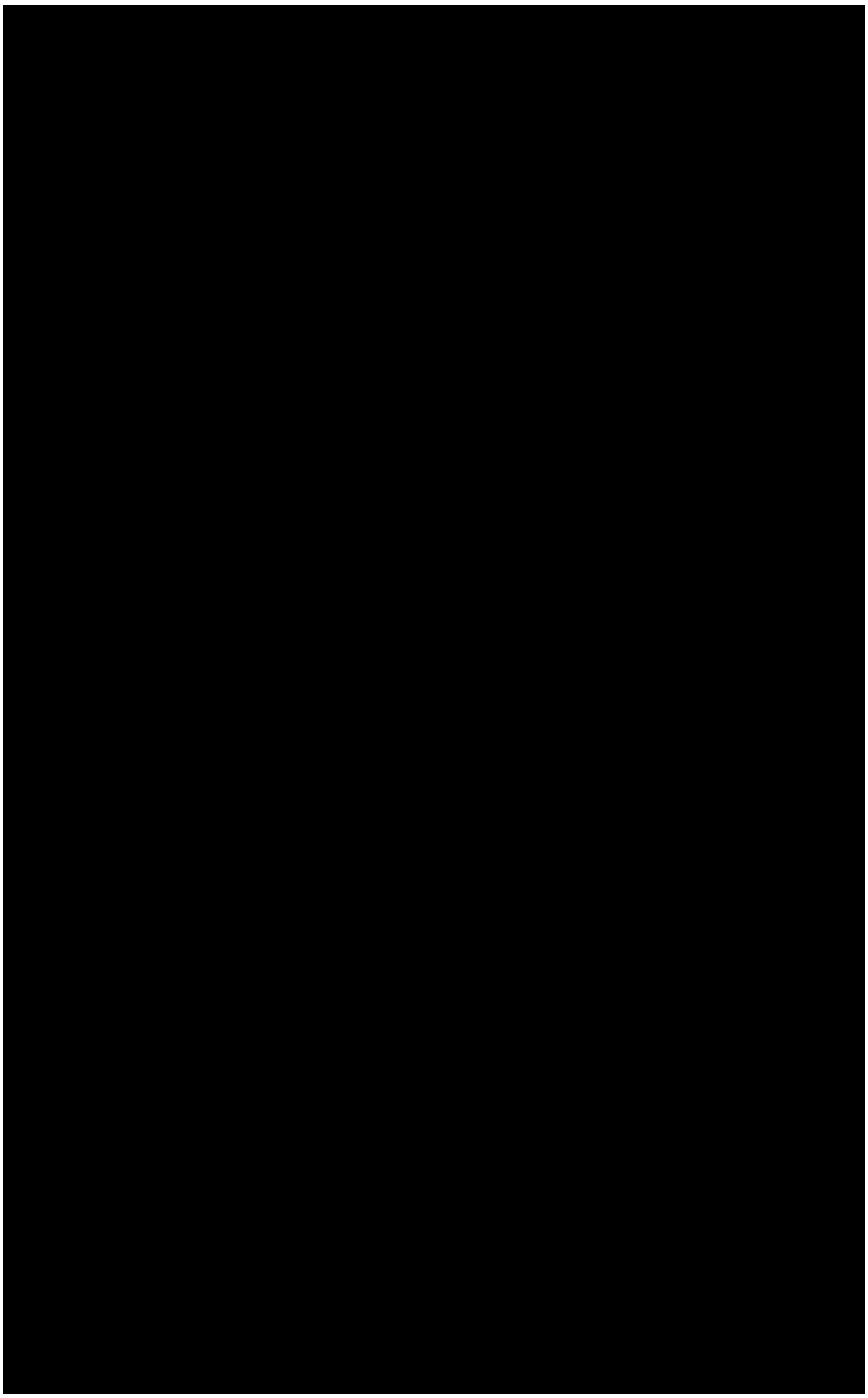
Instructions 95-8409-01

SlickWatch™ Oil Slick Detection System
SW9200A



DET-TRONICS

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DET-TRONICS®

INSTRUCTIONS

SlickWatch™

Oil Slick Detection System

SW9200

Section 1
General Information

The installation, operation and maintenance instructions contained in this manual are for use by qualified personnel only. All personnel assigned to this equipment should read the instructions provided before initiating any procedures. The manual should be maintained on file so that it is available to installation, operation and maintenance personnel. To avoid injury to personnel or damage to the equipment, do not perform any procedures other than those described in this manual unless instructed by the factory or qualified by training.

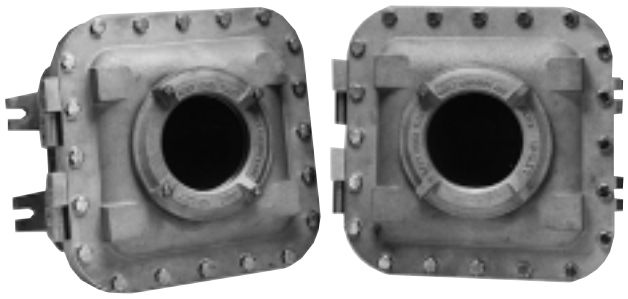
GENERAL DESCRIPTION

The SlickWatch oil slick detector is a remote electro-optical instrument designed to detect oil films floating on water surfaces. Oil detection is based on changes in infrared reflectance that occur when an oil film is present on the water.

These changes are detected by measuring the water surface reflectance at two points in the infrared spectral region near 3 microns. In this region, sharp changes in reflectance due to absorption bands are observed. Water surface reflectance dips from approximately 2% at 2 microns to a valley of 0.75% at 2.7 microns and then rises sharply to a peak of 4.7% at 3.07 microns before returning to approximately 2% at 4 microns.

The reflectance spectrum of oil films differs from that of water surfaces in an unambiguous manner when viewed in the 3 micron region. Oil films do not exhibit the deep valley and adjacent sharp peak at approximately 2.7 and 3.1 microns. When a ratio is computed using reflectance readings at the peak and valley points, water surfaces exhibit a low reflectance ratio while oil films show a much higher reading.

The SlickWatch system consists of a transmitter and a receiver which are mounted above the water surface to be monitored. The transmitter projects a light beam to the water surface and the reflected infrared light is analyzed by the receiver. An alarm relay is activated when an oil film is detected.



FEATURES

- Non-contact design – instrument never comes in contact with contaminants being monitored.
- Reliable, continuous monitoring day and night.
- Low maintenance.
- Modular design for easy service.
- Internal Fault alarm.
- Rugged, explosion-proof construction.
- CSA certified.

SPECIFICATIONS

HOUSING SIZE—
Transmitter and receiver dimensions are: 12-l/4 inches (W) x 11-1/2 inches (H) x 9-1/2 inches (D).

WEIGHT—
Transmitter: 34 lbs. (15.4 kg).
Receiver: 39 lbs. (17.7 kg).

SENSITIVITY—
Minimum film thickness detected is approximately 0.1 micrometer average thickness.

MOUNTING—
3/8-16 bolts (4 per housing) to user-supplied mounting plate. The mounting plate interfaces between the instrument housings and the user-supplied mounting framework.

OPERATING VOLTAGE—
105 to 125 VAC, 50/60 Hz.

POWER CONSUMPTION—
Transmitter: 250 watts.
Receiver: 60 watts.

OPERATING TEMPERATURE—
In ambient air with instrument shaded from direct sunlight: –4°F to +110°F (–20°C to +43°C) at 60 Hz operation; –4°F to +100°F (–20°C to +38°C) at 50 Hz operation.

OPERATING HEIGHT—
5 to 30 feet above the water surface, depending on wave angle. (See graph in APPENDIX).

AREA MONITORED—
A circle with a diameter approximately 0.05 times the height of the instrument above the water. Typically 28 square inches at a 10-foot operating height.

RESPONSE TIME—
Approximately 63% of final reading within 20 seconds after a step change in water surface condition.

OIL ALARM—
SPST relay, rated at 7 amps continuous, 120 VAC or 28 VDC. Also rated at 1/3 HP at 120 VAC. Contacts are closed under normal clean water conditions and open when oil film is present.

INSTRUMENT STATUS ALARM—
SPST relay, rated at 7 amps continuous, 120 VAC or 28 VDC. Also rated at 1/3 HP at 120 VAC. Contacts are closed under normal conditions and open when the beam is interrupted or a malfunction occurs.

ANALOG OUTPUT—
A 0 to 10 VDC analog output is available from the instrument. Under 2.0 VDC corresponds to clean water while over 2.0 VDC corresponds to an oil film on the water surface.

OPERATION IN HAZARDOUS ENVIRONMENTS—
Canadian Standards Association certified for operation in Class I, Div. 1 Groups C & D, and CSA enclosures 3 & 4. Temperature code T2A for 250 watt transmitters.

FUNCTIONAL DESCRIPTION

A functional description of the operation of the SW9200 is detailed in the following paragraphs. See Figure 1.

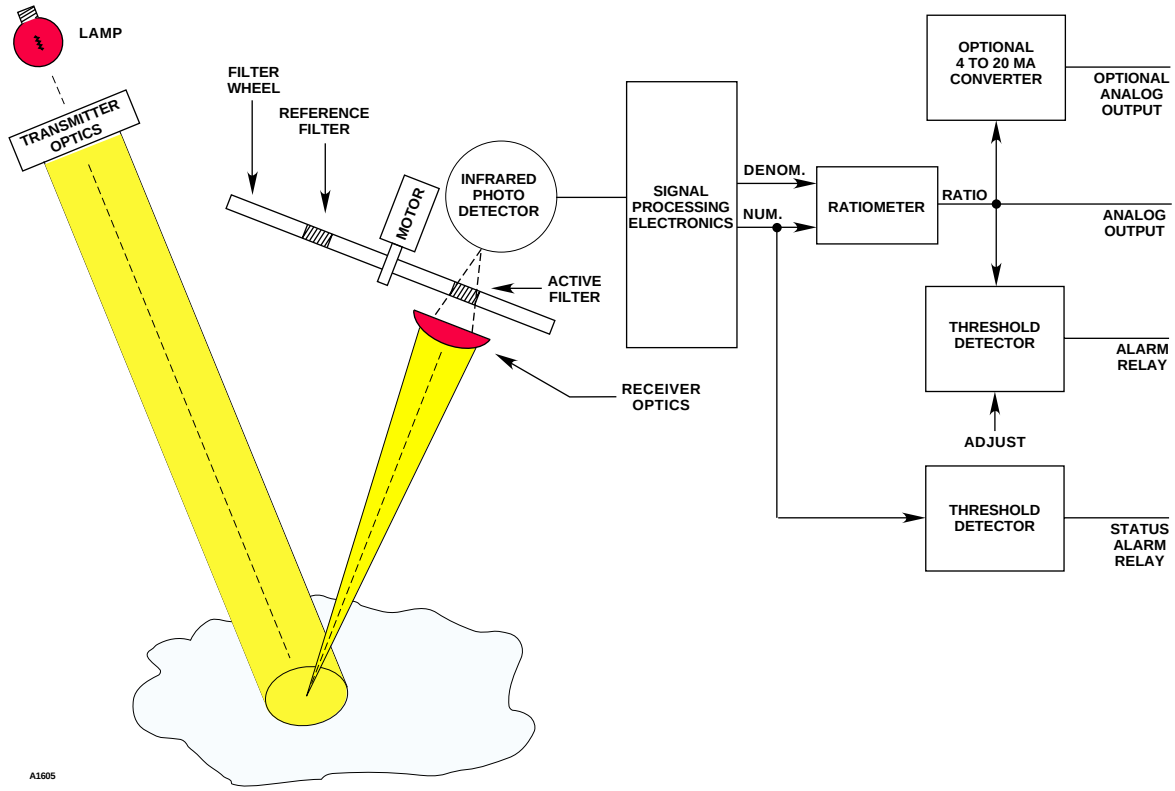


Figure 1—Functional Block Diagram

TRANSMITTER

The transmitter projects a beam of light onto the water surface to be monitored. A tungsten halogen lamp is mounted at the focal point of an aluminum parabolic reflector in the transmitter housing.

RECEIVER

The receiver contains the optical and mechanical components and electrical circuits that receive the light emitted by the transmitter and process the signal to obtain an oil film/no oil film output.

Receiver Lens

Light enters the receiver through the infrared transmitting lens located within the lensholder. The lens focuses the incoming light onto the face of the infrared photodetector.

Filterwheel Motor

This motor is a small 115 VAC shaded pole ball-bearing motor. The filterwheel is attached to the motor shaft.

Filterwheel

The filterwheel is located between the receiver lens and the photodetector. It contains the DENOMINATOR (active) and NUMERATOR (reference) optical interference filters. Rotating at a rapid rate, the filterwheel chops the incoming light beam and alternately passes infrared light at the two distinct wavelengths to the photodetector.

Sync Pickoff

The sync pickoff is a small, "U"-shaped optical switch mounted on the Rear Panel printed circuit board and straddling the filterwheel. It employs a light source and a silicon photodetector at opposite ends of the "U" to sense when each filter is in front of the infrared photodetector. Light emitted by the sync pickoff passes through slots in the outer edge of the filterwheel and generates the synchronization signal.

Photodetector

The infrared photodetector is mounted at the focal point of the receiver lens. The photodetector converts the intensity of the incoming infrared light to a proportional electrical signal. It alternately senses the light intensity at both wavelengths during each revolution of the filterwheel. The photodetector is thermo-electrically cooled to increase the sensitivity to infrared light.

Amplifiers

The signal at the photodetector is amplified by the preamplifier circuitry. The gain of the preamplifier can be adjusted with an internal potentiometer to optimize the signal strength for long or short operating distances.

The amplified signal is fed to the AGC amplifier, which maintains the signal within the proper operating range.

Signal Processing Electronics

The signal from the AGC amplifier is separated into two outputs: active (DENOMINATOR) and reference (NUMERATOR).

Ratiometer

The ratiometer circuit generates an analog output by calculating the ratio of the NUMERATOR (reference) signal to the DENOMINATOR (active) signal.

Optional Film Thickness Discriminator

This option converts the 0 to 10 VDC voltage into a positive voltage (approximately +1.0 VDC) for "thin" oil films (average thickness of less than 10 micrometers) and a negative voltage (approximately -15.0 VDC) for "thick" oil films (average thickness greater than 10 micrometers). With this option the oil alarm relay is energized when a "thick" film is present and inhibited when a "thin" film is present.

Optional Selectable Criteria Alarm

With this option the oil alarm relay activates only if either of the following conditions are met:

1. The time of uninterrupted oil observation exceeds a preset duration between 1 second and 999 seconds.

2. The percentage of accumulated time during which oil is observed exceeds a preset percentage between 10% and 90% measured over a 1000 second interval.

Optional 4-20 mA Converter

This option converts the 0 to 10 VDC voltage into a 4 to 20 mA current when a load resistor is connected between the RATIO output and the signal ground. The loop resistance cannot exceed 500 ohms.

Threshold Detector: Oil Alarm Relay

This threshold detector activates when the voltage of the RATIO increases above a preset value. Activation of this threshold detector causes the oil alarm relay to energize indicating that oil is present on the water surface within the instrument's field of view. The threshold level at which the oil alarm relay is energized can be adjusted and tested on the front panel.

Threshold Detector: Instrument Status Alarm Relay

This threshold detector activates when the NUMERATOR voltage level approaches zero. Activation of this threshold detector causes the instrument status alarm relay to de-energize. Because the relay is energized in normal operation and is de-energized when the beam is blocked or when an instrument malfunction occurs, the alarm is fail-safe.

Receiver Power

The incoming power (115 VAC) is used to operate the filterwheel motor, the oil alarm relay, the obstruction/instrument status alarm relay and the low voltage power supplies. The instrument's signal circuits are powered by a ±15 VDC supply. The circuit that controls the photodetector's thermo-electric cooler is powered by a +5 VDC supply.

Fuses

The incoming power line is fused internally to protect the instrument from damage. These fuses are accessible on the front panel.

Section 2
Operation

SAFETY INFORMATION

EXPLOSION-PROOF INTEGRITY

WARNING

The SW9200 housings or associated junction boxes must never be opened when circuits are alive and hazardous vapor conditions may exist. In procedures where the cover, window assembly or junction box is to be opened when circuits are alive, first ensure that no hazardous vapor conditions exist.

CAUTION

If power is to be disconnected for an extended period, e.g., over one week, the instrument should be removed to a protected environment.

Special precautions must be taken with the SW9200 to ensure the integrity of the explosion-proof housings. When the instrument is in operation, the window assemblies must be securely tightened. The cover bolts must be torqued to 20 foot pounds.

It is recommended that the window retaining ring tightness be verified after shipment and just prior to initial setup. The window assembly retaining ring must be tightened to hold the window securely against the window cover. The retaining ring must be tightened until 0.003-inch feeler stock will not penetrate more than 1/8th of an inch between the window and the window cover. This should be checked on both the transmitter and the receiver around the entire circumference of the window on both the inside and the outside.

Scratches may affect the strength of the instrument windows, so care must be taken to avoid scratching them during installation, operation, and servicing. Similarly, the mating surfaces of the cover and the housing flange should not be scratched and these surfaces should be protected during servicing.

The light beam projected by the SW9200 transmitter could cause combustible materials within its path to ignite, or raise the temperature of an object within its path above the self-ignition temperature of some gases. Check the temperature code for the transmitter wattage used (see instrument nameplate) and do not install the instrument at any location where this dangerous condition could occur. Do not allow any object to intercept the transmitter beam path to the water surface.

PERSONNEL SAFETY

The American Conference of Governmental Industrial Hygienists (ACGIH) has roughly established Threshold Limit Values (TLVs) or maximum allowable exposures to bright light sources during an eight-hour workday. According to ACGIH, "these values are to be used as guides to the control of exposure to light and should not be regarded as the fine line between safe and dangerous levels".

WARNING

It is possible to exceed the ACGIH limit values by viewing the oil slick detector's light source directly from the center of the light beam at distances less than approximately ten feet from the source. DO NOT stare directly into the light source at close range.

As with the sun, which greatly exceeds the Threshold Limit Values established by the ACGIH, the eye's self-protection mechanism (blinking) activates and automatically prevents overexposure.

FRONT PANEL CONTROLS

Front panel controls are described in the following paragraphs and are illustrated in Figure 2. Access to the front panel controls is gained by removing the receiver window assembly.

ZERO

The ZERO adjustment potentiometer is used to factory set the analog output (RATIO) for oil-free water.

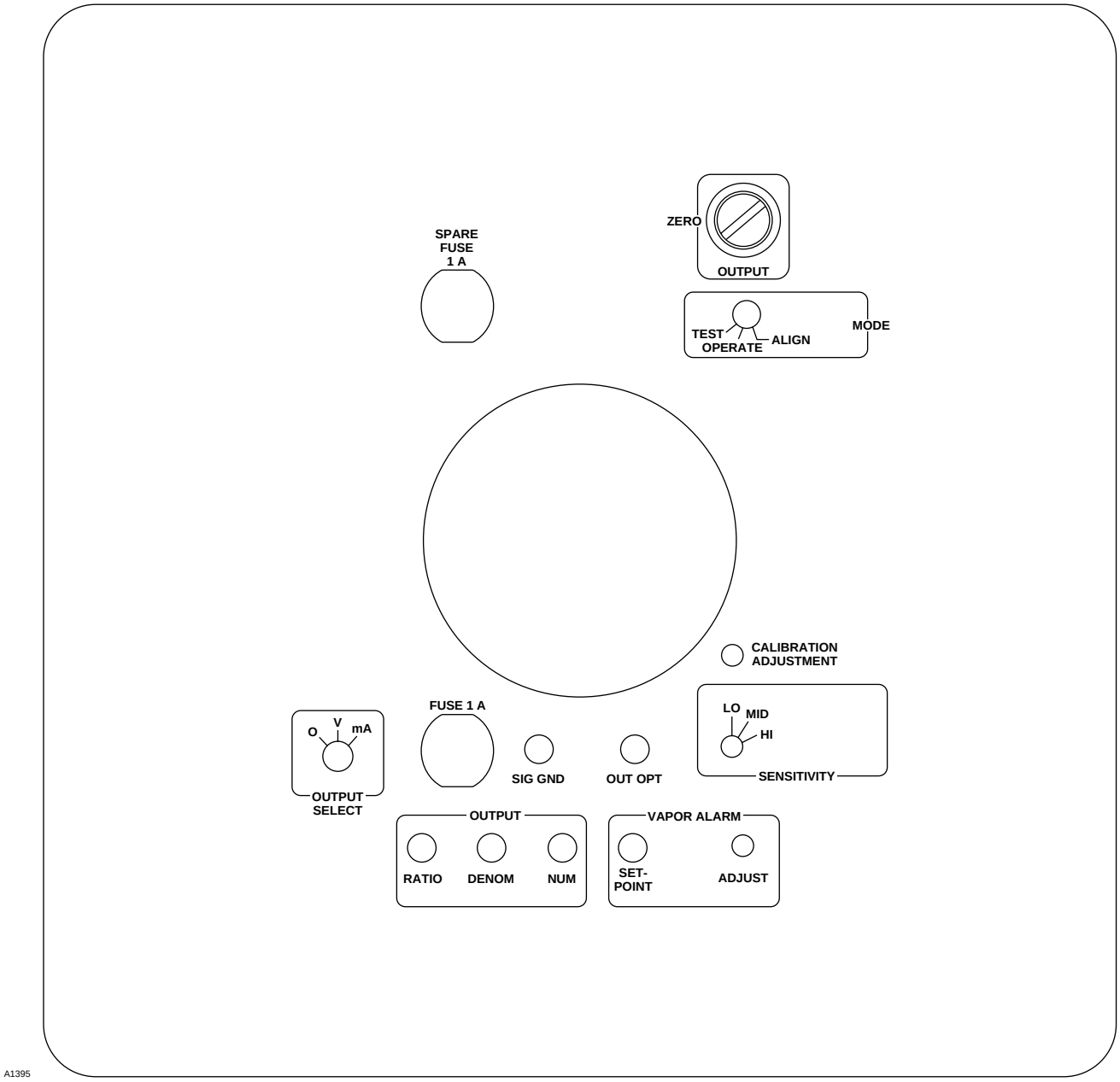


Figure 2—Front Panel Controls

MODE

The MODE selector switch permits adjustment of the instrument's response time and testing of the alarm relays.

Align

A shorter response time (approximately 2 seconds) is used only during the alignment and testing process.

Operate

A longer response time (approximately 20 seconds) is used during normal operation to compensate for short term signal variations and to prevent the oil alarm from activating on short oil slicks.

Test

Test mode activates the oil alarm circuits.

OIL ALARM

Adjust

The OIL ALARM adjustment potentiometer is used to set the threshold at which the RATIO voltage energizes the oil alarm relay. The OIL ALARM is adjustable from 10% full scale to 100% full scale. This adjustment is disabled when the Film Thickness Discriminator optional p.c. board is used. When the Selectable Criteria Alarm optional p.c. board is installed, this control sets the threshold at which the selectable criteria alarm circuit is activated.

Setpoint

The OIL ALARM Set Point test jack is used to access the oil alarm threshold setting. This test jack is not used with the Film Thickness Discriminator option.

OUTPUT

The OUTPUT test jacks permit access to the NUMERATOR, DENOMINATOR AND RATIO outputs:

RATIO (brown)

RATIO (processed ratio of the two reflected IR beams): 0 to 10 V.

DENOM (red)

DENOMINATOR (intensity of one of two reflected IR beams): 0 to 1 V.

NUM (blue)

NUMERATOR (intensity of the second of two reflected IR beams): 0 to 1 V.

SIG. GND. (green)

The SIG. GND. test jacks permits access to signal ground.

OUT. OPT.

The OUT. OPT. test jack permits access to the optional RATIO output and is used only if an Options p.c. board (e.g. Film Thickness Discriminator) is installed.

FUSE

Two power line fuses have been located on the front panel for accessibility. For standard 115 V power, only the hot line is fused. The other fuse is a spare.

OUTPUT SELECT

This switch is used to select the type of RATIO output that is available at the junction box:

O – Optional output mode

This position is available for optional processing data output (e.g. Film Thickness Discriminator) if the optional board is installed.

V – Voltage output mode

This position brings the RATIO output in 0-10 VDC to terminal 1 of the junction box.

mA – Milliamp output mode

This position brings the RATIO output in 4-10 ma to terminal 1 of the junction box, if this option was installed.

INSTALLATION

INSPECTION

Since the instrument may be subjected to shock or vibration during shipping, an inspection of the connections and filterwheel is recommended.

Prior to the initial setup of the instrument, open the housing (see Access to Internal Components procedure) and check that the printed circuit board(s) are securely held in the connector(s). If a board has become dislodged, return it to the proper connector. The Synchronous Demodulator Board is on the left of the filterwheel and the Options Board is on the right (Figure 3).

Observe the location of the keys and do not attempt to insert the printed circuit board(s) backwards. Be certain that the board is firmly seated in the connector and that both the top and bottom are held by the card guides. Check that the ribbon connectors on the AGC/TE Cooler Board and on the Rear Panel Board are fully engaged and that the latches are locked. Rotate the filterwheel to check that it spins freely. Check that the two receiver connectors are securely engaged.

SITE REQUIREMENTS

The SW9200 is normally mounted from five to 30 feet above the water surface to be monitored. It views a small area of the water surface directly below the instrument. The maximum operating height is determined by the turbulence of the water surface below the instrument. A graph in the APPENDIX shows the maximum operating height as a function of water turbulence, where turbulence is characterized by the maximum angle of the waves.

The instrument's viewing path down to the water must be unobstructed. It should be placed where oil spilled on the water is likely to be carried past the receiver's field of view by spreading, prevailing winds, currents, waves or deflecting booms. An ideal site is just at a dam spillway, where turbulence is relatively low and constant. External hazards to the instrument, such as boat docking activity and possible vandalism, must be taken into account when choosing a location for instrument mounting. The instrument's field of view should be as far as possible (at least 12 inches) from obstructions in the water such as pilings, walls, ladders, etc., as such obstructions tend to repel an oil film by breaking up the film's surface tension.

If the instrument is installed in a high temperature, high humidity, or corrosive atmosphere, instrument air or dry nitrogen purge is recommended.

Do not install the instrument so that the receiver directly faces an intense heat source.

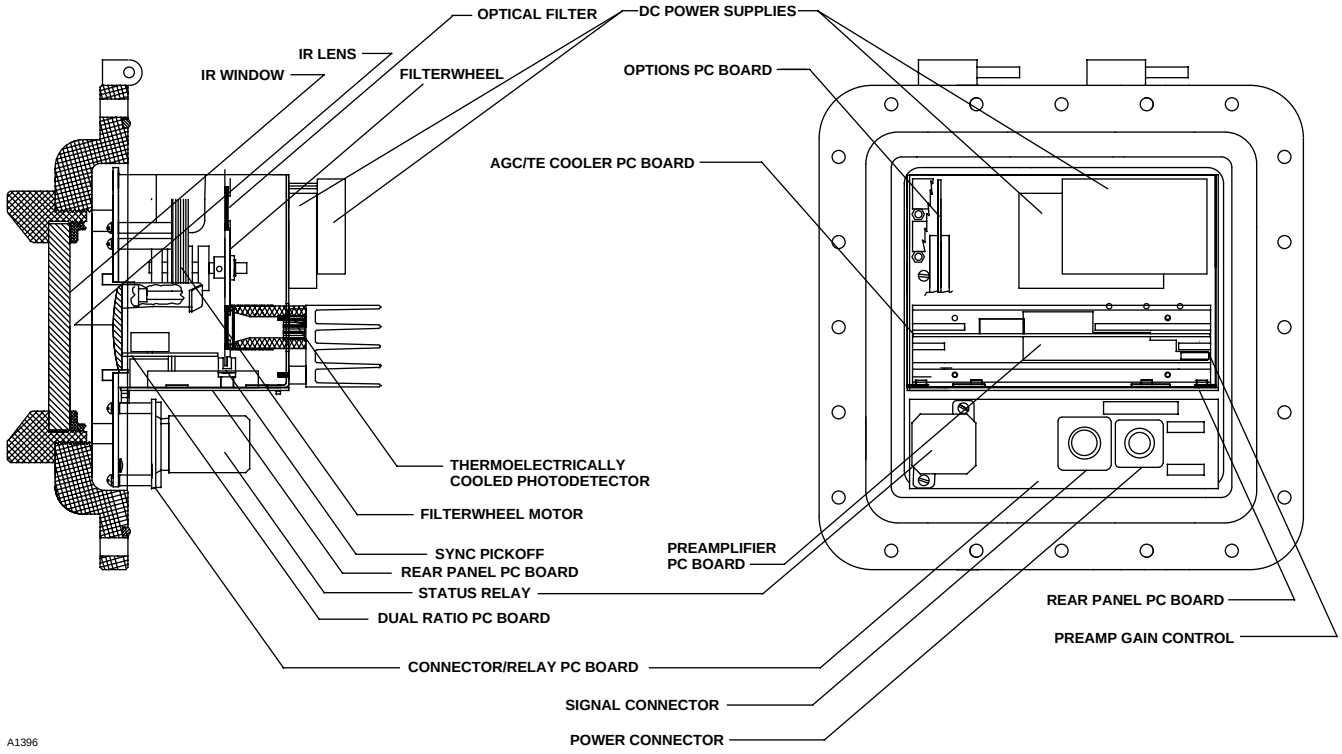


Figure 3—Location of Receiver Boards and Assemblies

CAUTION

If power is to be disconnected for an extended period (e.g. over one week), the instrument should be removed to a protected environment.

MOUNTING

The SW9200 transmitter and receiver are bolted side by side to a user-supplied mounting platform. See Figure 4 for hole locations on the mounting plate. The transmitter and receiver housings are attached to mounting plate as shown in Figure 5. A suggested mounting framework is illustrated in Figure 6.

The mounting framework must be securely stabilized to assure retention of alignment over time and temperature fluctuations. The framework should also be isolated against external vibration.

A hinged mounting platform is recommended for ease of service and adjustment. This type of platform has both a "service" and an "operate" position, which facilitates access to the controls without altering alignment.

INITIAL SETUP

When the inspection procedures and special precautions detailed above have been carefully observed, the initial setup of the SW9200 is accomplished by following Steps 1 through 11 below:

CAUTION

Do not remove protective window covers until Step 7.

Do not mount instrument until power is available. In order to minimize the possibility of condensation forming inside the instrument, once mounted the instrument should not be left without power for extended periods of time.

1. Attach the transmitter and the receiver to the user-supplied mounting plate with the 3/8-16 x 1-1/2" stainless steel bolts, nuts and washers provided with the instrument.

2. Connect external wiring as shown in Figure 7.

CAUTION

Power wire with AC voltage closest to ground potential should be connected to terminal "N". Power wire with AC voltage furthest from ground potential should be connected to terminal "L".

Strip the insulation back 1/4 inch. Insert the stripped wire into the terminal under the appropriate number. Tighten the screw above the number by turning it clockwise using a screwdriver with a 1/8" blade. All terminals in the junction box are numbered. Low voltage signal lines (RATIO, NUMERATOR and SIGNAL GROUND) and high voltage power lines from the junction box should be in separate cables, if possible. If the signal and power lines are not in

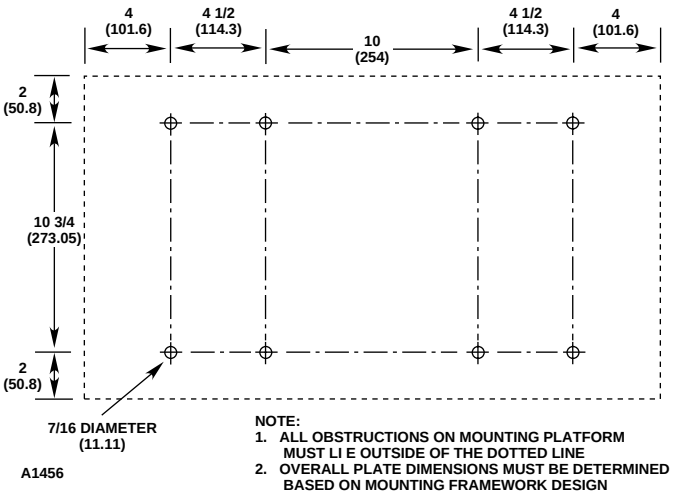


Figure 4—Mounting Platform Hole Pattern

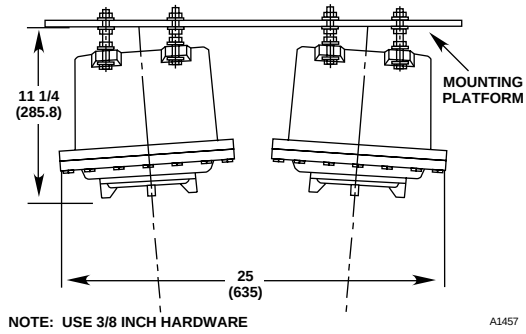


Figure 5—Mounting Platform

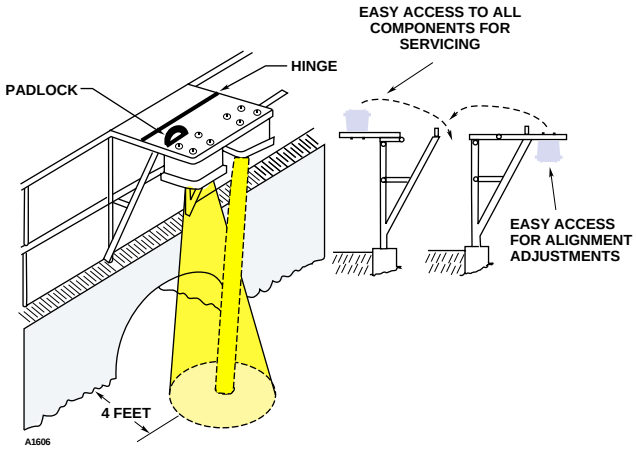


Figure 6—Typical Mounting Framework (User-Supplied)

separate cables, the high voltage power wires (115 VAC line and Power Ground) must be shielded from the signal lines for safety reasons. Any conduit installed must be of a flexible, explosion-proof type which will allow 180 degree rotation of the mounting plate and instrument and allow adjustment of the housings for optimum alignment.

WARNING

If both conduit entrances to the junction box are not used, the unused entrance must be fitted with an explosion-proof pipe plug with at least five full threads engaged.

RATIO, NUMERATOR and SIGNAL GROUND wiring from the junction box should be connected to external readout devices of at least 5,000 ohms impedance. If the 4-20 mA output is installed, the loop resistance must be less than 500 ohms.

3. Connect OIL ALARM relay and STATUS ALARM relay signal terminals (4,5,6 and 7) to external readout devices (e.g. indicator lamps, alarm buzzers, motors, computer interface, etc.). The Oil Alarm relay contacts open when a film of oil is present on the water surface. The Status Alarm relay contacts open when an obstruction or instrument failure is detected.

4. Connect transmitter and receiver to the power source. DO NOT apply power.

5. In preparation for optical alignment, remove the receiver window assembly by rotating it counterclockwise. Avoid touching the window with bare hands. Move the window assembly to a safe place, being careful not to scratch the window.

6. Set the MODE selector switch on the front panel to the ALIGN position and replace the window assembly.

7. Remove protective window covers from both the transmitter and the receiver. Do not discard.

8. Be sure that the cover bolts are tight. Check tightness of junction boxes and window assemblies.

9. Rotate both transmitter and receiver mounts 180 degrees so that the instrument is viewing the water surface.

10. As power is first applied to the instrument, the transmitter lamp should light and a faint rotation noise may be heard within the receiver housing.

11. Allow at least one hour warmup time with the instrument operating continuously before proceeding to alignment.

NOTE

The instrument is designed for continuous operation. Excessive application and disconnection of power to the transmitter will shorten the life of the lamp.

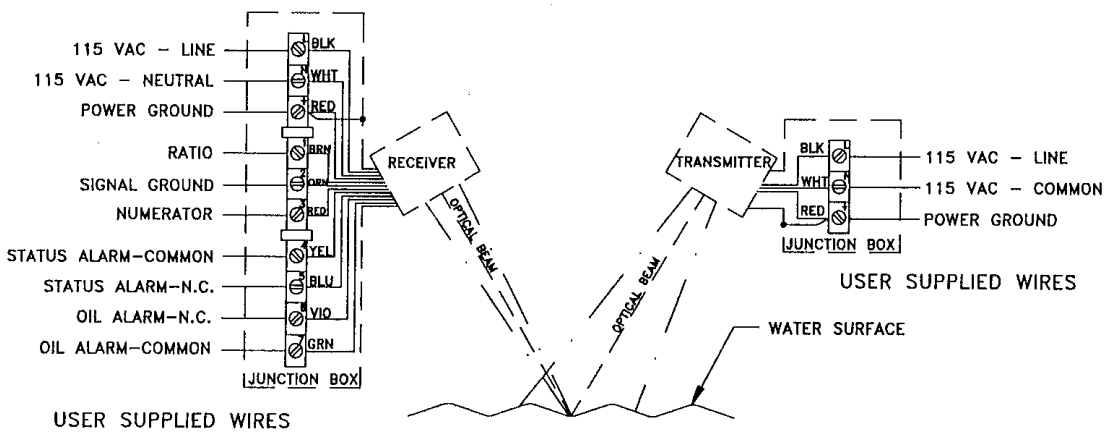


Figure 7—System Interwiring Diagram

Height Above Water (Feet)	(Meters)	Diameter Monitored (Inches)	(Millmeters)	Assuming 14.5 Inches Separation Angle From Vertical (Degrees)	Assuming 368.3 Millimeters Separation Angle From Vertical (Degrees)	Shim Thickness Under Box (Inches)	(Millimeters)
5	1.52	3.00	76.20	6.89	21.63	0.544	13.811
10	3.05	6.00	152.40	3.46	11.21	0.272	6.906
15	4.57	9.00	228.60	2.31	7.53	0.181	4.604
20	6.10	12.00	304.80	1.73	5.66	0.136	3.453
25	7.62	15.00	381.00	1.38	4.53	0.109	2.762
30	9.14	18.00	457.20	1.15	3.78	0.091	2.302

OPTICAL ALIGNMENT

Accurate alignment is generally not critical when the water surface is turbulent, but it is quite critical when the water surface is calm. For this reason, alignment should be accomplished when the water surface is calm to allow for the worst-case situation. If the water surface to be monitored is affected by tides or storm flood variations, these steps should be followed at mid-tide or the usual water level.

While alignment is time-consuming, it can be reassuring to note that it should not be necessary to repeat this procedure for the duration of the instrument's use at a particular site. Once the correct alignment has been achieved, the housings will be locked in position and removal of the cover or window assemblies for servicing should not affect the alignment of the instrument.

1. Use shims to "toe in" the transmitter and receiver so that both appear to be aimed at approximately the same point on the water surface directly below the instrument, as shown in Figure 8.

2. Using the test jacks on the front panel, connect a digital voltmeter (with a resolution of at least 1 millivolt DC) between the NUMERATOR output (blue) and SIGNAL GROUND (green).

NOTE

All voltage readings must be taken using a DC voltmeter with a 10 Megohm input impedance. Use of other devices will give inaccurate readings.

3. Change the transmitter angle slightly and note the change in the voltage observed in Step 3. If the voltage decreases, change the angle in the opposite direction to increase the NUMERATOR voltage.

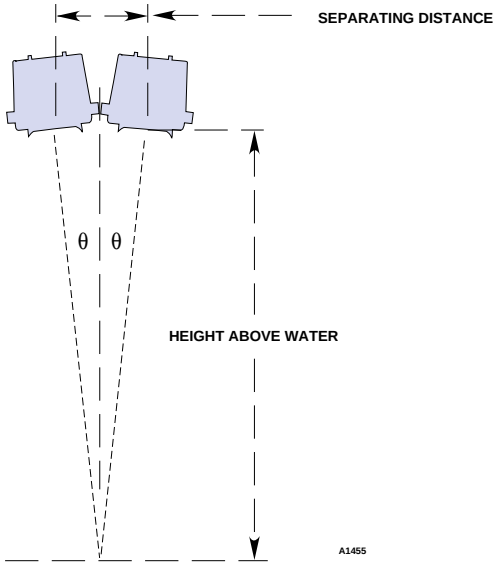


Figure 8—Alignment of Transmitter and Receiver

4. When the maximum possible voltage has been obtained and recorded with the transmitter, adjust the receiver angle until a maximum NUMERATOR signal strength is obtained. Record the voltage.

5. Repeat Steps 3 and 4 to maximize the NUMERATOR output.

6. Once optimum alignment has been obtained, carefully tighten the mounting nuts with a wrench, being careful to maintain the proper angle of alignment obtained in the previous steps.

7. Return the MODE selector switch on the front panel to the OPERATE position.

OPERATION/PERFORMANCE CHECK

SIGNAL STRENGTH

The NUMERATOR voltage should be measured to determine if the signal strength reflected from the water surface and received by the instrument is within the proper range. This voltage will decrease as the water surface becomes more turbulent and will increase as the water surface calms. The NUMERATOR voltage should be observed under the worst-case surface turbulence conditions as well as with the calmest water surface possible.

1. Observe and record the NUMERATOR voltage under the worst-case water surface turbulence conditions.

2. If the voltage drops below +0.25 VDC, increase the preamplifier gain as described in Step 3.

3. To adjust the preamplifier gain, follow the Access to Internal Components procedure (see MAINTENANCE section) and locate the Preamplifier p.c. board within the heat sink fins. The Preamplifier Gain Adjustment potentiometer is located on the Preamplifier p.c. board and can be reached by inserting a screwdriver between the fins from the bottom of the heat sink (as viewed when the cover is open but attached to the housing by its hinges). Turn the Preamplifier Gain Adjustment potentiometer clockwise to increase the preamplifier gain.

4. Observe and record the NUMERATOR voltage with very calm water surface conditions.

5. If the voltage exceeds +0.75 VDC, decrease the preamplifier gain by turning the Preamplifier Gain Adjustment potentiometer counterclockwise.

OUTPUT ZERO

The Output Zero (RATIO) is factory set for oil-free water. The Output Zero (RATIO) should be checked periodically and the ZERO potentiometer should be adjusted when necessary.

1. With the instrument viewing oil-free water and both transmitter and receiver windows in place, record the RATIO voltage at the junction box (TERMINAL 1). If the RATIO voltage is not 1.0 ±0.5 VDC, the ZERO potentiometer should be adjusted as described in the following steps.

2. Remove the receiver window and locate the ZERO potentiometer on the front panel.

3. If the RATIO voltage recorded in Step 1 was higher than 1.0 ±0.5 VDC, rotate the ZERO potentiometer counterclockwise until the RATIO output is within the desired range.

4. If the RATIO voltage recorded in Step 1 was lower than 1.0 ±0.5 VDC, rotate the ZERO potentiometer clockwise until the RATIO output is within the desired range.

OIL RESPONSE CONFIDENCE TEST

To verify that the instrument is responding to the presence of an oil film on the water surface:

1. With power applied to the instrument, connect a digital voltmeter between the RATIO output (brown) and SIG. GND. (green) on the front panel, or on the appropriate terminals in the junction box.

2. With the instrument viewing clean water, introduce a small amount of test oil - either in a test pan or on the actual water surface being monitored.

3. The RATIO should increase above +2.0 VDC. If the RATIO output does not increase, consult Troubleshooting Table.

STATUS ALARM CONFIDENCE TEST

To verify that the instrument status alarm is working properly:

1. With power applied to the instrument, block the beam with an opaque object.

2. The Status Alarm should activate within 120 seconds. If Status Alarm does not activate, contact the factory for assistance.

INSTRUMENT OUTPUT

The 0-10 VDC RATIO output is available on all SW9200 instruments at the RATIO (brown) test jack on the front panel, and at terminal 1 of the receiver junction box when the OUTPUT SELECT switch is set to position V (volts). When viewing an oil film using the standard 0-10 VDC output, the RATIO output will vary according to the type and severity of the oil spill. The output does not increase linearly with film thickness. Generally, a thin film of oil will give a RATIO output between +1.5 and +10 VDC, with wide fluctuations due to irregularities in the film. Thicker oil films (greater than 10 um average thickness) tend to produce a steady RATIO output between +3.0 and +7.0 VDC.

An optional Film Thickness Discriminator can be ordered with the instrument. Located on the Options p.c. board, this option converts the standard 0 to 10 VDC RATIO output to a "high" -"low" output. With the Film Thickness Discriminator option, the OUTPUT SELECT switch on the front panel must be set on the O position (options). When a "thin" film (less than 10 micrometers) is observed, the RATIO output will be a positive voltage (approximately +1.0 VDC). When a "thick" film (greater than 10 micrometers) is observed, the RATIO output will be a negative voltage (approximately -15.0 VDC).

The Selectable Criteria Alarm option, located on the Options p.c. board, delays the activation of the oil alarm relay until either of two selectable conditions are met.

NOTE

If either the Film Thickness Discriminator or Selectable Criteria Alarm Option has been purchased with the SW9200, additional information will be found in the APPENDIX.

An optional 4-20 mA output can be ordered with the instrument or can be field installed at any time after purchase. The 4-20 mA output option, located on the Options p.c. board, converts the standard RATIO output from 0 to 10 VDC to 4-20 mA. If installed, the 4-20 mA output will be available at terminal 1 of the receiver junction box when the OUTPUT SELECT switch on the front panel is set to the mA position. The 4-20 mA current can be tested by removing the RATIO wire in the junction box and connecting a current meter between the RATIO wire and terminal 1. The 4-20 mA output will drive a user-supplied load of 0 to 500 ohms. The 4-20 mA output is surge protected by transient protection devices.

NOTE

The Film Thickness Discriminator, the Selectable Criteria Alarm and the 4-20 mA Output options cannot be used in combination in the SW9200.

The RATIO output in this manual is indicated in 0-10 VDC. For instruments using the 4-20 mA output, the standard 0-10 VDC output can be read at the RATIO test jack (brown) on the front panel or at the receiver junction box when the OUTPUT SELECT switch is set to the V position. In addition, a voltage to current transfer curve is provided in the APPENDIX.

Outputs should be monitored as required by the particular application. When the instrument views clean water, the RATIO voltage will be between 0.5 and +1.5 VDC. The voltage levels at the outputs of the NUMERATOR and DENOMINATOR will vary according to the water surface condition.

If the above mentioned indications do not occur, or in the event of a prolonged instrument status alarm, consult the Troubleshooting Table.

OIL ALARM THRESHOLD ADJUSTMENT

Based on the specific application of the instrument, select the RATIO voltage threshold at which the Oil Alarm will activate. The Oil Alarm is factory set at +2.0 VDC. To test the SW9200's sensitivity to oil films, allow it to view clean water and then add a small quantity of oil to the water, either in a test pan or on the water surface being monitored. Appropriate containment and cleanup procedures must be carefully followed to avoid violation of Federal, state or local regulations. If the oil alarm activates at a smaller quantity of oil than required by the instrument's application, instrument sensitivity may be slightly decreased (or increased) by the following procedure:

1. Attach a digital voltmeter between the OIL ALARM SETPOINT jack (grey) and SIG. GND. (green) on the front panel.

2. Adjust the OIL ALARM ADJUST potentiometer on the front panel so that the Oil Alarm set point voltage is slightly lower than the desired RATIO output.

NOTE

The oil alarm threshold adjustment is disabled when the Film Thickness Discriminator optional p.c. board is used.

The oil alarm threshold adjustment provides the definition of "oil observation" for the Selectable Criteria Alarm Option. See the APPENDIX for information on the alarm criteria settings for this option, if installed.

INFRARED PHOTODETECTOR TEMPERATURE ADJUSTMENT

The infrared photodetector is thermo-electrically (TE) cooled to increase its sensitivity to infrared light and to maintain a constant sensitivity over a wide range of ambient air temperatures. Two temperature settings are available on the AGC/TE Cooler p.c. board. The JP-1 setting (two left pins) maintains the detector temperature at approximately -20^{o} C and the JP-2 setting (two right pins) maintains a temperature of approximately 0^{o} C. The coolest temperature setting (JP-1) should be used under normal ambient conditions and for normal and long operating heights. The JP-2 setting should be used for short operating heights and in extremely hot environments where the cooler may not be able to maintain a constant -20^{o} C temperature.

Section 3
Maintenance

GENERAL PRECAUTIONS

As with all precision electro-optical equipment, care must be taken to avoid sharp blows to the instrument. Do not drop it or allow heavy objects to strike it. Do not touch the windows, lenses, lamps, filters, or other optical surfaces with bare hands. Customary precautions for the use of explosion-proof instruments in hazardous environments should be observed. In procedures where either cover, window assembly, or junction box are to be opened when circuits are alive, first ensure that no hazardous vapor conditions exist.

WARNING

Live line voltage is exposed at several points within the SW9200. This is potentially dangerous, and contact by maintenance personnel must be avoided.

ACCESS TO INTERNAL COMPONENTS

All internal components of the transmitter and receiver are mounted to the cover (see Figure 3). Access to these components is obtained either by swinging open the cover on its hinges, or by removing the cover and associated components from the housing.

1. Disconnect all power to the instrument. Rotate the mounting plate 180 degrees so that the instrument faces up.

2. Remove the 20 bolts which hold the cover to the housing.

3. Swing open the cover to permit access to the connector(s). DO NOT OPEN the receiver cover more than three inches, to prevent undue stress on the connector(s).

4. Disconnect the connector plug(s) from the receptacle(s). The transmitter has one connector and the receiver has two connectors. The instrument can be inspected or serviced on-site while the cover is opened and attached by its hinges. If service is to be performed off-site, the cover and attached components may be removed from the housing as described in Step 5.

5. With the cover swung open, lift the cover up to disengage the hinges. Care must be taken to avoid scratching the flanges or damaging the internal components.

Each time the instrument housing is opened for maintenance, the desiccant pack should be checked. When the desiccant is expanded only slightly, no change is necessary. If it is expanded to twice or more its original size, the desiccant should be replaced. Extra desiccant packets are available from Detector Electronics (see Recommended Spare Parts List). DO NOT replace the desiccant until all other maintenance procedures have been completed. Remove the old desiccant by cutting the strings that attach it to the power supply wiring. Remove the plastic bag on the replacement packet and tie it to the power supply wiring. Be sure that the desiccant packet is securely attached to the power supply wiring so that it cannot come loose inside the housing. Close the cover immediately after replacing the desiccant.

To reattach the cover to the instrument housing:

1. Holding the cover completely open, slide the cover hinge pins onto the housing hinges. Do not tighten the hinge screws.

2. If necessary, replace the desiccant pack.

3. Reconnect the plug(s) and receptacle(s) in the housing and close the cover. Guide the cable to insure that it is not pinched.

4. Rotate the mounting plate 180 degrees so that the instrument is in position for operation.

SCHEDULED MAINTENANCE

NOTE

To avoid dropping assemblies, tools, etc., into the water, it is recommended that all maintenance procedures be accomplished with the mount and instrument rotated up to face the technician.

It is recommended that the following maintenance procedures be performed periodically as described:

Maintenance Procedure	Scheduled Interval 12 mo.	24 mo.
Clean exterior optical components	X	
Clean interior optical components		X
Replace filterwheel motor	X	
Replace 250W lamp*	X*	
Replace desiccant	X	

* Interval is dependent on line voltage (see Replacement of Transmitter Lamp procedure).

CLEANING OF OPTICAL COMPONENTS

Exterior (12 month interval) - Due to the gradual accumulation of dust, chemical deposits, or other foreign matter, the exterior optical surfaces must be cleaned at least every twelve months. In some applications, cleaning of the windows may be required more frequently. The need for cleaning can usually be detected by a gradual decrease in the NUMERATOR and DENOMINATOR outputs and/or by visual inspection of the optical surfaces.

1. Disconnect all power to the instrument.

NOTE

If possible, direct a flow of clean, oil-free compressed air onto the optical surfaces before and after cleaning.

2. Clean the outer surfaces of the transmitter and receiver windows with clean cotton swabs and alcohol. Finish with clean optical tissue. DO NOT TOUCH the windows or other optical surfaces with bare hands.

3. Reconnect the instrument and reapply power.

Interior (24 month interval) - Interior optical components (inside surface of window, lens, filters and sync pickoff) should be cleaned every two years. Although it is possible to perform all these procedures on-site, a lab environment is preferable as it is cleaner and easier to work in. (See ACCESS TO INTERNAL COMPONENTS.)

Window

Interior windows are reached by removal of the transmitter and receiver window assemblies. Clean as described in exterior optical cleaning procedure above.

Lens, Sync Pickoff and Optical Filters

1. Remove motor and filterwheel by following Replacement of Filterwheel Motor procedure.

2. The lens is located in the center of the receiver baseplate. Using clean cotton swabs and alcohol, clean both sides of the lens. Finish with clean optical tissue.

3. The sync pickoff is located at the center of the Rear Panel p.c. board on the inside of the motorbox. The optical surfaces are located on the inside of the "U" shaped device. Using clean cotton swabs and alcohol, clean both optical surfaces of the sync pickoff. Remove any excess alcohol and completely dry the surfaces with clean, dry cotton swabs.

4. The optical filters are located in the filterwheel, which is attached to the motor shaft. Clean both sides of each filter using clean cotton swabs and alcohol. Finish with clean optical tissue.

REPLACEMENT OF FILTERWHEEL MOTOR (12 month interval)

It is recommended that this procedure be performed in a lab environment. (See ACCESS TO INTERNAL COMPONENTS). Cleaning of interior optical components should be done after the filterwheel motor is removed. Power should be disconnected for this procedure.

1. The receiver cover and internal components should be placed so that the open side of the motorbox faces the technician and so that the power supplies are to the left. The assembly should be securely propped during this procedure to avoid damage to the internal components.

2. Remove the Sync Demod and Options p.c. boards and disconnect the motor connectors. Note the routing of the wires.

3. While holding the motor still, remove the four 6-32 screws that attach the motor and standoffs to the front panel.

4. Avoiding contact with the sync pickoff on the Rear Panel p.c. board, carefully slide the motor and attached filterwheel out of the motorbox. Viewing ports have been provided on each side of the motorbox to permit visual inspection of the position of the filterwheel relative to the sync pickoff.

5. Remove the nut that holds the hub to the filterwheel and detach the filterwheel from the hub. DO NOT TOUCH the optical filters with bare hands.

6. Remove the nut from the replacement motor hub and slide the filterwheel onto the replacement motor shaft. Make sure that the side of the filterwheel with the filter retaining rings/fan blades is facing toward the body of the motor. Replace the nut, using low strength thread locking compound on the threads of the hub. Make sure the compound is thoroughly dried before rotating the filterwheel.

7. Replace the motor/filterwheel assembly ensuring that the filterwheel edge is straddled by the sync pickoff. Check that the filterwheel does not come into contact with the sync pickoff during rotation. Route the wires so that they are not in front of the lens.

8. Replace the four screws that hold the motor to the front panel. Reconnect the motor connectors.

REPLACEMENT OF TRANSMITTER LAMP (Variable Interval)

Replacement of the 250 watt lamp is dependent on the line voltage at the installation:

LINE VOLTAGE	EXPECTED 250 W LAMP LIFE*
130 VAC	2,000 hours
123 VAC	4,000 hours
117 VAC	8,000 hours
111 VAC	16,000 hours

* Repeated application and disconnection of power to the instrument or excessive shock/vibration can significantly reduce the expected lamp life.

WARNING

Do not inspect the transmitter while the lamp is operating. To avoid possible eye damage, disconnect instrument power before checking.

To replace the transmitter lamp, use the following procedure:

1. Disconnect all power to the instrument.

2. As an additional precaution, disconnect power wires at the junction box.

3. Remove the window assembly from the transmitter housing by rotating it counterclockwise.

4. Move the window assembly to a safe place, being careful not to scratch the window.

5. Remove the old lamp by rotating it counterclockwise in the socket. DO NOT TOUCH the transmitter reflector with bare hands.

NOTE

DO NOT TOUCH the lamp envelope with bare fingers. Use lamp wrapper provided with new lamp, clean white gloves, or clean optical tissue when inserting a new lamp. Also, be careful to avoid touching the inner surface of the reflector.

6. Install the new lamp by rotating it clockwise until it is firmly seated in the socket. Replacement lamps are available from the factory. (See Recommended Spare Parts List.)

7. Be sure that the lamp is centered in the reflector and does not touch the edge of the reflector opening. If the lamp is touching the reflector, gently apply sideways pressure to bend the lamp/socket assembly until it is no longer touching the reflector opening and is centered. Use clean gloves, tissue, etc., and do not touch the reflector surface or lamp envelope with bare hands, since acid from the fingertips will etch the lamp envelope and materially reduce the life of the lamp.

8. Replace the window assembly and tighten down securely until at least five full threads are engaged.

9. Check tightness of cover bolts and window assemblies on both housings.

10. Reconnect power wires in the junction box.

11. Close and recheck tightness of junction box cover.

12. Reapply power.

13. Repeat Optical Alignment procedure.

TROUBLESHOOTING

For assistance in rectifying set-up problems and simple malfunctions, consult the Troubleshooting Table.

If malfunctions cannot be corrected by carefully following the procedures described in this manual, contact the factory for assistance. In many cases, sufficient information to correct the malfunction can be provided over the telephone. If it is necessary to contact the factory by telephone, it is helpful to have the operation and maintenance manual accessible and to obtain the following readings for the service technician:

Instrument S/N_____

Optionspurchased_____

RATIO _____ VDC

DENOMINATOR _____ VDC

NUMERATOR _____ VDC

Oil Alarm Set Point _____ VDC

Operating Height _____ FT

General Description of Water Surface (Calm, Turbulent, Oily, Flow Rate, etc.):

_____
_____

Both field and factory service are available from Detector Electronics. If it becomes necessary to return an instrument to the factory, extreme care must be taken in packing the instrument for shipment. The monitor should be enclosed in a plastic bag, surrounded with at least two inches of foam or shipping pellets on all sides and shipped in a heavy duty carton. Lack of sufficient cushioning can cause extensive damage to internal components. It is not usually necessary to return the transmitter and, if carefully packed, just the receiver cover and attached components can be shipped without the housing.

TROUBLESHOOTING TABLE

SYMPTOM: **Transmitter lamp does not light.**

POSSIBLE CAUSE: No power to transmitter.
CHECK: Voltage into transmitter. Should be nameplate voltage rating (±10%).
REMEDIAL ACTION: If wrong voltage, check external fusing or defective power wiring to transmitter.

POSSIBLE CAUSE: Defective lamp.
CHECK: Voltage into transmitter before concluding that the lamp is defective.
REMEDIAL ACTION: See Replacement of Transmitter Lamp procedure.

SYMPTOM: **Transmitter lamp consistently burns out before 6 months.**

POSSIBLE CAUSE: Constant high line voltage.
CHECK: Voltage into transmitter. Should be nameplate voltage rating (±10%).
REMEDIAL ACTION: Reduce power line voltage.

POSSIBLE CAUSE: Excessive vibration or shock at transmitter.
CHECK: Environment at transmitter.
REMEDIAL ACTION: Alter mechanical environment at transmitter with vibration isolators, etc.

POSSIBLE CAUSE: Repeated application and removal of power to the transmitter.
CHECK: History since installation.
REMEDIAL ACTION: Maintain power to the instrument at all times.

SYMPTOM: **Transmitter lamp lights, but no output voltage on NUMERATOR relative to SIGNAL GROUND.**

POSSIBLE CAUSE: No power to receiver.
CHECK: Voltage into receiver. Should be nameplate voltage rating (±10%).
REMEDIAL ACTION: If wrong voltage, check external fusing or defective power wiring to receiver.

POSSIBLE CAUSE: Fuse blown in receiver.
CHECK: Listen for faint sound of filterwheel motor in receiver.
REMEDIAL ACTION: If filterwheel is not turning, replace fuse.

POSSIBLE CAUSE: Filterwheel motor failure.
CHECK: Is filterwheel rotating?
REMEDIAL ACTION: If filterwheel does not rotate after replacing fuse, see Replacement of Filterwheel Motor procedure.

POSSIBLE CAUSE: Transmitter and receiver not properly aligned.
CHECK: NUMERATOR voltage when a flashlight or 60W light bulb is held in front of receiver window. Voltage should increase from zero.
REMEDIAL ACTION: Repeat Alignment procedure.

SYMPTOM: **NUMERATOR voltage relative to SIGNAL GROUND exceeds 0.75 VDC or drops below 0.25 VDC after proper alignment.**

POSSIBLE CAUSE: Improper Preamplifier Gain setting.
REMEDIAL ACTION: See Step 3 and Step 5 of Signal Strength Operation/Performance Check.

SYMPTOM: **RATIO voltage is negative or 4-20 mA output is below 4 mA.**

POSSIBLE CAUSE: The ZERO adjustment potentiometer located on the front panel is not set properly.
CHECK: Setting of ZERO adjustment potentiometer on front panel.
REMEDIAL ACTION: Adjust ZERO potentiometer until RATIO is 1.0 ±0.5 VDC (See Output Zero OPERATION/ PERFORMANCE CHECK procedure).

POSSIBLE CAUSE: Instrument malfunction.
CHECK: NUMERATOR and DENOMINATOR voltage when a bare flashlight bulb or bare 60 watt light bulb is held in front of the receiver window.
REMEDIAL ACTION: Replace printed circuit boards one at a time and repeat CHECK. Contact factory if fault cannot be located.

SYMPTOM: **RATIO voltage is steady and does not appear to be responding to oil within field-of-view.**

POSSIBLE CAUSE: Malfunction of signal processing circuitry.
CHECK: RATIO voltage when a small amount of oil is introduced within the instrument's field of view. The RATIO voltage should increase above +2.0 VDC.
REMEDIAL ACTION: Substitute spare boards and assemblies until defective part is located and RATIO responds properly to oil. Defective part can be returned to factory for analysis and repair.

SYMPTOM: **Oil Alarm does not activate when oil is present in instrument's field-of-view, or Oil Alarm activates too frequently.**

POSSIBLE CAUSE: Improper Oil Alarm threshold setting.
CHECK: Voltage at OIL ALARM SETPOINT test jack (grey) relative to SIGNAL GROUND (green).
REMEDIAL ACTION: Adjust setpoint if required. See Oil Alarm Threshold Adjustment procedure.

POSSIBLE CAUSE: Malfunction of Oil Alarm circuitry.
CHECK: RATIO voltage relative to voltage on OIL ALARM SETPOINT jack. If RATIO voltage exceeds alarm setpoint, and alarm does not activate, a malfunction of alarm circuitry exists.
REMEDIAL ACTION: Replace Rear Panel p.c. board and/or Oil Alarm relay on Connector/Relay p.c. board.

SYMPTOM: **Signal strength of NUMERATOR and DENOMINATOR decreases when water becomes calm.**

POSSIBLE CAUSE: Transmitter and receiver not properly aligned.
REMEDIAL ACTION: Repeat Alignment procedure.

SYMPTOM: **RATIO output is negative or very positive and does not respond to oil on the water.**

POSSIBLE CAUSE: Transmitter and receiver not properly aligned.
CHECK: NUMERATOR voltage.
REMEDIAL ACTION: If NUMERATOR voltage is less than +0.25 VDC, repeat Alignment procedure.

CORRECTIVE MAINTENANCE

GENERAL INFORMATION

The SW9200 electronics, located in the receiver, are comprised of six printed circuit boards and electrical wiring and components located on the Receiver Baseplate and the Motorbox. Two of the printed circuit boards are permanently mounted and the other four are easily removed and replaced as indicated below:

P.C. BOARD	PERMANENT OR REMOVABLE
Preamplifier	permanent
AGC/TE Cooler	removable
Synchronous Demodulator	removable
Rear Panel	removable
Options	removable
Connector/Relay	permanent

The receiver functions described in Section 1 and Figure 1 of this manual are located on a printed circuit board or assembly as shown below:

RECEIVER FUNCTION	LOCATION
Infrared Photodetector	Detector/Preamp Assembly
Sync Circuitry	Rear Panel and Sync Demod p.c. boards
Amplifier	Preamp and Sync Demod p.c. boards
Signal Processing Electronics	AGC/TE Cooler and Sync Demod p.c. boards
Ratiometer	Rear Panel p.c. board
Threshold Detector	Rear Panel p.c. board
Obstruction/Status Alarm Relay	Connector/Relay p.c. board
Adjustable Threshold Detector	Rear Panel p.c. board
OIL Alarm Set	Rear Panel p.c. board (accessed from front panel)
Oil Alarm Relay	Connector/Relay p.c. board
4-20 mA Converter	Options p.c. board

Assemblies and printed circuit boards are available as spare parts. To facilitate troubleshooting and corrective maintenance of the SW9200, users are advised to stock the items listed in the Recommended Spare Parts List.

P.C. BOARD AND ASSEMBLY REPLACEMENT

(See Figure 3 for locations)

Synchronous Demodulator and Options P.C. Boards

The Sync Demod board is located to the left and the Options board is located to the right of the filterwheel motor inside the motorbox. Remove either board by pulling it out of its connector on the Rear Panel p.c. board and sliding it through the card guides out of the motorbox. To replace the Sync Demod or Options board, make sure that the notch on the board matches the key in the connector and slide the board along the card guides into the motorbox. Make sure that the board is seated firmly in the connector.

Rear Panel P.C. Board

The Rear Panel p.c. board is attached to the side of the motorbox next to the Connector/Relay p.c. board. The Sync Demod and Options board must be removed before the Rear Panel board can be removed.

To remove:

1. On the Connector/Relay p.c. board, remove the STATUS ALARM and OIL ALARM relays from their sockets.
2. Release the ribbon connector that connects the Rear Panel board to the Connector/Relay board.
3. Remove the six screws that hold the Rear Panel board to the motorbox tabs.
4. Pull the top of the Rear Panel board away from the motorbox to release the two connectors at the top of the board.
5. Being careful not to touch the sync pickoff with the filterwheel, remove the board.

To replace:

1. Being careful not to touch the sync pickoff with the filterwheel, slide the board into place.
2. Firmly press the connectors at the top of the board into the mating connectors on the motorbox.
3. Attach and lock the ribbon connector to the Connector/Relay p.c. board.
4. Replace the six screws that hold the Rear Panel board to the motorbox tabs.
5. Examine the wire lug (connected to the green wire) that is screwed to the Rear Panel board. Be sure the lug does not short against any traces on the p.c. board. It may be necessary to space the lug away from the board with a small lockwasher.
6. Replace the STATUS ALARM and OIL ALARM relays in their sockets on the Connector/Relay p.c. board.

Because the sync pickoff can easily be dislodged during this procedure, check the sync pickoff connection after replacement of the Rear Panel p.c. board.

AGC/TE Cooler P.C. Board

The AGC/TE Cooler board is mounted in the Detector/ Preamp assembly within the fins of the heat sink.

To remove:

1. Release the ribbon connector that connects the AGC/TE Cooler board to the Preamplifier board, which is permanently attached to the bottom of the heat sink.
2. Holding the ribbon connector to the side, pull the AGC/TE Cooler board so that the connector to the motorbox disengages. Slide the board out of the heat sink fins.

To replace:

1. Position the board so that the two parts of the connector to the motorbox are lined up.
2. Holding the ribbon connector to the side, slide the board into the fins of the heat sink as far as it will go, so that the connector to the motorbox engages.
3. Attach and lock the ribbon connector from the Preamplifier board.

Detector/Preamp Assembly

The Detector/Preamp assembly is comprised of the infrared photodetector mounted inside a baffle, an optical filter, the heat sink and the permanently mounted Preamplifier p.c. board. The Detector/Preamp assembly is located on the top of the motorbox, beside the power supplies.

NOTE

Exposure to direct light (particularly fluorescent light or sunlight) can cause permanent damage to the infrared photodetector. Care should be taken to avoid exposing the photodetector to light when the Detector/Preamp assembly is removed from the instrument.

To remove:

1. Remove the four 6-32 screws that hold the assembly to the motorbox.
2. Lift the assembly up until the baffle clears the motorbox.

To replace:

1. Position the assembly over the motorbox so that the connector and hole for the baffle are aligned.
2. Slide the assembly into place.
3. Replace the four 6-32 screws that hold the assembly to the motorbox.

Sync Pickoff

The sync pickoff is mounted in a socket that is located in the center of the Rear Panel p.c. board. The sync pickoff is removed by pulling it from the socket. To replace the sync pickoff, install with the red dot up (toward the motorbox connectors).

DEVICE REPAIR AND RETURN

Prior to returning devices or components, contact the nearest local Detector Electronics office so that an RMI (Return Material Identification) number can be assigned. A written statement describing the malfunction must accompany the returned device or component to expedite finding the cause of the failure, thereby reducing the time and cost of the repair to the customer.

Pack the unit or component properly. Use sufficient packing material in addition to an anti-static bag or aluminum-backed cardboard as protection from electrostatic discharge.

Return all equipment transportation prepaid to the Minneapolis location.

Office Locations

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, Minnesota 55438 USA
Telephone (612) 941-5665 or (800) 765-FIRE
Telex 6879043 DETEL UW
Cable DETRONICS
Facsimile (612) 829-8750

Detector Electronics Corporation
3000 Wilcrest
Suite 145
Houston, Texas 77042 USA
Telephone (713) 782-2172

Detector Electronics Corporation
466 Conchester Highway
Aston, Pennsylvania 19014 USA
Telephone (215) 497-5593
Facsimile (215) 485-2078

Detector Electronics (UK) Limited
Riverside Park, Poyle Road
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SL3 OHB
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Telex 848124 GRAVIN G
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Detronics Scandinavia AB
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Facsimile 431-52236

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Facsimile 58-61-529144
Telex 61331

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C/O Walter Kidde Aerospace
The ADELPHI
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SINGAPORE, 0167
Telephone (65) 334-1255
Facsimile (65) 334-1607

ORDERING INFORMATION

RECOMMENDED SPARE PARTS

Description	Part Number
Transmitter lamp (250 watt)	102709-001
Filterwheel motor - 115 VAC	006624-001
1 Amp Fuse	107407-002
Alarm Relay, 115 VAC	102590-001
Alarm Relay, 230 VAC	102589-001
Desiccant Pack	102669-001
2 Inch Diameter Lens	005616-001
Test Power Cable	005791-001
Sync Demod p.c. board	005795-001
AGC/TE Cooler p.c. board	005797-001
Detector/Preamp assembly	005798-001
Rear Panel - standard or 4 to 20 mA	005794-004
Rear Panel - Film Thickness	005794-005
Rear Panel - Selectable Criteria	005794-006
Film Thickness Discriminator	005828-001
Selectable Criteria Alarm	005829-001
Single 4 to 20 mA Output	005793-001

For assistance in ordering a system to meet the needs of a specific application, please contact:

Detector Electronics Corporation
6901 West 110th Street
Minneapolis, Minnesota 55438 USA
Telephone (612) 941-5665 or (800) 765-FIRE
Telex 6879043 DETEL UW
Cable Detronics
Facsimile (612) 829-8750

APPENDIX

This APPENDIX contains:

FILM THICKNESS DISCRIMINATOR OPTION

GENERAL DESCRIPTION

The oil slick detector bounces a beam of light off an oil/water surface below and analyzes the reflected optical signal. The optical signal reflected from a thin oil film (average thickness of less than 10 micrometers) produces a RATIO output between +1.0 and 10.0 VDC with wide fluctuations due to irregularities in the film. The signal reflected from a thick oil film (average thickness greater than 10 micrometers) produces a steady RATIO output between +4.0 and +7.0 VDC. The optional Film Thickness Discriminator printed circuit board processes the differences between the reflected signals and provides information on whether a thin or thick oil film has been detected.

FUNCTIONAL DESCRIPTION

In the first stage of processing, the RATIO signal into the Film Thickness Discriminator is simultaneously compared with a “window” and differentiated (the rate of change is measured).

“Window” Condition

The RATIO signal is compared with a “window”, where the upper limit is set by the potentiometer labeled “upper window” and the lower limit is set by the potentiometer labeled “lower window” on the printed circuit board. When the RATIO output is within the “window” limits, the voltage at the green test point is positive. When the RATIO output is either above or below the “window”, the voltage at the green test point is negative. The “window” voltages are adjustable and are usually factory set at +4.0 VDC for the lower window and +7.0 VDC for the upper window.

Rate of Change Condition

The RATIO signal is fed into a differentiator, which senses the rate of change of the signal. When the RATIO output is steady and unchanging, the yellow test point is positive. When the RATIO output is either increasing or decreasing, the yellow test point is negative.

The final output stage of the Film Thickness Discriminator compares the RATIO voltage conditions from the first processing stages. If the RATIO voltage is within the "window" and is steady (the conditions required for a thick film), the blue test point voltage is negative and the oil alarm is activated. If the RATIO voltage is above or below the "window" or is not steady (either condition indicating a thin film), the blue test point voltage will be negative and the oil alarm will not be activated.

SPECIFICATIONS

Specifications of the optional Film Thickness Discriminator printed circuit board are tabulated below:

Power Consumption:	less than 0.1 Watts
Alarm:	Alarm relay is activated and contacts open.
Alarm Response Time - ON:	approximately 70 seconds for an abrupt change from clean water to a continuous thick film – longer if the thick film has breaks in it.
Alarm Response Time - Off:	approximately 5 seconds for an abrupt change from a continuous thick film to clean water.

INSTALLATION

If the Film Thickness Discriminator board is ordered with the instrument, the optional printed circuit board is installed and ready for operation. If this option has been ordered after the delivery of the instrument, one operational amplifier (A211) on the inside of the Rear Panel p.c. board must be removed prior to installation of the Film Thickness Discriminator board. Removing A211 disables the normal oil alarm condition where the relay is activated on either thin films or thick films. The Film Thickness Discriminator board is then plugged into the Options p.c. board connector (see Figure 3 and P.C. Board and Assembly Replacement procedure in the MAINTENANCE Section of this manual).

SELECTABLE CRITERIA ALARM OPTION

GENERAL DESCRIPTION

An optional printed circuit board for the Oil Slick Detector, the Selectable Criteria Alarm option adds considerable flexibility in selecting the criteria and conditions under which the oil alarm will activate. This option delays activation of the oil alarm relay until either of the following conditions is met:

1. The time of uninterrupted oil observation* exceeds a preset duration between 1 and 999 seconds. The duration of oil observation is set in one second increments by direct reading thumbwheel switches labeled OIL DURATION (SECS) on the printed circuit board.

2. The percentage of accumulated time during which oil observation* exceeds a preset percentage measured over a 1000 second interval. The percentage of accumulated time is set in increments of 10% by a direct reading thumbwheel switch labeled %OIL (X10) on the printed circuit board.

*Oil observation is defined by the oil alarm threshold setting.

NOTE

When either of the above conditions is met, the oil alarm relay activates (contact open) for approximately 60 seconds, then deactivates (contacts close). If oil film is constantly present in the detector's field of view, the oil alarm will close twice (once for each criteria) for approximately 60 seconds every 1000 seconds.

For example, if the OIL DURATION switches are set for 20 seconds, the oil alarm relay will activate after the instrument observes any continuous slick that exceeds 20 seconds in duration. However, if a large spill occurs where the resulting slick observed by the instrument has small 1 second breaks of clean water every 15 seconds (due to turbulence, wind action, etc), the oil alarm relay will not activate because no continuous period of oil observation exceeds 20 seconds in duration. The internal timer is reset every time clean water is observed. The alarm will not activate even though the water surface is covered with oil 94% of the 1000 second measurement cycle (15 out of every 16 seconds).

Following the same example, if the %OIL switch is set at 10%, the oil alarm relay will activate after the total accumulated time of oil observation exceeds 10% of the 1000 second measurement cycle or 100 seconds. The oil alarm relay will activate 106 seconds after the oil slick

described began. The six extra seconds are the result of six 1 second intervals of clean water that were observed during the first 100 seconds of the measurement cycle.

INSTRUMENT OUTPUT

If the OUTPUT SELECT switch on the front panel is set on position V, the RATIO output at terminal 1 of the junction box will be the standard 0 - 10 VDC. If the O position is used, the RATIO output at the junction box will be 0 VDC when the OIL Alarm relay contacts are closed and approximately -14 VDC when the Oil Alarm relay contacts are open.

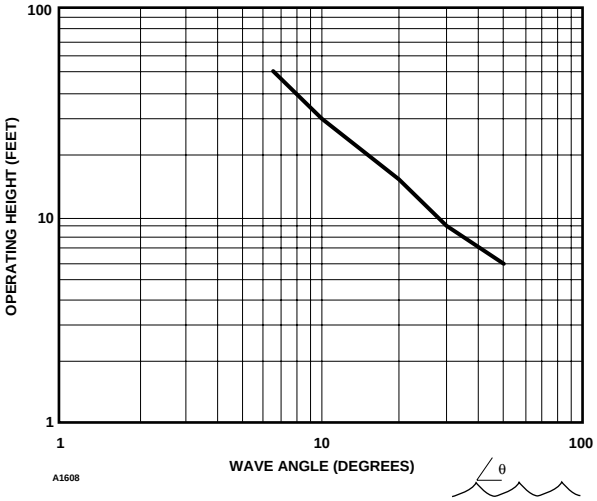
INSTRUMENT SENSITIVITY

The instrument can be decreased in sensitivity to nuisance oil in the water or to residual sheens by increasing either the OIL DURATION thumbwheel setting or the %OIL thumbwheel setting, or both. Likewise, the instrument can be increased in sensitivity to small spills by decreasing either the OIL DURATION thumbwheel setting or the %OIL thumbwheel setting, or both. The optimum settings for the alarm conditions depend on the user's requirements and the condition of the water surface at the installation site. The settings are best determined by trial and error until the nuisance alarm rate due to residual or background oil is reduced to an acceptable level.

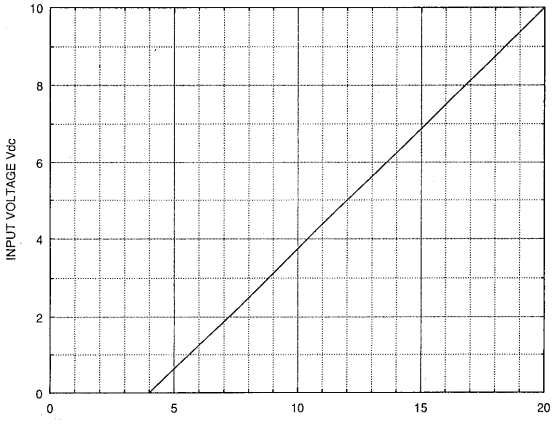
The factory settings for the Selectable Criteria Alarm board are 60 seconds and 50%. These settings can be changed without removing the receiver assembly from the housing. Open the receiver cover and locate the Selectable Criteria Alarm board to the right of the filterwheel motor. The yellow thumbwheel switch at the top of the board is %OIL (X10). The other three white thumbwheel switches are OIL DURATION (SECS). The top switch is units, the second switch is tens and the bottom switch is hundreds.

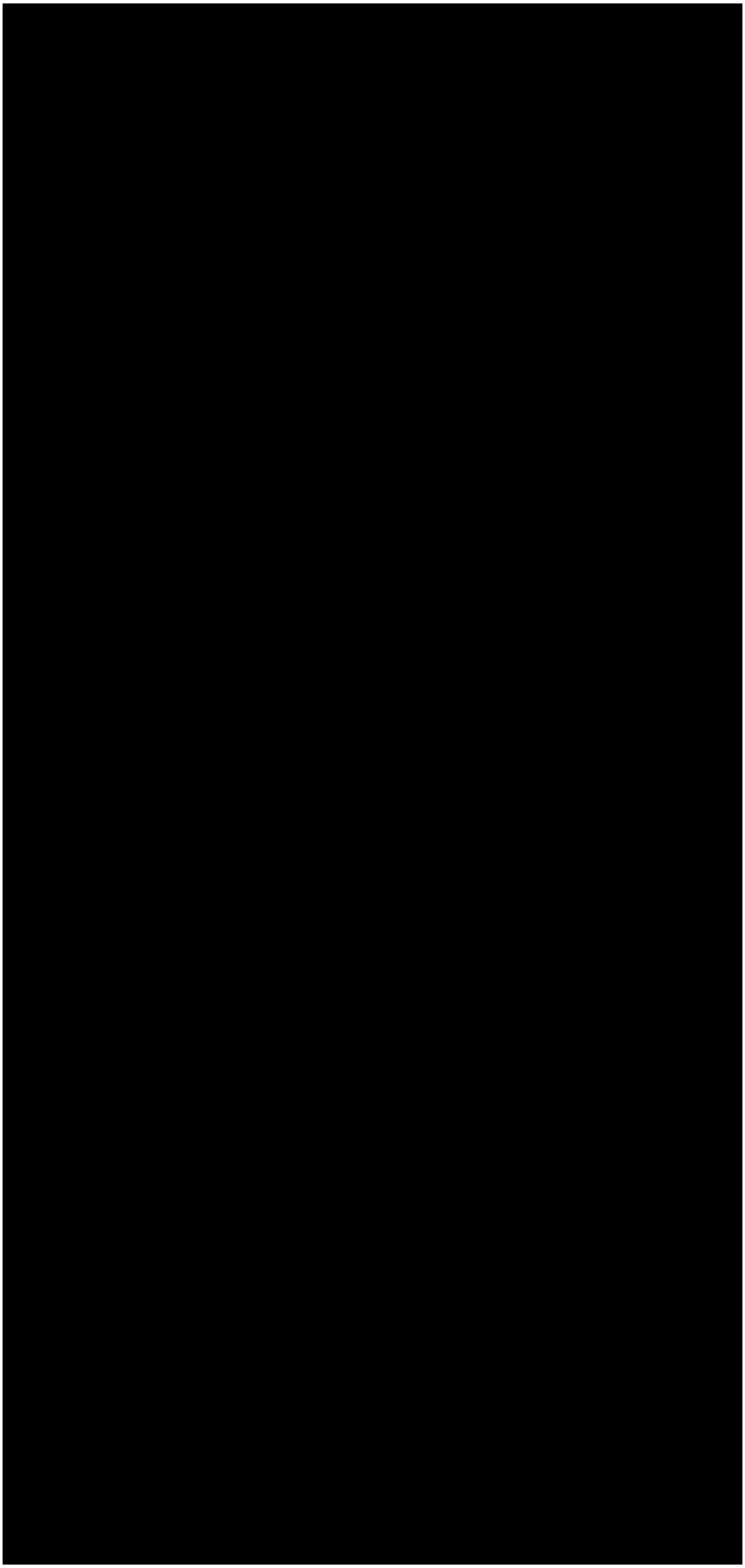
OIL ALARM RELAY CLOSURE

The Oil Alarm relay contacts are closed when clean water is observed. When oil film is observed by the instrument, the Oil Alarm relay contacts will open after a delay of N seconds (N is the setting of the OIL DURATION switches). The Oil Alarm relay contacts will remain open for approximately 60 seconds and then will close, even if oil is still present. If oil continues to be observed, the Oil Alarm relay contacts will close again for approximately 60 seconds each 1000 seconds until the oil spill is removed.



Relationship of Wave Angle to Operating Height





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