
A
2
6
R2
S
J1 ON
HOUSING
PC1
C
U1
V−
V+
3
7
4
LM11 OR
OPAIIIBM
100
S1226BK
P/O UPPER
HOUSING
C
B
C2
10/20
− POWER OUT
C3
10/20
A
8
5
7661
U2
VOLTAGE
CONVERTER
2
3
4
C4
10/20
G
C5
1.0
H
SCREW
CONNECTION
* VALUE TBD
** VALUE SET FOR ≈ 0.1 SECOND TIME CONSTANT
NOTES: UNLESS OTHERWISE SPECIFIED.
1. ALL RESISTANCES IN OHMS.
CAPACITANCES IN μF
INDUCTANCES IN μH
2. − COMPONENT NOT INSTALLED FOR
THIS APPLICATION.
PWB: −
70.000758
DRAWN
McGUIRE
DATE
8/2/93
CHECKED
ENGINEER
NEUSCHULER
11/14/94
DO NOT SCALE DRAWING
FINISH: −
−
−
DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES:
.X ±.050
.XX ±.010
.XXX ±.005
ANGLES ±.5°
MACHINED
SURFACE
FINISH
63
Biospherical Instruments Inc.
5340 RILEY STREET
SAN DIEGO, CA 92110−2621, USA
TEL: (619)686−1888
FAX: (619)686−1887
CABLE: "BIOSPHERE"
QSR240 PREAMPLIFIER
PCA
SIZE
B
DWG.NO.
001541EB
PREVIOUS:
0200−AICA
REV.
B
SCALE
NONE
DATE
7/21/81
SHEET
1 OF 1