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InfraCal Analyzer®
Biodiesel Blend Analyzer

Model HATR-T2B

User's Guide

www.WilksIR.com

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1. InfraCal Biodiesel Analyzer Overview

1.1. Introduction

InfraCal Biodiesel Blend Analyzers are filter based infrared analyzers, providing the precision and accuracy necessary for repetitive quantitative mid infrared (mid IR) measurements in the laboratory, in the manufacturing plant, or in the field. The InfraCal Analyzer utilizes a fixed band pass filter/pyroelectric detector having one or two measurement wavelengths. The sample setup is a Horizontal Attenuated Total Reflection (HATR) zinc selenide crystal. Infrared radiation is passed through a sample using an elliptical source mirror and focused through the crystal and onto the detector package that contains filters to isolate an analytical and a reference wavelength. The result is calculated from the difference in the measured light absorbed by the sample at the analytical wavelength(s) and the reference wavelength. Details for your sampling option and a procedure for sample preparation and analysis may be provided for your specific application.

1.2. Basic measurement concept

The InfraCal Analyzer makes use of the fact that many molecules absorb infrared energy at a specific wavelength and the amount of energy absorbed is proportional to the concentration. The energy collected at the analytical wavelength (I_A), is reduced when compared to the energy collected at the reference wavelength (I_R). The sample concentration is determined by a calculation of the logarithm of the ratio of the light transmission at the reference wavelength to the light transmission at the analytical wavelength (Beer-Lambert law). "A" equals the infrared absorbance. The Beer-Lambert law assumes a linear relationship between absorbance and concentration.

Beer-Lambert Law: $\mathbf{A = \log I_R/I_A}$

Deviations from linearity are determined by obtaining absorbance values from known samples and an internal point to point calibration table is prepared (see Section 3) so that concentration in the desired units is directly presented on the display.

1.3. InfraCal Analyzer description and physical properties

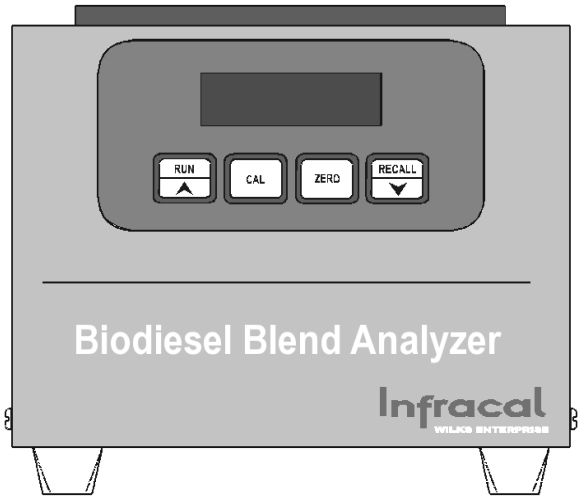

Figure 1: The InfraCal Analyzer: Front View

1.3.1. Front operating panel

The front panel consists of a 4 digit LED display and four labeled, touch-sensitive push button controls as illustrated in Figure 2. The LED display remains illuminated at all times while the analyzer is plugged in (switched on). When the instrument is not in use, and ready for use, the display may either show the result of the last analysis, or it may show ***idLE***.

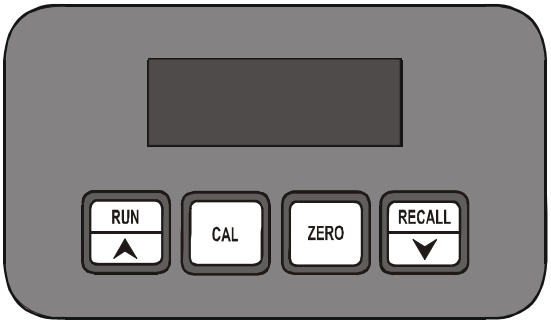

Figure 2: The Display and Control Panel

1.3.2. Back panel

The main power socket for the 12 Volt power supply is located on the back panel. The back panel also provides a standard nine pin, female DB9 connector for serial (RS232-C) data communications with the analyzer. This requires the use of a standard straight through serial data cable. A USB connection is also located on the back panel. See Section 7 for details of data communications with the InfraCal Analyzer.

The back panel also contains the CE Mark designation indicating compliance with the codes for operation within the European Community countries, and also the analyzer serial number. The CAL lockout switch deactivates the front panel CAL button to keep the internal calibration table from being inadvertently changed or turned off. For calibration, the switch is ON (I). After calibration the switch may be moved to the locked position (O). Make a permanent note of the serial number, and quote this when contacting Wilks Enterprise with a service or warranty related issue.

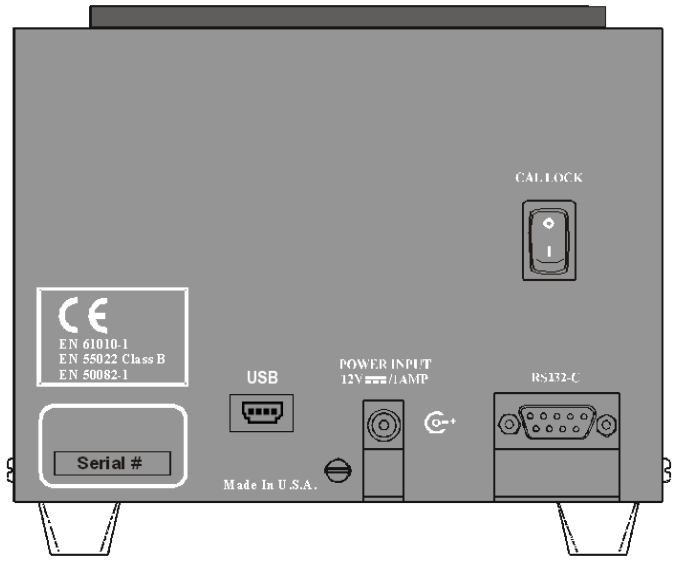

Figure 3: The InfraCal Analyzer: Rear View

1.3.3. Description of the push button controls

RUN - initiates sample analysis (Section 4). Also used in the calibration mode (***CAL***) to record a calibration sample (Section 3).

UP arrow control - used to increase numerical values used in the calibration mode (***CAL***) (Section 3).

CAL – Hold for 2 seconds to select calibration type (***uSEr, Edit*** or ***oFF***). Also used to generate a new user calibration. Quickly press and release to print the last result.

ZERO - Hold for 2 seconds to zero balance the instrument (***bAL*** appears on display during operation (2.2). Also used to exit the calibration mode (***CAL***). For printer, quickly press and release to print the current calibration table.

RECALL - Quickly press and release to recall up to the last ten results (recall mode) or to display the average (averaging mode). Hold for 2 seconds to reset the printer sequence number.

DOWN arrow control - used to decrease numerical values used in the calibration mode.

1.4. Biodiesel Blend Analyzer features

1.4.1. Internal Calibration

The InfraCal Analyzer reads in relative absorbance units that are proportional to concentration. An internal microprocessor allows the user to enter a calibration in order to read in the desired units. The InfraCal Analyzer contains three different user selectable calibration modes. These are ***oFF***, ***uSEr*** or ***Edit***. Section 3.4 explains the calibration functions in detail.

1.4.2. External Communication and Calibration

The InfraCal Biodiesel Blend Analyzer supports communications to a PC, printer or controller via an RS-232C asynchronous serial communications port. This capability allows for collection of sample measurement data and instrument control by a host computer. It also allows for multiple calibration tables if more than one table is being used with a single instrument. Specification details for communication parameters are in 7.

1.4.3. Recall Function/Averaging Results

The InfraCal Analyzer has the ability to store ten results for use with the averaging function or for local recall and display (see Section 4.2.1). Results may be data logged via the serial communications interface to a serial printer available as an accessory or to an external PC.

1.4.4. Printing the Result

An optional printer can be connected to the analyzer through the RS-232C port located on the back. To print the result, momentarily press and release the **CAL** button. Note that the Cal Lock switch must be in the (I) position. The result is printed on one line. The first number printed is a 5-digit sequence number. The sequence number is followed by the result. The remainder of the line contains the date, time and day of the week. To reset the print sequence number, unplug the printer and plug it back in. The next result will print as sequence number 000001.

2. Getting Started

2.1. Installation

2.1.1. Location

The InfraCal Biodiesel Blend Analyzer may be installed virtually anywhere. It is not affected by vibration and it can operate over a broad range of ambient temperatures (40°F, 4°C to 110°F, 45°C).

2.1.2. Power Requirements

The InfraCal Analyzer is powered from a 12 volts d.c. power source. A standard 12 volt power supply is provided with the analyzer, and this may be operated from any grounded a.c. outlet (line power requirements: 100 - 250 VAC, 50-60 Hz, 0.5-0.3 amps). When operating, the InfraCal Analyzer consumes approximately 8 watts (0.67 amps). For field use, the instrument may be connected to other sources of 12 volt d.c. power, such as an external battery pack or the cigarette lighter output of an automobile (contact Wilks Enterprise for details).

Plug in the external 12 volt supply to the power connector at the rear of the instrument. When plugged in, the instrument display will show ***init*** for a short time. Once the power-on initialization is complete, the instrument displays ***idLE***. The InfraCal Analyzer is now ready for use.

Note: *the connector is polarized with the center pole positive. Failure to use the correct power supply or the correct cable can result in permanent damage to the InfraCal Analyzer and may invalidate the warranty.*

The InfraCal Analyzer internal memory, which retains the factory and user calibration tables could be erased from a voltage spike or surge on the 120-220VAC line. The use of a surge protection device between the user's AC line and the 12V DC power supply is recommended to prevent the loss of calibration tables

2.1.3. Warm up time

For normal operation, it is recommended that the instrument be allowed to warm up for 1 hour prior to use. However, the analyzer is sufficiently stable after 15 minutes, and meaningful measurements may be obtained at this time. If the analyzer is used under the 1 hour warm-up time, frequent checking of the zero is recommended for best results. The longer warm-up time is recommended prior to making critical measurements and when performing analyzer calibration. The InfraCal Analyzer draws very little power and, if used daily, it can be left on at all times (unless operated from an external battery pack).

2.2. Zeroing the InfraCal Biodiesel Analyzer

For initial set-up, the InfraCal Analyzer will need to establish a zero using the following procedure. We recommend re-zeroing every hour when running samples or prior to a new sample if it has been more than an hour since the last test.

2.2.1. Establishing Zero

- Clean the sample crystal at least two times with hexane, pentane or similar solvent. Make sure that the crystal is completely clean and dry. It is very important that the crystal be clean and dry before zeroing the analyzer.

- Press and hold the **ZERO** button until the display reads ***bAL***. Release the button. A multiplier value to 3 decimal places will be displayed when zero is established. The actual value is only of interest when reporting problems to the factory.
- Re-run the zero every hour while the instrument is in use.

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3. InfraCal Analyzer Calibration

3.1. Data Presentation

The InfraCal Biodiesel Blend Analyzer is preset to have one decimal place. Changing the data presentation mode once the analyzer has been calibrated will require the analyzer to be recalibrated.

The different data presentation modes available for the InfraCal Analyzer are as follows:

Percent Mode (*PCt*): Calculated values are displayed to a single decimal place.

Decimal Mode (*dEC*): Calculated values are displayed to two decimal places.

Absorption Mode (*AbS*): An arbitrary scale related to the raw absorption of the sample.

Ratio Mode (*RAt*): A threshold based scale where a value defining an acceptable limit for maximum or minimum acceptable concentration is set to the value of 1.000. All values less than 1.000 indicate that the concentration is less than the threshold, while all values greater than 1.000 indicate that the concentration is greater than the threshold.

The InfraCal Analyzer display format can be switched between modes by pressing and holding both the **CAL** and **ZERO** buttons for two seconds. Each time the **CAL** and **ZERO** buttons are pressed the display mode changes. Release both buttons and repeat until the desired mode is displayed. The display will read: ***AbS*** for absorption mode, ***PCt*** for percent mode, ***dEC*** for decimal mode, and ***RAt*** for ratio mode. Push run to return back to ***idLE.***

3.2. Selection of suitable calibration standards

Select a set of carefully prepared samples covering the desired range for the analysis. A maximum of 20 samples can be used. Ensure that the reference samples are fresh and accurately prepared. Select standards that cover the entire measurement range. For best results, standards should be made with the diesel and biodiesel to be used for analysis. Samples above the highest calibration standard will need to be diluted.

The InfraCal Biodiesel Analyzer may also be calibrated against an alternate method. For calibration against an alternate method obtain duplicate samples or if possible, test the same sample with the InfraCal Analyzer and the alternate method. Data collected for this purpose should always be obtained with the calibration ***oFF.*** With a minimum of 10 data points, make a graph with InfraCal Analyzer absorbance data vs. the alternate method values. Select data points within the desired measurement range of operation and enter these calibration points into the InfraCal Analyzer memory using the "edit" program that is described in section 3.4.3.

3.2.1. Mixing Standards

Standards can be mixed volumetrically. A maximum of 20 standards can be used in the calibration. Select the analysis range for the application and mix the appropriate standards for that range. The list below can be used as a guideline for mixing standards. It is recommended that 10 calibration points spaced evenly between 0-100% are used. This will provide sufficient data for the InfraCal Analyzer to display accurate results.

Volumetric Standards

%	Diesel	Biodiesel
0	20 ml	0 ml
5	19 ml	1 ml
10	18 ml	2 ml
15	17 ml	3 ml
20	16 ml	4 ml
25	15 ml	5 ml
30	14 ml	6 ml
35	13 ml	7 ml
40	12 ml	8 ml
45	11 ml	9 ml
50	10 ml	10 ml
55	9 ml	11 ml
60	8 ml	12 ml
65	7 ml	13 ml
70	6 ml	14 ml
75	5 ml	15 ml
80	4 ml	16 ml
85	3 ml	17 ml
90	2 ml	18 ml
95	1 ml	19 ml
100	0	20 ml

3.3. Calibration considerations

- Allow the InfraCal Analyzer to warm up at least one hour.
- Always zero the InfraCal Analyzer prior to calibration or collecting data for calibration analysis (see section 2.2).
- Prepare a set of reference samples covering the desired range for the analysis. Ensure that the samples are accurately prepared. When comparing against an alternate method, collect enough data for a good representation of the measurement range.

3.4. Calibration modes

The InfraCal Analyzer contains three different user modes in the calibration. These are ***uSEr, Edit*** **or** ***oFF*****.** If a factory calibration is installed there will be a fourth mode, ***FACt***.

In the ***oFF*** mode the instrument measures levels in arbitrary absorption units that are proportional to concentration levels. Higher values indicate increased levels of hydrocarbons. This mode should be used to collect "raw" data for the ***Edit*** mode or for comparing to an alternate method.

The ***Edit*** mode allows the user to edit an existing calibration table or to create one from scratch, using absorption values obtained in the ***oFF*** mode. In this mode, standards (or samples used to calibrate to an alternate laboratory method) may be run several times and an average can be entered into the table.

The ***uSEr*** mode enters the calibration at the time the standards are presented to the analyzer.

3.4.1. Selecting the Calibration Mode

- Press the **CAL** button for two seconds, until ***CAL*** appears on the display. Press the **RECALL** button to display the active table, one of ***uSEr, Edit*** or ***oFF***. Press and release the **RECALL** button repeatedly until the desired mode is displayed.
- Press the **ZERO** button to exit the calibration mode. ***iDLE*** will be displayed.

3.4.2. Collecting calibration data

Take several samples for each calibration standard including the zero (100% diesel) or for each comparison to an alternate method and measure the absorbance value with calibration ***oFF*** (section 3.4.1). Average the results after discarding any obviously erroneous results. The results can be recorded as shown on the sample table below, or with the Excel calibration file that can be found on the CD included with the instrument. Since the InfraCal does not allow a concentration of zero to be entered into the calibration table, the first concentration point must be calculated at 0.1%. To do this, use the following equation:

A01= ((A02-A00)/C02)*0.1+A00

Where A01 is the calculated relative absorbance value to enter into the instrument for the CO1=0.1, A00 is the relative absorbance of the 0% biodiesel (pure diesel) standard, A02 is the relative absorbance of the second biodiesel standard (from the 5% standard with standards from Wilks) and C02 is the concentration of the second biodiesel standard (5.0 with standards from Wilks). This calculation is done automatically in the Excel file that can be found on the CD included with the instrument. Contact Wilks if you would like that file emailed to you: tech@WilksIR.com

3.4.3. Absorbance Versus Calibration Standard or Alternate Method Table

(Relative absorbance Value)		(Calibration Standard in Desired Units)	
A01 =	_____	C01=	_____
A02 =	_____	C02 =	_____
A03 =	_____	C03 =	_____
A04 =	_____	C04 =	_____
A05 =	_____	C05 =	_____
↓		↓	
A20 =	_____	C20 =	_____

N (Number of calibration points or calibration standards) = _____

3.4.4. Entering Calibration Data into the Edit Mode

1. Press the CAL button for two seconds, until *CAL* appears on the display. Press RECALL until *Edit* is displayed.

2. Press CAL. The display will read *n*= for a short time, followed by the number of entries currently in the calibration table. Scroll to the desired number of entries (0 - 20). ***Selecting 0 will erase any existing calibration table.***

3. Press CAL to proceed. The display will read *A01*= for a short time followed by the current absorption value for the first calibration table entry. Scroll this to the desired value from the "relative absorbance versus calibration standard" table.

4. Press CAL again and the display will read *C01*= followed by the current analyzer concentration value for the entry. Scroll this to the desired value from the table. Continue to press CAL to step through all absorption and concentration values for the table size (*n*=) entered. Once all entries have been created press CAL and the display will read *idLE*.

3.4.5. User Calibration Mode Procedure:

Note that this is not the preferred method to use for calibration of the InfraCal Analyzer. If you would like to use this method, please contact tech@wilksir.com for instructions.

3.5. Calibration printing

With the optional printer, the current calibration table can be printed by momentarily pressing and releasing the **ZERO** button when the analyzer is idle. The first line indicates which calibration is active followed by the date and time. The second line gives the headings for the calibration table that follows. **ABS** represents absorption and **CON** represents concentration. The table headings are followed by the balance value. One additional line is printed for each calibration table entry. The absorption and concentration values are given.

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4. Analyzing a Sample

4.1. Samples

Unless the user ordered a factory calibration, the InfraCal Analyzer will read out in relative absorbance units. If the user would like the readout in their desired units directly presented on the display, refer to section 3, analyzer calibration. The InfraCal Analyzer will provide reliable concentration measurements within the range specified for your application. When the maximum value is exceeded, a notr warning code (Section 7) indicates that the light throughput has fallen below an acceptable level, making the results unreliable. The measurement range can often be adjusted by either concentrating or diluting the sample.

4.2. Sample analysis

For technical support, contact Wilks Enterprise at tech@wilksir.com.

- Clean the sample crystal at least two times with hexane, pentane or similar solvent. Make sure that the crystal is completely clean and dry.

- Next zero the analyzer by pressing and holding the zero button. See section 2.2 for more detailed information on zeroing.
- Present a prepared sample to the analyzer. Apply enough fuel to entirely cover the sample crystal. As the infrared light only penetrates 1 micron into the sample only a small amount is necessary.
- Press the **RUN** button. The sample concentration will appear on the display within 20 seconds. If a calibration table has not been entered into the InfraCal Analyzer, the readout will be in relative absorbance units.

4.2.1. Averaged Results Display

The InfraCal Analyzer can display the average of up to ten sample measurements. To use the averaging mode, use the following procedure:

- Momentarily press the **RECALL** button once and ignore the result displayed.
- Analyze up to ten replicate samples using the measurement procedure described above.
- Momentarily press the **RECALL** button to display the average.

The next sample measurement will then start a new average accumulation.

The Analyzer alternatively can be configured to recall the last 10 measurements (from newest to oldest) in a circular fashion. First the InfraCal Analyzer must be switched from the average mode (factory default) to the recall mode as described below. Once the recall mode is selected momentarily press the **RECALL** button repeatedly to display the previous results.

The InfraCal Analyzer recall mode can be switched by pressing the **ZERO** button first, immediately followed by the **RECALL** button and holding both buttons for two seconds. The display will read ***rCL*** when switched to the recall mode. Repeat the procedure to return to average mode. The display will read ***Ag***.

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5. InfraCal Analyzer Sample Stage

5.1. Sample Stages Overview

The InfraCal Biodiesel Analyzer is offered with a horizontal attenuated total reflection (HATR) sample stage. Other sample stages include cuvette, sealed cell and card reader stages for other applications or special circumstances. The HATR sample stage is described in this manual.

5.2. HATR-T2B Sample Stage

The InfraCal Biodiesel Analyzer, Model HATR-T2B is supplied with an integrated ATR zinc selenide crystal and an integrated optics sensing system. Different crystal material can be custom ordered. The sample stage includes the infrared source (modulated) and detector system, positioned such that an elliptical energy beam is transmitted through the ATR crystal and focused directly on the detector-sensing window.

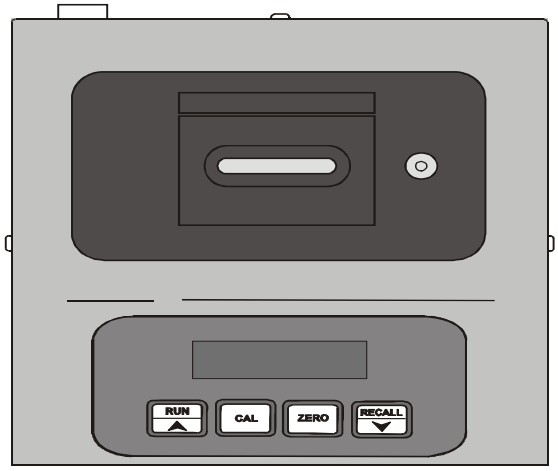

Figure 4: The InfraCal Analyzer HATR-T2B Sample Stage: Top View

5.2.1. HATR-T2B Measurement Concept

The InfraCal Analyzer makes use of the fact that many molecules absorb infrared energy at a specific wavelength and the amount of energy absorbed is proportional to the concentration. The energy collected at the analytical wavelength (I_A).The sample concentration is determined by a calculation of the logarithm of the ration of the light transmission at the reference wavelength (I_R) to the light transmission at the analytical wavelength (Beer-Lambert law). "A" equals the infrared absorbance. The Beer-Lambert law assumes a linear relationship between absorbance and concentration. Deviations from linearity are determined by obtaining absorbance values from known samples and an internal calibration table is prepared (Section 3 in the InfraCal Analyzer Manual) so that actual concentration is directly presented on the display.

Beer-Lambert Law: $\mathbf{A = \log I_R/I_A}$

With the HATR-T2B, an IR beam is internally reflected down the ATR crystal and the output is focused directly on the dual detector package. Since there is an evanescent wave that penetrates the sample at each internal reflection point, energy is absorbed at the analytical wavelength by the sample.

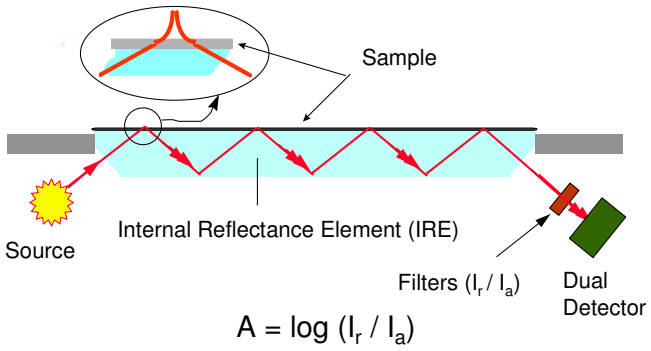

Figure 5: The Measurement of IR Absorption of a Sample with an HATR-T2B

5.2.2. HATR-T2B Considerations

- The sample must cover the entire crystal in order to obtain repeatable results.
- Always zero the InfraCal Analyzer with the ATR crystal cleaned with the appropriate solvent, such as hexane. Dry with an anti-static wipe. Repeat the clean and wipe a second time to insure residual fuel is removed. Water is not recommended for cleaning since residue will affect the zero.

5.2.3. Auto Evaporation Timer Programming

The InfraCal Analyzer supports an evaporation timer for some applications. This feature is not needed for biodiesel analysis and is included only for reference. Press and hold the **RUN** button until the current timer value is displayed. The value is displayed as 1 or 2 digits in minutes and 2 digits in seconds, separated by a period (.). Release the **RUN** button once the current value (initially 0.00) is displayed. Use the up-arrow and down-arrow keys to scroll the timer to the desired value. The optimum time will vary with the type analysis and atmospheric conditions at the point of use. To zero the timer during programming, press the **ZERO** button. Once the desired time has been programmed press the **CAL** button. The display will read ***idLE***.

5.2.4. Timer Operation

The timer is disabled when programmed to zero (0.00). When the timer is non-zero, it is invoked during the normal **RUN**, **ZERO** and **CAL** functions.

Press and release **RUN** and the timer value is displayed. The timer will count down one second at a time. The dot separating minutes and seconds flashes to indicate the timer is counting. Once the timer reaches zero the display will read ***run*** during the sample measurement cycle followed by the result.

The **ZERO** function is initiated by pressing and holding the **ZERO** button until the timer value is displayed. The timer will count down as described above and **bAL** will then be displayed. On completion the balance result is displayed.

The timer is also invoked during calibration, each time the RUN button is pressed to analyze a sample.

To override the timer, press the RUN button a second time and the analyzer will go directly into the ***run*** cycle.

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6. InfraCal Analyzer Specifications

6.1. External power requirements

The InfraCal Analyzer operates off external 12-volt power. The power sources can be either regulated DC power supplies or an external battery. This power can be provided by the user or by Wilks Enterprise, Inc. The suggested minimum requirement specifications for the 12 volt power source applied to the analyzer are described below:

Wall Supply Specifications:
- Input: 100-250 VAC, 50-60 Hz, 0.5A
- Output: 12 VDC, ±1%, 25 Watts

Battery Supply Specifications:
- Output: 14 VDC Maximum, 11 VDC Minimum

Load Specifications:
- 1.5 Amperes Peak

6.2. Physical

Dimensions:		6.5 in. x 6.5 in. x 5 in. (165 mm x 165 mm x 127 mm)
Weight:		4.5 lb. (2.0 kg.)
Control:		Display (output) 4 digit 7 segment red LED, 5/8 in. character height
	User (input)	4 multi-function push-button switches
Connectors:	Power --	Switchcraft Model 760 plug or equivalent
	Communications --	9-pin D-Sub, female

6.3. Environmental

Temperature:	Non-operating --	0°F (-18°C) to 125°F (52°C)
	Operating --	40°F (4°C) to 110°F (45°C)
Humidity:	Relative --	10% to 60% non-condensing

6.4. Electrical

Noise:	Rejection --	60 dB minimum
Drift:	Short term Ambient --	(< 1 Hr.) ± 0.3% of full scale
	Long term Ambient --	(> 1 Hr.) ± 0.1% of full scale
	Temperature --	± 0.03% of full scale per degree C
	Repeatability --	± 0.1% of full scale
Response:	On Delay --	5, 10, 15 or 20 second factory-set intervals
	Measure Time --	5 seconds
	Modes --	Local control or remote PC control
Resolution:	Conversion --	16 Bits (0.0015%)
Ranging:	Digital Ranging --	256 step automatic ranging
	Analog Range --	0 to 4.096 volts
	Answer Range --	Absolute; 00 to 9999
		Percent; 0.0 to 100.0%
		Decimal; .00 to 99.99
	Measure Range --	Dependant on sample concentration ratio
Measurement Accuracy:		± 1% of full scale
Measurement Repeatability:		± 0.1%, ±1 digit
Memory:		Non-volatile memory for calibration and configuration data

6.5. Calibration

- Electronic zero balance adjustment
- Up to 20 point curve fitting calibration
- Modes: User Table
  Off
  Factory (special order)

7. InfraCal Analyzer Communications Interface

The InfraCal Biodiesel Analyzer supports communications to a PC or other host via an RS-232C asynchronous serial communications port. This capability allows for collection of sample measurement data and instrument control by a host computer. The host can also maintain calibration tables and download them to the instrument as required. This is particularly useful when more than one table is being used with a single instrument.

7.1. Physical connection

The InfraCal Analyzer is connected to the external device via the 9-pin female DB9 connector located on the rear panel in the lower left-hand corner. The InfraCal Analyzer operates as a DCE device. To connect to a PC, a standard straight through 9 pin cable can be used, but only 3 wires are required.[1] The required signals are Transmit Data (TXD), Receive Data (RXD) and Ground (GND). The pinout is as follows:

Function	Pin
RXD	3
TXD	2
GND	5

[1] *Systems with serial numbers lower than 10200 require a null modem cable or null modem adapter.*

7.2. Communications port setup parameters

The port setup required by the InfraCal Analyzer is:

- 9600 baud
- 8 data bits, 1 stop bit
- No parity

7.3. Operation

The InfraCal Analyzer accepts ASCII commands from the host and returns data as a response to certain commands or, in data logging mode, on completion of a measurement cycle. All commands are two characters in length. Certain commands have parameters that follow the command. Parameters are separated by commas. All commands are terminated by a carriage return character. All data responses are comma separated ASCII fields, terminated by a carriage return character. The first field indicates the result type; the remaining fields are the result. Result types are 'B' for balance results, 'R' for run results or 'C' for calibration data. The result format is determined by the presentation mode and is identical to the LED display data. The Read Display Mode command returns a two character mode code. Alphabetic characters can be sent in upper or lower case. Response data is always upper case.

Command Set

Command	Description	Response Examples
RB	Read balance	B,1.025 B,0.865
RR	Read displayed result	R,27.5 R,315 R,1.873
RU	Run (same as RUN button)	None
RA	Run & display uncalibrated result	None

BA	Balance (same as Zero switch)	None
LR	Enable results data logging	None
DR	Disable results data logging	None
RM	Read display mode	MA, MP, MD or MR
MA	Set display mode to absolute	None
MP	Set display mode to percent	None
MD	Set display mode to decimal	None
MR	Set display mode to ratio	None
WB,<params.>	Set balance data	None
RC,<params.>	Read calibration table	See detailed description
WC,<params.>	Set calibration table	None
CM	Read Calibration Mode	CD, CE or CF
CD	Disable Calibration	None
CE	Enable User Calibration	None
CF	Enable Factory Calibration	None
ES	Return error status	E,0 E,2
RE	System reset	None
ID	Return firmware ID	2.02.06

7.4. Data logging

Data logging provides results output at the end of each RUN or BALANCE cycle. The results are output when data logging is enabled both for functions initiated from the instrument control panel and functions initiated by the host. The format of the data returned after a RUN cycle is as shown for the RR command and is determined by the display mode. The format of the data returned after a BALANCE cycle is as shown for the RB command. The RA command allows the host to initiate a run cycle and data log a result that is not adjusted by the calibration procedure. This can be used by an intelligent host resident calibration table generator.

7.5. Remote zero balance control

The instrument zero balance can be controlled via the communications port. The RB, WB and BA commands provide the necessary controls. This feature can be used to store multiple zero values for different operating conditions. This feature combined with the calibration controls described in the next section can be used to maintain multiple calibration curves when using the instrument for multiple applications.

The RB command will retrieve the current zero balance data. The WB command can then be used to reset the current zero balance to a previously recorded value. The WB data field is identical in format to the data returned in response to the RB command.

The BA command can be used to initiate a zero balance function under remote control. The operation is identical to initiating a zero balance from the instrument control panel. The user must insert the zero sample in the instrument prior to issuing this command. If data logging is enabled the result will be returned on completion of the function. The data format is identical to the RB command response. The result can optionally be read with the RB command if data logging mode is not used.

7.6. Remote calibration control

Calibration data can be retrieved or set under remote control. Due to the complexity of the calibration function (and the need to utilize multiple calibration standards) initial calibration can only be performed from the instrument panel. Another approach is to use the host to generate one or more calibration curves from uncorrected data log results collected with the RA command. This technique is extremely useful if the user desires to generate a calibration curve based on an average result of several measurements from a lot of each calibration standard.

The RC command is used to retrieve the current calibration table. A Calibration table consists of zero to twenty entries. The RC command can take the following forms:

RC	Read entire calibration table
RC,0	Read calibration table size
RC,n	Read a single calibration table entry, where n is the entry number.

The RC,0 command response is C,n where n is the number of calibration table entries from 0 to 20. If 0, the instrument is not calibrated. Otherwise, n is the number of calibration table entries.

The RC,n command response is C,n,x,y where n is the entry number as received, x is the raw measurement data as it appears on the display during calibration and y is the actual value as set by the user during calibration. The format is determined by the display mode (absolute, percent, or decimal). Calibration commands should not be used when in ratio mode since ratio mode does not use a calibration table. An RC command requesting data for a table entry number greater than the current table size returns erroneous data.

The RC command with no arguments returns the complete calibration table, one entry at a time starting with the table size information. The individual entries are then returned in numerical order up to the number of entries.

Read Calibration Table Example

Assume the instrument is calibrated in the absolute mode using three standards. Assume the calibration results were as follows:

Entry	Measured	Actual
1	15	30
2	26	50
3	33	70

The RC command will return the following:

C,0,3
C,1,15,30
C,2,26,50
C,3,33,70

The RC,0 command will return C,0,3

The RC,2 command will return C,2,26,50

The WC command can be used to download calibration table data based on previously uploaded data or as determined by a host program. The command format is WC,n,x,y where the parameters are identical in format to the RC command. The parameters must match the current display mode. When using the WC command the table size and all necessary table entries should always be downloaded. Once all table entries have been downloaded the table size should be set.

Write Calibration Table Example

To download the calibration table described in the previous example, send the following commands:

WC,1, 15,30
WC,2, 26,50
WC,3, 33,70
WC,0,3

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8. Service and Technical Support

Your InfraCal ® Biodiesel Analyzer may have been purchased either directly from Wilks Enterprise or from a local dealer or representative. If you have a technical question relative to the operation of the instrument or relative to the analysis, please contact Wilks Enterprise at the contact address provided below:

Customer Services Department
Wilks Enterprise, Inc.
25 Van Zant St, Suite 8F
East Norwalk, CT 06855
USA
Telephone: **(203) 855-9136**
FAX: **(203) 838-9868**
E-mail: tech@wilksir.com

During the warranty period, Wilks Enterprise, Inc. offers free factory service for all failures that occur from normal instrument usage. The user is only required to cover the cost of shipping the instrument to the factory. After the warranty period, the user is required to cover the factory's cost of servicing plus all shipping charges. Normal one week turnaround is offered for all InfraCal Analyzer instruments that are returned to the factory for service. For users requiring faster service times, Wilks Enterprise also offers an advance replacement program that can respond to a user's needs with instrument replacement typically in less than 24 hours. For extended service contracts, advanced replacement programs, factory service charges or sample system installation procedures, please contact Wilks Enterprise, Inc. for details.