Duratech

Custom Scientific Controls and Equipment

DTIR 970 Infrared Analyzer

User's Manual

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DURATECH INFRARED ANALYZER

Model 970

Operation & Maintenance Manual

REVISION 021904GNE

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WARRANTY INFORMATION AND NOTICES

DURATECH, warrants all products of its manufacture to be free from defects in material and workmanship. This warranty is effective for one year from the date of delivery to the original Purchaser.

DURATECH, warrants all other products not of its manufacture but sold as part of this DURATECH. system to be free from defects in material and workmanship. This warranty is effective for ninety days from the date of delivery to the original Purchaser.

Upon prompt notification by the Purchaser, DURATECH will, at its option, repair or replace equipment that proves to be defective during the warranty period. The equipment must be returned to DURATECH, at the expense of the Purchaser, if required by DURATECH. Parts, labor and return shipment to the Purchaser shall be at the expense of DURATECH. Parts used and labor performed during on-site warranty service requested by the Purchaser shall be at the expense of DURATECH. Travel costs, meals, and lodging shall be at the expense of the Purchaser.

This warranty shall not apply to defects originating from:

1. Improper maintenance or operation by the Purchaser.
2. Purchaser-supplied accessories or consumables.
3. Modification or misuse by the Purchaser.
4. Operation outside the environmental and electrical specifications for the product.
5. Improper or inadequate site preparation.
6. Purchaser induced contamination or leaks.

DURATECH reserves the right to make changes in design or construction at any time without incurring any obligation to make any changes whatsoever on units previously purchased. DURATECH assumes no obligation of any kind with respect to design or construction of products not of DURATECH manufacture.

This warranty is expressly made by DURATECH and accepted by Purchaser in lieu of all other warranties, including warranties of merchantability or fitness for a particular purpose, whether written, oral, expressed, implied, or statutory. Purchaser agrees that DURATECH shall not be liable for normal wear and tear, nor for any contingent, incidental or consequential damage or expense due to partial or complete inoperability of its products for any reason whatsoever.

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1.00 SPECIFICATIONS

Method:	Infrared transmittance
Detector:	Thermally compensated Pyroelectric in a TO-5 package (standard)
IR Source:	Sealed tungsten (standard)
Filter:	3.45 micron center wavelength (standard) 100 nanometer 50% bandwidth (standard)
Signal Drift:	±0.1% full scale, less than 1 hour ±0.3% full scale, less than 8 hours
Signal Repeatability:	±0.1% full scale
Response Settle Time:	less than 5 seconds, small change in transmission less than 20 seconds, blocking to 100% transmission
Resolution:	A / D conversion: 16 bits D / A conversion: 12 bits
Analog Output:	0–1, 0–2, or 0–4 volts (user selectable)
Display:	Backlit liquid crystal, 4 lines x 20 characters
Control:	4 front panel push buttons
Connectors:	Power – IEC 320 Standard AC power inlet Analog Output – Banana jacks
Power:	90VAC – 250VAC, 50/60Hz, 1A
Temperature:	Non-operating: -18°C (0°F) to 52°C (125°F) Operating: 4°C (40°F) to 45°C (110°F)
Relative Humidity:	10% to 60%, non-condensing
Dimensions:	12cm high x 27cm deep x 28cm wide (maximum)
Weight:	3kg (unpacked)

2.00 INTRODUCTION

2.01 Overview

The DTIR 970 is a basic functional replacement for the discontinued Foxboro Miran 1FF. The DTIR is used to measure infrared energy at a single infrared wavelength that has been transmitted through a sample.

The DTIR 970 reports this data in two ways: as an analog voltage available via (2) banana jacks on back of the DTIR (which provides 100% Miran 1FF compatibility), and on its LCD display.

2.02 Basic Theory

The DTIR uses a sealed tungsten bulb as an infrared energy source. The bulb is electronically pulsed at 5Hz. The light energy generated passes through an infrared filter, which blocks out of the light except for a narrow band centered about a specific wavelength. This wavelength is chosen depending on the properties of what is to be measured. This filtered band of light then passes through the sample, which is dissolved in a solvent. As the light energy passes through the dissolved sample, a portion of the energy is absorbed by the sample and solvent. The remaining energy then enters the detector where its intensity is measured.

By knowing how much energy passes through the pure solvent, a comparison can be made, and either %Transmission or Absorbance for the sample can be calculated and displayed. If a calibration curve has been made, then the concentration of the dissolved sample can also be calculated and displayed.

%Transmission is defined as:

$$\%T = \frac{L'}{L}$$

where:

%T = %Transmission (transmission percentage)
L = light energy entering the sample
L' = light energy exiting through the sample

Absorbance is defined as:

$$A = \log_{10}\left(\frac{1}{\%T}\right) = \log_{10}\left(\frac{L}{L'}\right)$$

where:

A = Absorbance

Calibration is discussed in detail in Section 5.05.

2.03 System Description

The DTIR has three areas of note. These are the Front Panel, the Rear Panel, and the Optical Bench on the left side of the DTIR.

Front Panel

The Front Panel contains the LCD Display and four push buttons.

The LCD Display provides the operator information on the current sample being analyzed and any errors or potential problems that occur during normal operation, as well as information for changing the various options of the DTIR while in Factory Setup mode.

In Absorbance and %Transmission modes, the LCD Display will constantly show the gain step, current signal and reference levels, and Absorbance or %Transmission of the sample, respectively. In Concentration mode, the LCD Display will constantly show the current calibration points and calculated concentration in mg/l. If an error or potential problem occurs, an error message will be displayed instead of Absorbance, %Transmission, or Concentration.

In addition, the LCD Display shows manufacturer information during initial power on and also potential internal failure and fault information during a power-up self-diagnostic check.

The four push buttons are labeled: AUTO GAIN, MENU / RESET, ⬆ (up arrow), and ⬇ (down arrow).

Pressing the AUTO GAIN button will cause the DTIR to automatically set the internal gain such that 100%T is obtained. No operator adjustments for %T are needed.

Pressing the MENU / RESET button and quickly releasing this button will bring up the Display Mode Menu. Pressing and holding it will bring up the Calibration Menu.

Pressing the ⬆ (up arrow) button will normally increase the internal gain setting, increasing the displayed signal. This will increase the displayed %Transmission, decrease the Absorbance, or increase the Concentration, depending on what mode is selected. If inside the Factory Setup mode, this button is used to select various features and change settings.

Pressing the ⬇ (down arrow) button will normally decrease the internal gain setting, decreasing the displayed signal. This will decrease the displayed %Transmission, increase the Absorbance, or decrease the Concentration, depending on what mode is selected. If inside the Factory Setup mode, this button is used to select various features and change settings.

Rear Panel

The Rear Panel contains the Analog Output Jacks, Power Entry Inlet, Power Switch, Purge Gas Fitting, and the Lamp Plug.

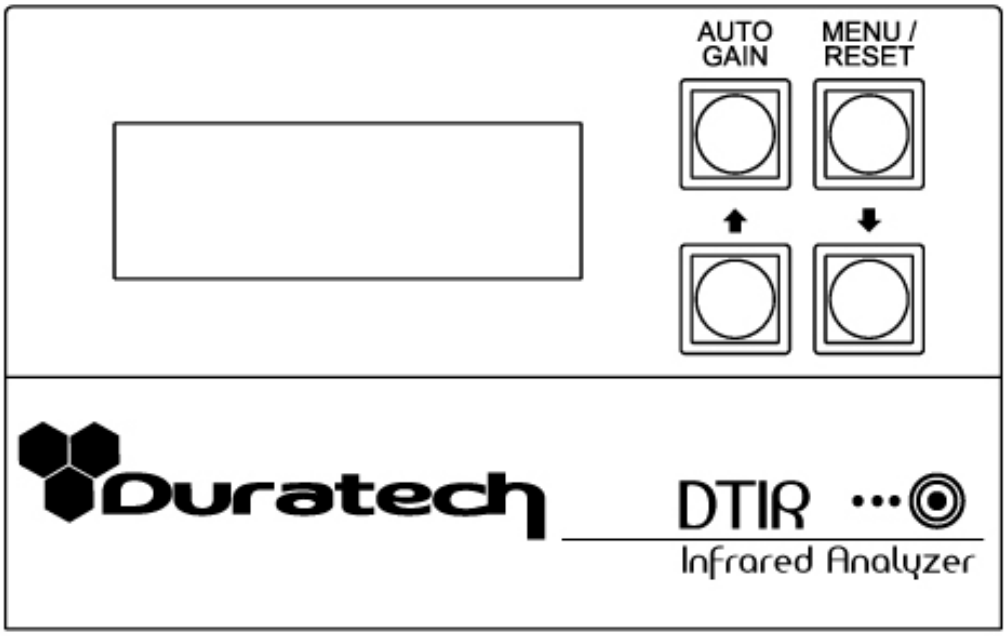
The Analog Output Jacks provide an analog DC voltage output in the 0-1, 0-2, or 0-4 volt range, depending on an internal jumper setting.

The Power Entry Inlet is where the power cord is plugged in.

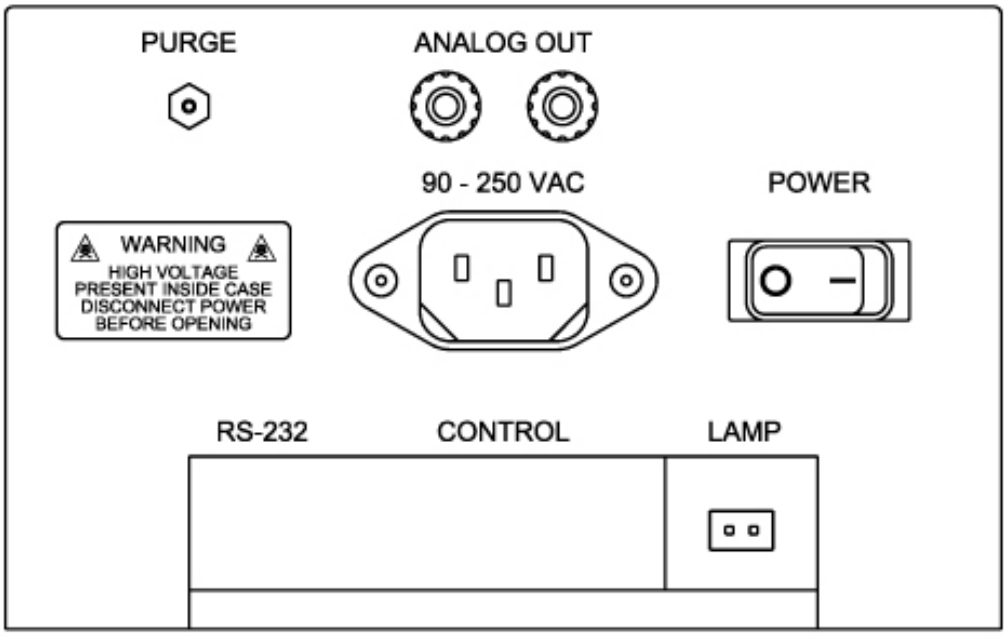
The Power Switch turns the unit on and off.

The Purge Gas Fitting is used to connect to an air supply to keep clean, dry air circulating inside the DTIR.

The Lamp Plug is used to connect and provide power to the light source.



FRONT PANEL



REAR PANEL

3.00 SITE PREPARATION

3.01 Environment

The DTIR is designed for operation in most environments. It must not be operated in locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids or combustible dust. (The presence of elevated temperatures and exposed electrical components inside the DTIR make it unsuitable for such locations.) The DTIR will be most reliable when operated in reasonably constant temperature and humidity conditions. Exposure to airborne contaminants should be avoided.

3.02 Location

Use a conventional laboratory bench or other level surface free from excess vibration. There should also be enough room to accommodate any other items and supplies that are to be used with the DTIR such as solvent supply and waste containers, and glassware such as funnels, beakers, and graduated cylinders.

3.03 Power

The DTIR 970 requires 90-250VAC, 50/60Hz power and should be properly grounded.

It used outside the United States, the user may need to supply the appropriate power cord or modify the existing power cord to correctly fit the wall outlet or power source.

For optimum performance, the power source should be free from noise from other electrical equipment such as motors or solenoids, and free from power surges and transients. The power source should also be properly grounded.

If the line voltage is noisy, a line filter should be used.

3.04 Purge Gas

If the DTIR is placed in a particularly dirty or poorly ventilated area, then a purge gas may be necessary to keep the interior free from excessive dust.

If required, clean dry compressed air should be used. The air supply must be regulated and restricted to provide a flow of 50 to 100cc/min and be delivered to the unit via soft 1/8” OD PVC tubing.

4.00 INSTALLATION

4.01 Unpacking and Installation

The DTIR and associated accessories were carefully packed in compliance with carrier requirements. When unpacking, adhere to any unpacking instructions found inside and inspect carefully for possible damage sustained during shipment. Any claims for loss or shipping damage should be filed with the carrier.

4.02 Placement

Place the DTIR on the laboratory bench or tabletop. Make sure that the power cord will be able to reach the power source.

4.03 Purge Gas

If optional purging is to be performed, set the regulator so that the flow rate is 50 to 100cc/min. Slide the end of the 1/8" PVC tubing connected to the purge gas supply over the barbed fitting labeled PURGE on the Back Panel of the DTIR. A flow rate of 50 to 100cc/nim will purge the air inside the DTIR every 30 minutes to 1 hour.

4.04 Installing the Cuvette Holder or Flow Cell

Slide the cuvette holder or flow cell into the two dovetail grooves on the left side of the DTIR until it hits the stop. For the cuvette holder, make sure that the stop on the cuvette holder is down. For the flow cell, make sure that the windows in the flow cell line up with the source and detector on the DTIR. Snug the two thumbscrews on the two dovetail grooves.

4.05 Electrical Connection

If the power switch on the back of the DTIR is on (the dash pressed in), switch the unit off. Plug one end of the supplied electrical cord into a 90VAC - 250VAC, 50/60Hz power source. Plug the other end of the electrical cord into the IEC 320 standard AC power inlet marked 90 - 250 VAC on the back of the DTIR.

5.00 OPERATION

5.01 Overview

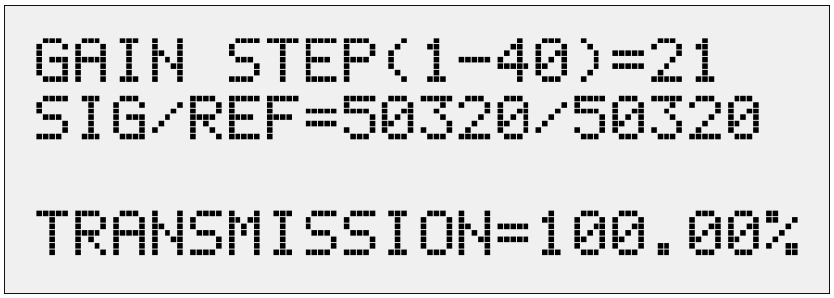
The DTIR performs measurements and supplies measurement voltage data during operation. Once initialized, the Absorbance, %Transmission, or Concentration, depending on configuration, will be continuously shown on the LCD Display. The Analog Output Jacks on the back of the unit will also continuously output a voltage proportional to Absorbance or %Transmission that mirrors the LCD Display. (A voltage proportional to Absorbance will also be outputted while in Concentration mode.)

5.02 Mode Selection

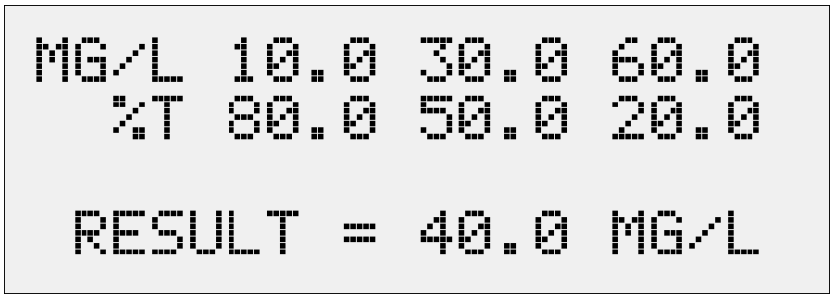
There are three display modes that can be selected. The first two, Absorbance and %Transmission, are always available. The third, Concentration, is available only if a calibration curve has been entered.

Absorbance Display:

%Transmission Display:



Concentration Display:



To select the display mode:

1. Press the MENU / RESET button. This will bring up the Output Selection Display menu.
2. Press either the ⬆ (up arrow) or ⬇ (down arrow) button until the desired output mode is displayed.
3. Press the MENU / RESET button. This will return the DTIR to the normal display mode.

5.03 Initialization

To initialize the DTIR, a reference reading should be obtained.

To obtain a reference reading:

1. Rinse and fill the cuvette or flow cell with pure solvent.
2. Press and hold down the AUTO GAIN button until the message SETTING GAIN… appears on the display. This will automatically adjust the gain for maximum signal and set the current signal as reference, which will set Absorbance to zero or %Transmission to 100%, depending on the display mode selected. If in Concentration mode, %Transmission will be temporarily displayed to reveal the new settings before changing to zero concentration.

5.04 Gain

Gain is a multiplier applied to the signal from the detector inside the DTIR. As gain is increased, the displayed signal level increases. Likewise, as gain is decreased, the displayed signal level will also decrease. The DTIR has 40 different gain steps.

Gain can be changed either manually or automatically.

To manually change the gain on the DTIR, press the ⬆ (up arrow) or ⬇ (down arrow) button while in the normal display mode. This will increase or decrease the gain on the DTIR respectively.

NOTE: USING THE ARROW BUTTONS TO CHANGE THE GAIN WILL ONLY INCREASE OR DECREASE THE SIGNAL LEVEL. THIS WILL NOT CHANGE THE REFERENCE LEVEL.

NOTE: IT IS POSSIBLE TO INCREASE THE GAIN TO THE POINT WHERE THE DTIR IS IN SIGNAL SATURATION. ONCE IN SIGNAL SATURATION, THE SIGNAL LEVEL WILL NO LONGER INCREASE EVEN IF ENERGY PASSING THROUGH THE CUVETTE OR FLOW CELL INCREASES. THIS ALSO MEANS THAT THE DISPLAYED SIGNAL MAY REMAIN THE SAME EVEN IF ENERGY PASSING THROUGH THE CUVETTE OF FLOW CELL DECREASES. THE DTIR WILL NOT PROVIDE RELIABLE INFORMATION ONCE IT IS IN SIGNAL SATURATION.

To avoid the possibility of signal saturation, the gain can be changed automatically.

To automatically change the gain on the DTIR, press and hold down the AUTO GAIN button until the message SETTING GAIN… appears on the display. As stated above this will automatically adjust the gain for maximum signal (while avoiding the possibility of signal saturation). This process will take a few minutes to complete.

NOTE: PRESSING AND HOLDING DOWN THE AUTO GAIN BUTTON WILL ALSO SET THE RESULTING SIGNAL AS THE NEW REFERENCE SIGNAL.

While pressing and holding down the AUTO GAIN button will start the Auto Gain procedure, the AUTO GAIN button also has a second function.

Pressing and quickly releasing the AUTO GAIN button will set the current signal as reference, resetting the output to 100%Transmission or 0 Absorbance, but will not change the gain step. This action is instant.

This feature can be used to quickly reset the output to 100% when it is already near 100%. This should be used when the signal level is between 46000 and 52000. (This is with temperature compensation on. It may be somewhat higher with it off.) If it is more, there may be a danger of saturating the instrument. While the reference can be less than 46000, a reference of less than 20000 should be avoided if at all possible. A low reference lowers the resolution of the instrument.

The following example illustrates changing gain, pressing and quickly releasing the AUTO GAIN button, and pressing and holding down the AUTO GAIN button.

Shown below is a typical example of the display presentation.

The display shows the gain step at 21, current signal level of 51184, and a reference setting of 51220. The reference setting of 51220 represents the output that will produce 100%Transmission. The instrument calculates the transmission to be 99.93%.

Pressing the ⬇ (down arrow) button, decreasing the gain, will result in the following:

Notice that the reference reading is still 51220, and that the %Transmission decreased because of this. Pressing and quickly releasing the AUTO GAIN button will set the reference reading to 48316 without starting the Auto Gain procedure.

The display will now look like:

Pressing the ⬆ (up arrow) button, increasing the gain, will result in the following:

Notice that the reference reading is still 48316, and that the %Transmission increased because of this. If the gain is increased still further, the signal will continue to increase until saturation is reached. At this point, any increase in gain will not change the signal, the detector is saturated. Also, an error message would be displayed, and the DTIR will sound an internal alarm if the beeper is enabled.

The signal level will read 65535 if temperature compensation is off and the unit is in full saturation. Temperature compensation reduces the signal level unless the unit is operating at the extreme high end of its operating temperature range.

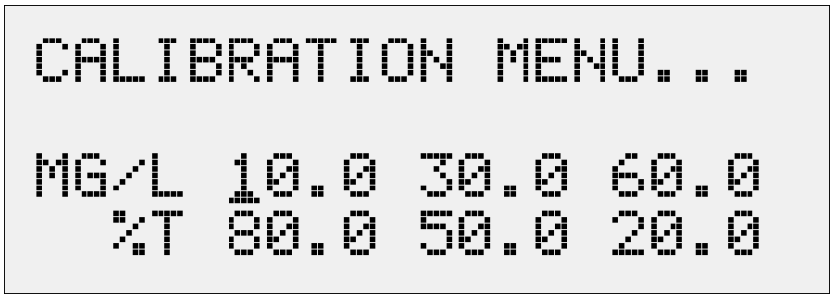
5.05 Calibration

The DTIR model 970 includes a built-in calibration capability for detecting the concentration of oil, grease and total petroleum hydrocarbons in water. Accordingly, the calibration units are milligrams per liter (mg/l). However, calibration for measurement of other concentrations would differ only in the units of measurement.

To Enter a Calibration Curve

Press and hold the MENU / RESET button to enter calibration entry mode.

The screen will display:



Please note the cursor under the first digit on the third row. Pressing the ⬆ (up arrow) button increments the underlined digit. Digits can only be incremented, not decremented, except that a digit wraps from 9 to 0. Pressing the ⬇ (down arrow) button moves the cursor to the next digit, if there is one, otherwise it wraps around from the end of line four to the beginning of line three.

Pressing the MENU / RESET button at any time leaves this screen. If any entry is invalid, no values will be changed, and the user will be informed of the error. If all entries are valid, they will be updated, and used to compute a new calibration curve. Either way, the menu is terminated and the next screen is the main operating display.

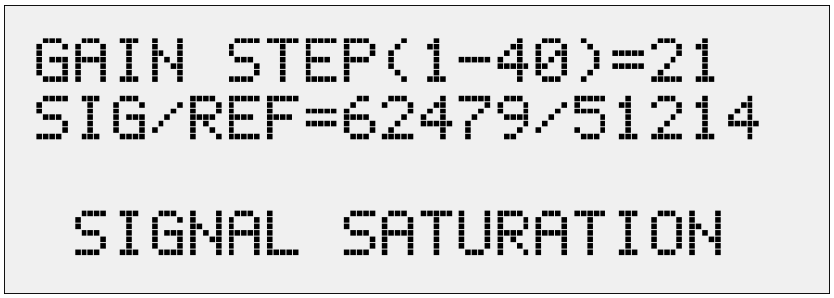
5.06 Error Messages

The last line of the display normally shows the result, but when there is an error, the type of error is displayed instead.

The main purpose of the error message is to aid the operator with the correct operation of the instrument. It is possible for multiple errors to occur at once. Only one error will be displayed at a time. When it is corrected, and if there are other errors, the next highest priority error will then be displayed.

There are four errors that appear when the instrument is being used incorrectly. The errors are SIGNAL SATURATION, REFERENCE TOO LOW, LOW SIGNAL WARNING, AND TEMP OUT OF RANGE. These errors can be corrected by the operator.

SIGNAL SATURATION



Normally, the signal will not be this large when there is pure solvent in the flow cell and the unit has been correctly initialized. This could happen if there is air in the flow cell, or if the gain is set too high. As the signal approaches the saturation point, this error will be displayed.

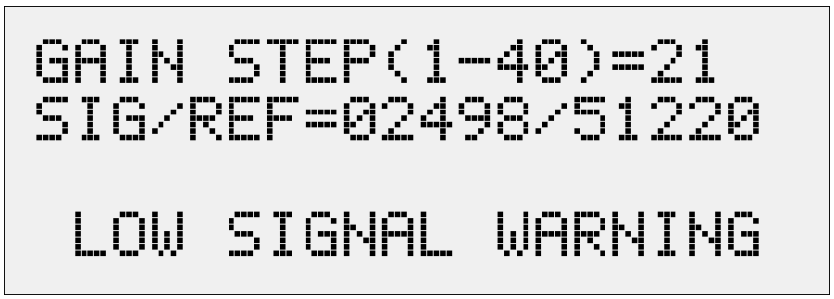
Generally, if there is pure solvent in the flow cell, the way to correct this is to press and hold down the AUTO GAIN button until the unit begins its Auto Gain procedure.

REFERENCE TOO LOW

Normally, the signal will not be larger than the reference. If the signal is normal, and the reference is too low, this error will be displayed.

Generally, if there is pure solvent in the flow cell, the best way to correct this is to press and hold down the AUTO GAIN button, to obtain a new reference and gain setting.

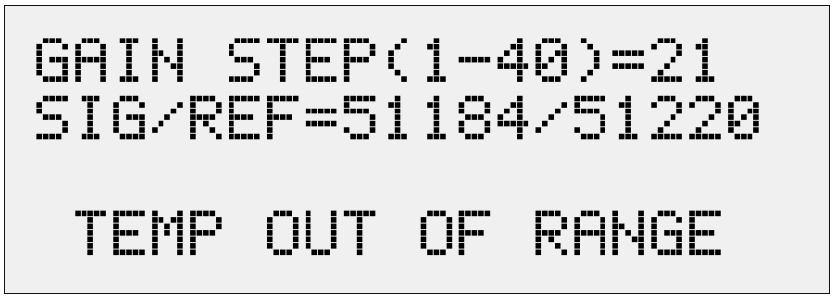
LOW SIGNAL WARNING



This error indicates that the signal is so low that a good result can not be obtained. It is usually caused by too many hydrocarbons in the flow cell or a blockage of the light path.

Check to make sure that the source is still blinking and that there is nothing blocking the light path through the flow cell. If the source and path are both good, the concentration in the flow cell should then be diluted.

TEMP OUT OF RANGE



This error only occurs if the temperature compensation is enabled and the measured internal temperature is outside its normal compensated parameters. The compensation works over the range of 15 to 50 °C.

For certain situations, such as a stable high or low temperature operating environment, temperature compensation may be disabled to avoid this message. In environments where the temperature quickly varies over a few degrees, temperature compensation should be left on.

The following errors indicate an internal fault with the analyzer:

NUMERICAL OVERFLOW
A/D COLLISION ERROR
NON-VOL MEMORY ERROR
TEMP DETECT FAILED

If any of these occur, contact your vendor.

6.00 SUPPLEMENTORY SETUP AND DIAGNOSTIC MODES

6.01 Overview

There are additional modes of operation that can be accessed only at power-up to set infrequently changed options, perform a diagnostic self test, and provide vendor contact information. Also, there is one internal jumper on the circuit board that must be changed to change to voltage output range on the Analog Output on the back of the unit.

6.02 Voltage Output Setting

The output voltage range on the Analog Output on the back of the DTIR can be selected by changing the position of jumper PL2 on the circuit board inside the DTIR.

The settings are:	PINS	OUTPUT VOLTAGE RANGE
	1 – 2	0V – 4V
	2 – 3	0V – 2V
	3 – 4	0V – 1V

To change the Voltage Output Setting:

1. Turn off and unplug the DTIR.
2. Remove the four thumbscrews from the bottom corners of the DTIR.
3. Carefully tilt the DTIR cover onto its right side next to the DTIR base.
4. Locate jumper PL2.
5. Remove jumper PL2 by pulling straight up.
6. Select the desired output voltage by pushing the jumper onto the appropriate pins.
7. Carefully tilt the DTIR cover back onto its base.
8. Replace the four thumbscrews.
9. Plug in and turn on the DTIR.
10. Fine tune the output voltage using a voltage meter and VOLTS OUT AT 100%T under the Factory Setup Menu

The factory default is the jumper across pins 1 – 2 (0V – 4V).

NOTE: WHILE IN %TRANSMISSION MODE, 0% TRANSMISSION WILL RESULT IN 0 VOLTS OUT AND 100% TRANSMISSION WILL RESULT IN EITHER 1, 2, OR 4 VOLTS OUT. WHILE IN ABSORBANCE MODE, 0 ABSORBANCE (100% TRANSMISSION) WILL RESULT IN 0 VOLTS OUT AND 1 ABSORBANCE (10% TRANSMISSION) WILL RESULT IN 1, 2 OR 4 VOLTS OUT.

6.03 Factory Setup Menu

The Factory Setup Menu contains four options that have been set at the factory. These are AVERAGING, BEEPER ON/OFF, DETECTOR POLARITY, TEMPERATURE COMPENSATION, and VOLTS OUT AT 100%T.

To enter the Factory Setup Menu:

1. Turn off the DTIR.
2. Hold down the AUTO GAIN and MENU / RESET buttons while turning on the DTIR.

Once in the Factory Setup Menu, press the Menu button repeatedly to scroll through the options. Once the desired option has been reached, press the ⬆ (up arrow) or ⬇ (down arrow) button to change the parameter or value. When all desired changes have been made, turn the DTIR off. All changes will be automatically recorded and applied the next time the DTIR is turned on.

AVERAGING:

The results displayed on the DTIR are averaged together based on this selected time setting. The choices for averaging are: NONE, 1.25, 2.5, 5, and 10 seconds.

The longer averaging is set, the longer will it take the DTIR to respond to changes. For example, a setting of 10 seconds means that the output of the DTIR is the average of the last 10 seconds of data, while a setting of NONE means that the output of the DTIR is not averaged at all and is the instantaneous reading of the detector. The DTIR should always be allowed to stabilize longer than the AVERAGING Set Time for an accurate reading.

This function is useful for "noisy" setups or very low %Transmission measurements. As the signal becomes less stable, averaging should be increased to even out the variation in the signal.

The factory default for AVERAGING is 2.5 seconds.

BEEPER ON/OFF:

The circuit board inside the DTIR contains an electronic beeper. This parameter enables or disables the built-in beeper from sounding when an error is reported. It does not affect beeps that occur when a button is pressed, or beeps commanded over the serial port, neither of which can be disabled.

The factory default for BEEPER ON/OFF is off.

DETECTOR POLARITY:

The infrared detector, which outputs a voltage proportional to the energy received from the IR source, may have either + (positive) or – (negative) polarity. This menu item allows the instrument to operate with either type of detector.

The factory default for DETECTOR POLARITY is + (positive).

TEMPERATURE COMPENSATION:

This option enables compensation for drift in the instrument that can occur as ambient temperature changes.

A sensor attached to the detector detects these temperature changes inside the DTIR. The output of the DTIR is then linearized with respect to mild temperature changes. The range of this temperature compensation is 15°C to 50°C. A temperature detected above or below this range will result in an error if TEMPERATURE COMPENSATION is on.

The factory default for TEMPERATURE COMPENSATION is on.

VOLTS OUT AT 100%T:

This option enables the user to fine-tune the maximum output voltage at the Analog Output Jacks.

When this menu screen is entered, the voltage that represents 100%Transmission or 0 Absorbance is placed at the analog output, regardless of what is in the flow cell or in the infrared path. Use the ⬆ (up arrow) or ⬇ (down arrow) button to adjust the voltage. Quick presses of the buttons result in small changes (0.5 - 1.0mV) while holding the button down gives larger changes (about 10mV increments).

The output voltage can be adjusted from about 49% to 110% of the maximum voltage. This means that if the jumper is set so that the output is 0V - 1V, the voltage at the banana jacks that represents 100%T can be adjusted from approximately .49 to 1.1 volts.

The factory default is 4.00 volts.

6.04 Self Test Mode

The DTIR has a self test mode in which the following are checked: analog output jumper voltage, minimum gain, resistor values and switches used to control gain steps, non-volatile memory, and performance of the infrared source.

This diagnostic procedure is performed without user intervention, displaying each step in the process and reporting success or failure along the way.

To enter the Self Test Mode:

1. Turn off the DTIR.
2. Hold down the ⬆ (up arrow) button while turning on the DTIR.

After completion of the series of tests, the instrument will initialize normally. Contact the manufacturer to report and resolve any errors detected during this test.

6.05 Software Version and Release Date

The DTIR can display both the software version and software release date.
Release the button, and the instrument will initialize normally.

To display the software version and release date:

1. Turn off the DTIR.
2. Hold down the ⬆ (up arrow) and ⬇ (down arrow) buttons while turning on the DTIR.

The DTIR will continue to display the information until the buttons are released or for a few seconds if the buttons are released immediately. After displaying the information, the instrument will initialize normally.

6.06 Manufacturer Information

Manufacturer information is displayed for four seconds at power up.

To indefinitely display the manufacturer information:

1. Turn off the DTIR.
2. Hold down the ⬇ (down arrow) button while turning on the DTIR.

The DTIR will continue to display the information until the buttons are released or for a few seconds if the buttons are released immediately. After displaying the information, the instrument will initialize normally.

7.00 MAINTENANCE AND SERVICE

7.01 Overview

The DTIR requires very little maintenance. There are no moving parts to replace, and no control knobs to wear out.

As long as no parts fail, cleaning the optics every month is the only maintenance required. However, in the event that an infrared source burns out or the detector fails, replacement is easy.

7.02 Optical Component Cleaning

After a prolonged period of use, dust may start to collect on the optics of the DTIR. If a decrease in signal level is noted, then the optics should be cleaned.

To clean the optics on the DTIR:

1. Turn off and unplug the DTIR. (This is to allow the source assembly to cool.)
2. Use inert dusting gas to blow off any dust on sapphire detector lens, the filter window on the exterior of the infrared source assembly, and to blow out any dust that has accumulated inside the source assembly. (If necessary, dry, filtered compressed air may be used.) Because of the way the source assembly is designed, only a minimal amount of dust should have accumulated inside the assembly.

If necessary, denatured alcohol and cotton swab can be used to clean the filter window and sapphire lens. While the lens is almost indestructible under normal use, the filter is delicate and great care should be exercised when cleaning it.

NOTE: USE GREAT CARE WHEN CLEANING THE FILTER. THE FILTER HAS SEVERAL OPTICAL COATINGS APPLIED THAT ARE USED TO FILTER OUT THE APPROPRIATE WAVELENGTHS OF LIGHT. USING A HARSH CLEANER CAN CAUSE THESE COATINGS TO DELAMINATE AND RUIN THE FILTER.

7.03 Infrared Source Assembly Alignment

To insure optimum energy transfer at the correct wavelength, the Infrared Source Assembly must be aligned with the cell and detector. (Changing the angle of the Source Assembly to the sample will change the wavelength of light that passes through the sample.)

To align the Infrared Source Assembly for maximum signal:

1. Loosen the two (2) thumbscrews clamping the Infrared Source Assembly in place.
2. Slide the Infrared Source Assembly up to the cell.
3. Make sure that the Infrared Source Assembly is aligned straight with the cell and not at an angle.
4. Press and hold down the AUTO GAIN button to obtain 100%T.

7.04 Infrared Source Replacement

The Infrared Source Assembly uses a tungsten bulb mounted in a 3/8" diameter parabolic reflector as the infrared source. The two wires from the bulb are terminated with two Trifurcon Molex contacts inside a nylon plastic housing. This bulb will eventually burn out.

To replace the Infrared Source:

1. Turn off and unplug the DTIR.
2. Unplug the Molex connector from the rear of the unit.
3. Cut the cable tie holding the wires in place
4. Remove the two thumbscrews clamping the Infrared Source Assembly in place.
5. Remove the Assembly.
6. Use a 5/64" Allen wrench to remove the two large screws from the front of the Assembly. These screws hold the Filter Assembly in place.
7. Set the two screws and Filter Assembly to the side.
8. Use a 5/64" Allen wrench to remove the two large screws from the back of the Source Assembly. These screws hold the Source Backplate in place.
9. Set the two screws and Source Backplate to the side.
10. Use a 1/16" Allen wrench to loosen the setscrew holding the parabolic reflector in place.
11. Remove the old infrared source and throw it away.
12. Slide the new infrared source into the hole until the front of the reflector is flush with the front of the Source Mount.
13. Use a 1/16" Allen wrench and tighten the setscrew to hold the reflector in place.
14. Gently bend down the wires coming from the back of the infrared source.
15. Use the 5/64" Allen wrench and two previously removed screws and replace the Source Backplate.
16. Use the 5/64" Allen wrench and two previously removed screws and replace the Filter Assembly.
17. Use the two thumbscrews to reattach the Infrared Source Assembly to the DTIR.
18. Plug the Molex connector into the plug on the back of the unit labeled LAMP.
19. Use a new wire tie to attach the wires to the bottom of the DTIR.
20. Plug in and turn on the DTIR.
21. After initialization, press and hold down the AUTO GAIN button.

7.05 Infrared Detector Replacement

The Infrared Detector Assembly is located inside the DTIR. While failure or the Detector is extremely unusual, it is possible for it to fail.

To replace the Infrared Detector Assembly:

1. Turn off and unplug the DTIR.
2. Remove the four thumbscrews from the bottom corners of the DTIR.
3. Carefully tilt the DTIR cover onto its right side next to the DTIR base.
4. Locate the Detector Assembly, mounted in the Cell Holder.
5. Use a 1/16" Allen wrench to loosen the two setscrews holding the Detector Assembly in place.
6. Slide out the old Detector Assembly and unplug it from the circuit board.
7. Slide the Detector Assembly into the Cell Holder until the front of the Detector is flush with the front of the Cell Holder.
8. Use a 1/16" Allen wrench and tighten the two setscrews to hold the Detector in place.
9. Plug the Detector cable into the circuit board. The plug is keyed so it will fit only one way.
10. Carefully tilt the DTIR cover back onto its base.
11. Replace the four thumbscrews.
12. Plug in and turn on the DTIR.
13. After initialization, press and hold down the AUTO GAIN button.

7.06 Solvent Supply

The quality of the new solvent should be checked for purity against a known pure sample of solvent before replacment. The %Transmission of the new solvent should be at least 90% of the pure sample of solvent.

Also, the drop in %Transmission from a clean empty cell with no solvent to one with the solvent in it should be noted and kept on record in case all the pure sample is used up and unavailable for comparison.

To compare the %Transmission of pure solvent to the %Transmission of air:

1. Flush out the cell with the new solvent several times to remove any oil and dirt from the windows.
2. Completely dry the flow cell. Make sure there are no droplets of solvent on the windows or sides.
3. Place the clean, empty flow cell in the DTIR.
4. Press and hold down the AUTO GAIN button to obtain 100%Transmission.
5. Using a clean dropper, fill the flow cell with the new solvent. Make sure all air bubbles are out of the cell.
6. Record the transmission of the solvent.

This procedure has already been done for the solvent tetrachloroethylene:

CUVETTE/CELL SIZE	%TRANSMISSION
1 cm	76% - 86%
2.5 cm	48% - 58%
4.0 cm	38% - 48%

NOTE: THIS CHART IS ONLY FOR THE SOLVENT PERCLENE ALSO KNOWN AS TETRACHLOROETHYLENE, ALSO KNOWN AS PERCHLOROETHYLENE, PERCLENE, OR PERC. IT CAN NOT BE USED WITH ANY OTHER SOLVENTS.

If the %Transmission of the new solvent is lower than what was previously recorded, then the solvent is possibly dirty and probably should not be used. If the %Transmission is within the recorded range or higher, then the solvent is clean and can be used.

After replacing the solvent supply, flush the cell several times and press and hold down the AUTO GAIN button to reset the gain for 100%Transmission.

A.00 APPLICATION OF THE DTIR MODEL 970 FOR OIL-IN-WATER ANALYSIS

A.01 Introduction

Although the DTIR Model 970 is a general-purpose infrared analyzer, one of the more common applications is analysis of oil, grease and total petroleum hydrocarbons in water. This appendix is specific to that application.

The DTIR is easy to use for oil-in-water testing. The large display clearly indicates the status of the instrument, and it can be easily calibrated to display the result in concentration (mg/liter).

A.02 Equipment Needed

The following is a list of equipment needed for oil-in-water analysis:

Duratech DTIR Model 970 Infrared Analyzer with cuvette holder
10mm cuvette (5mm for Vertrel solvent)
25ml red stripe graduated cylinder
50ml glass graduated cylinder
50ml beakers, quantity 4
250ml separatory funnel
Stemless glass funnel
250ml glass beaker
Ring stand
Ring

A.03 Consumables

The following is a list of consumables, except solvent, needed for approximately 100 tests:

Glass graduated 6oz Rx bottle
Dilute hydrochloric acid
Fisher filter paper
Transfer pipettes
pH test strips

A.04 Solvent

Approximately 12ml of solvent is used for each test. There are four solvents that can be used for this analysis. Duratech recommends that they be purchased locally if possible to avoid shipping by ground and the special handling required.

The solvents are:

Perchloroethylene (Perc):	Duratech recommended solvent Very good solvent Not relatively expensive Not banned
AK225:	Good solvent More expensive
Freon 113:	Good Solvent Increasingly restricted availability due to environmental concerns
Vertrel:	Fair Solvent Not recommended for extracting heavy crude oil

A.05 Calibration

To calibrate, data points are derived by determining the %Transmission of three samples of known concentration. The default standards are 10.0, 30.0 and 60.0mg/l, but the user may specify any three standards from 0.1 to 99.9 mg/l. The results are recorded on paper, then entered into the DTIR

To derive a calibration curve:

1. Set the DTIR output to %Transmission.
2. Place a cuvette with pure solvent in the cuvette holder.
3. Wait for the instrument readings to stabilize.
4. Press and hold down the AUTO GAIN button to start the automatic gain process.
5. Place a cuvette with a standard solution in the cuvette holder and wait a few seconds for instrument readings to stabilize. Record the resulting %Transmission to one decimal place.
6. Repeat the previous step for the two additional standard solutions.

To enter the calibration curve:

1. Press and hold the MENU / RESET button to enter calibration entry mode.
2. Enter the previously recorded concentrations and %Transmissions.

(Entering a calibration curve was covered in detail in Section 5.05.)

A.06 Operation

The following procedure requires that the instrument already contain the appropriate calibration curve. (See above.)

To determine oil-in-water concentrations:

1. Use the glass, graduated, 6oz Rx bottle to collect a known amount of sample water to be analyzed. A typically amount is 80 to 120ml.
2. Record the milliliters of sample water in the bottle.
3. Add about 3 milliliters of dilute hydrochloric acid to the water sample until the sample has a pH of 2 or less. (Use the pH test strips to measure the pH.)
4. Cap the bottle and shake for 10 seconds.
5. Allow the water sample to reach room temperature.
6. Use the 25ml red stripe glass graduated cylinder to measure out the amount of clean solvent that will be added to the water sample at a ratio of 1/10 of the original amount of water sample that is in the bottle. For example, if 120 milliliters of water was collected, then add 12 milliliters of solvent.
7. Add the solvent to the Rx bottle.
8. Cap the Rx bottle with the solvent in it and shake vigorously for 2 minutes.
9. Pour the contents of the bottle into the separatory funnel and allow the water and solvent layers to separate. (This usually takes 30 seconds to one minute.) The solvent layer is on the bottom.
10. With the folded filter paper placed in the stemless glass funnel, filter only the solvent through the filter paper into a clean glass 50ml beaker. Stop the flow before any of the water begins to flow from the funnel.
11. Set the DTIR display to Concentration mode. (RESULT = XX.X MG/L should appear on the bottom line.
12. Fill the clean cuvette with pure solvent, and press and hold down the AUTO GAIN button. (This will start the Auto Gain procedure.) When finished, the display will show RESULT = 0.00 MG/L.
13. Empty the cuvette.
14. Pour the sample extract solvent that is in the 50ml beaker into the cuvette and place it into the instrument. The DTIR will display the concentration in mg/l.

If you have several beakers with samples ready to test within a short time, typically less than 30 minutes, you can repeat the final two steps using a clean cuvette without getting a new reference.

NOTE: STEP 12, GETTING THE REFERENCE, IS ONLY DONE WITH PURE SOLVENT IN THE CUVETTE. IF THIS IS DONE WITH A SAMPLE IN THE CUVETTE, IT WILL CAUSE AN ERRONEOUS RESULT OF 0.00MG/L, OR VERY NEARLY THAT.