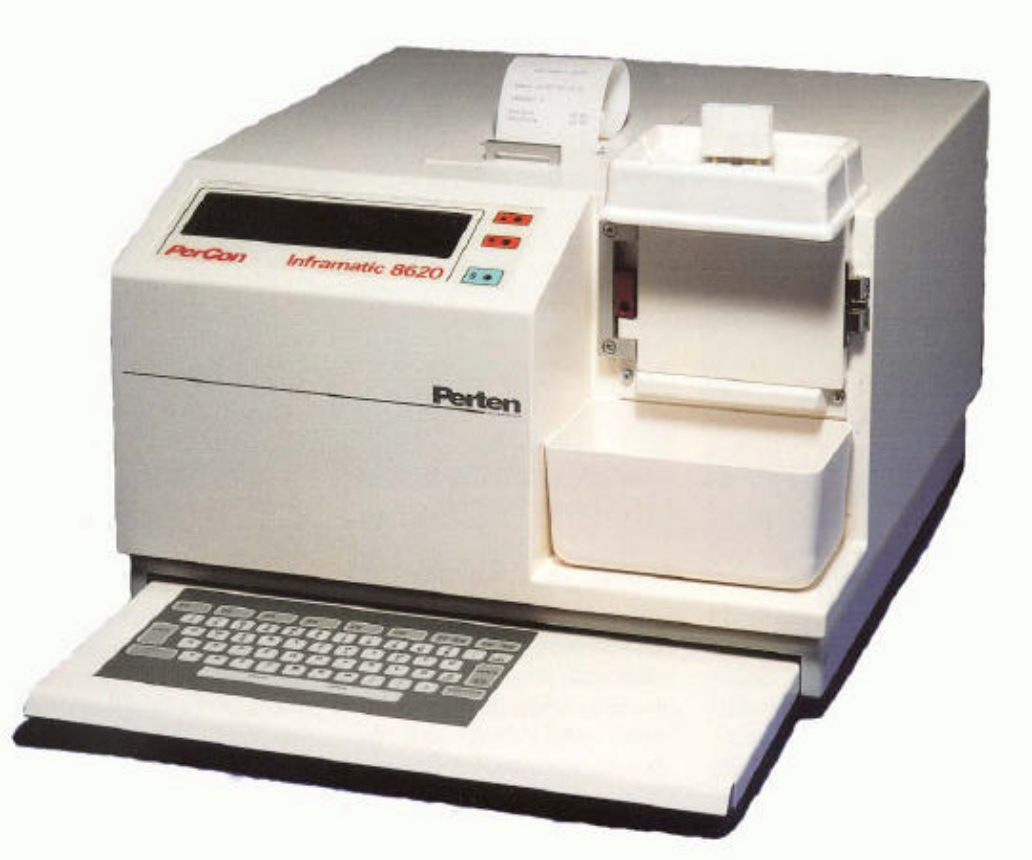
Inframatic 8600

Operation Manual



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INFRAMATIC 8600 S/N>1000

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continued...

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PACKING LIST INFRAMATIC 8600 NIR ANALYZER

THIS DELIVERY CONTAINS:

1 x 8600	Inframatic 8600 NIR Analyzer with 6-7 narrowband interference filters (6-7 wavelengths) Internal calibration memory for 106 calibrations Large LCD alphanumeric display (8 lines/40 characters) Sample presentation door for powders/interchangeable Standard RS-232 C data communication
1 x	Mains power cable
1 x	Key, for key switch
1 x 82.01.20	Sample compressor, powder
1 x 82.01.30	Sample container
1 x 82.01.40	Soft brush
1 x 82.01.50	Plastic spoon
1 x	Operating instructions and spare parts manual

SPARE PARTS SUPPLIED ONLY IF PRINTER INCLUDED

1 x 82.24.12	Ink ribbon cassette
3 x 82.24.52	Printer paper

Retain all packing materials for future possible service transport.

CHECK YOUR DELIVERY FOR ANY OPTIONAL ACCESSORIES ORDERED.

TECHNICAL DATA

Power requirement:	115V~ or 240V~, 50 or 60 Hz as specified on order
Fuse:	T 1AL 250V
Dimensions:	(HxDxW) 260 x 410 x 370 mm
Net weight:	23 kg

GENERAL DESCRIPTION

The Inframatic 8600 system is a rapid, general purpose near infrared reflectance (NIR) analyzer. It is used to analyze in particular the composition of food products by measuring the reflectance characteristics of a sample at specific wavelengths in the near infrared wavelength region.

Typically the measurement involves no chemicals and no weighing of the sample and no or very little sample preparation. This makes the technique safe to use, rapid and simple.

The NIR technique is empirical, which means that the Inframatic must be calibrated before it can be used. For many products calibrations exist, which can be adopted with only a minimum of work.

In case calibrations do not exist or new calibrations are required, then a set of calibration samples with known composition is needed. These samples are then read in the instrument. The instrument readings and the known compositions are processed by statistical techniques - regression analysis - to provide the new calibration. Complete extensive software for easy interfacing with the Inframatic system is available for the development of new calibrations.

STANDARD CALIBRATIONS & OTHER APPLICATIONS

The Inframatic 8600 system is generally delivered with factory standard calibrations for wheat, barley and wheat flour. These are also listed in the Appendices.

There is a great number of other applications as is evident from the wide NIR literature.

References to these as well as general information on NIR theory and calibration development can be found in for example:

Practical NIR Spectroscopy with Applications in Food Analysis and Beverage Analysis by B. G. Osborne, T. Fearn & P. H. Hindle, 220 p. published by Longman Scientific & Technical ISBN 0-582-09946-3, 1993.

Near Infrared Technology in the Agricultural and Food Industries, edited by Phil Williams and Karl Norris, 330 p, published by the American Association of Cereal Chemists, Inc ISBN 0-913250-49-X, 1987.

Also Perten Instruments or your local representative can advise you on other applications available.

ENVIRONMENTAL REQUIREMENTS - OPERATING CONDITIONS

The Inframatic should stand in a level and vibration free position.

There is evidence of a small but significant dependance of NIR readings on temperature and this should be borne in mind if either the instrument environment or the samples are subject to variations in temperature of +/- 5^{o}C or more (ICC recommendation No. 202).

It is important that the Inframatic is not sited in direct sunlight or close to other sources of heat (e g an ash oven) since these may cause large temperature variations for which the Inframatic thermostat can not compensate. Ambient temperature should be kept within 15 - 35 degrees C.

The Inframatic will automatically compensate for changes in power supply up to +/- 10 volts. If larger voltage fluctuations are suspected, an external voltage stabilizer is suggested.

SYSTEM CONNECTION AND WARM-UP

The Inframatic should have achieved room temperature before connecting to an electrical supply.

If the unit is equipped with a separate alpha numerical keyboard, place the Inframatic on the keyboard housing and lift the unit up slightly to connect the keyboard cable to the connector on the underside of the Inframatic. Check that the keyboard can slide out and in of the keyboard housing easily.

There is a mains switch and a key switch - a switch operated by a key - on the back panel of the Inframatic.

1. Make sure the KEY switch is in its VERTICAL position.

   The small rectangular (9-pin D-sub) connector is the RS-232 interface connector. It is suggested to explore the Inframatic first without any external computer connected.

2. Connect the Inframatic mains input to a grounded, appropriately fused electrical supply. Check details on the apparatus nameplate.

3. Switch the mains switch DOWN to switch the unit on. The switch red lamp is lit.

4. When the Inframatic 8600 is switched on, it will perform a self-check stepping through all filters and checking all functions.

The display will show date and time (if the optional calendar/clock is installed).

The available number of products and product names are shown on the left side of the display and the available parameters in the product, indicated with an asterisk *, are shown on the right side of the display.

```
20.01.92      Inframatic 8600          13:45:00
*  1 Wheat                 Protein
   2 Barley                Moisture
   3 Wheat Flour           Hardness
     **********
```

NOTE: *The date and date format as well as the time can be easily changed. See System Support Mode for details.*

Instrument warm-up

Before operating, at least 50 minutes warm-up time from room temperature is required. It is strongly recommended to leave the unit on continuously.

DESCRIPTION OF INSTRUMENT

At the front of the instrument is the LCD display with 3 keys, the optional printer and the powder door with the sample compartment.

The powder door is fixed by a spring loaded lock. Pull the door outwards to open.

Keys [-] [¯] and [S].

In normal run mode, (the key switch in the VERTICAL position), the keys [↑] (up) and [↓] (down) are used to select the product to be analyzed.

Pressing these keys steps up and down on the LCD display. The asterisk (*) to the left of the name field indicates the product which is presently selected. The parameters in the selected product are shown to the right.

The [S] key is used to start the analysis.

Input mode.

With the key switch in the HORIZONTAL position (input mode) the System support mode is activated.

This mode is used to read, enter or change calibration constants. See Entering or changing calibration constants and System support mode for details.

Printer

See Printer operation for details.

DIRECTIONS FOR USE

***NOTE**: The procedure described below is general. Special techniques for liquid samples and pastes are described separately.*

Calibrations

The Inframatic is generally supplied with standard calibrations for wheat, wheat flour and barley. Calibration constants are listed in the Appendices.

Calibration constants are a set of values by which the instrument calculates a result according to the following formula:

$$result = C_0 + (C_1*log1 + C_2*log2 + ... + C_7*log7)*slope$$

The C_0 constant is called the bias or offset constant. Adding for example a value of 0.2 to C_0 will increase the results with 0.2 units. A result of 10 will be increased to 10.2, a result of 11 to 11.2 etc. The C_0 constant is unique for each instrument and must be individually determined.

The C_1 to C_7 constants are referred to as filter constants. There is 1 constant for each filter/wavelength. If the filter is not used the filter constant is 0 (zero).

There is also one constant, called the slope constant. Increasing this constant generally increases high values more than low values and vice versa. The slope constant is generally 1 (one).

The log1, log2 values etc are the actual optical values measured by the Inframatic at filter/wavelength 1, 2 etc. Log values are generally between 0 and 2 and typically around 0.5 for a wheat sample.

The C_0 constant is determined using a known set of at least 20 reference samples, to make the Inframatic readings agree with your reference laboratory.

The procedure on how to adjust the bias or the C_0 constant is described in the section Adjusting an existing calibration.

The procedure on how to check and how to change instrument calibration constants is described in the section Entering or changing calibration constants.

If in doubt contact Perten Instruments or your local representative.

Sampling and sample preparation

Sampling should be as representative as possible, and comply with normal recommended practices.

For ground samples, the sample generally requires no further preparation, other than mixing to ensure that a homogenous sample is presented to the Inframatic.

For other products such as grain, the sample is ground to a consistent particle size. The same grinder and sieve must be used for all samples. The same grinding procedure as was used for the calibration must be used. Supplied calibrations have generally been developed using Perten Instruments Laboratory Mills type 120 or 3100 fitted with an 0.8 mm sieve.

It is recommended that a sample of 100 to 200 g is prepared in order to obtain a representative sample for the test.

Mix the ground sample well and allow it to cool to room temperature if the sample became warm during the grinding process. If a series of samples are ground it is good practice to first analyze the sample that was first ground - this allows samples to cool off.

Operation - Analyzing a sample

Select the product to be analyzed by pressing the up [↑] or down [↓] keys. The asterisk (*) marks the product presently selected.

The weight of the sample is not required.

1. Use a spoon to transfer approximately 10-15 g of the thoroughly mixed sample to the sample compartment. Do not pour the sample as this may cause segregation of material.

   Use the sample compressor supplied, and carefully compress the sample until the spring can be felt and the two parts of the sample compressor just come in contact with each other. A consistent packing is important to achieve reproducible results.

2. Make sure the correct product has been selected and start the analysis by pressing the S key.

3. The analysis starts and when finished the result is presented on the display. If the instrument is equipped with a printer the results can be printed.

   (See Printer Operation). The result remains on the display until a new test is started or the unit is turned off.

4. Open the sample compartment and clean out the sample using the soft brush supplied. Keep the sample window clean at all times. Should the sample window be contaminated with oil or fat residues these are best removed using a soft cloth moistened with alcohol or methylated spirits. Such cleaning may also be required between individual samples if the oil/fat content of the sample is high. For wheat, barley and wheat flour samples, cleaning with the soft brush is sufficient.

5. It is recommended to analyze each sample in duplicate (refill the sample compartment) and to take the average as the result.

To continue analyzing the same product, fill with a new sample and again press the S key.

To change to another product, press the up or down keys, until the asterisk marks the desired product.

Sample ID

If the Inframatic is fitted with an alpha-numeric keyboard, a sample number or sample id (identification) may be entered. Before starting the analysis with the S key press F1 on the alpha-numeric keyboard and key in the sample id. The sample id may be up to 20 characters long. Press Enter to enter the id and press S to start the Inframatic. The sample id is only presented on the printer.

Setting Date and Time

Date and time may be easily set. See System support for details.

Print average

An automatic averaging of results is available. Normally the result is displayed and printed after each measurement - print average is set to 1. If the print average is set to 2, the display will show - NEXT READING - and after the next measurement the average result will be displayed or printed.

It is possible to select 1-4 samples to be averaged. See special techniques for details.

Correction to a constant moisture basis

In some cases it is required to express a protein result on a constant moisture basis. For example protein on a 12.5 % moisture basis is sometimes used. Also other results may be corrected to a constant moisture basis. This feature is available in the Inframatic system. See Special techniques for details.

Daily check samples

A daily instrument checking procedure using for example a low, a medium and a high test sample is recommended. If results appear to drift, the C_0 may possibly be changed. Store the test sample carefully, to avoid that the sample itself changes.

If results do not agree with reference analysis

Results from the Inframatic may be consistently too low or too high when compared to reference analysis. This is called an instrument bias. To correct for this the C_0 calibration constant is changed. If the instrument is on average for example 0.2 % - units too low, then C_0 should be raised by 0.2. See Adjusting an existing calibration for details.

If results appear totally wrong, check that the correct calibration constants are being used.

PRINTER OPERATION

The optional built-in printer provides a printout of the analytical results.

The printer output is controlled by a 2 position switch, located below the printer cover. The switch operations are as follows

LEFT : Printer off
RIGHT : Normal operation (results are printed)

With the clock option installed, a sequential sample number, date and time are printed. A typical print-out is shown below.

Inframatic 8600

00008 03.06.96 12:44

Wheat

Protein 13.0 %
Moisture 14.9 %
Hardness 35

Log values can also be printed. See System support mode - set parameters and print average for details. All calibration constants can be listed on the printer, see Special techniques for details.

ENTERING OR CHANGING CALIBRATION CONSTANTS

Entering Constant Input Mode

To enter or change calibration constants you must enter into the constant input mode.

Set the KEY switch into its HORIZONTAL position.

The display will show SYSTEM SUPPORT and a selection menu of 5 different choices.

```
20.01.92     SYSTEM SUPPORT     13:45:00

* SET PARAMETERS
  CONSTANT INPUT
  CALIBRATION TEST
  TEST OPTICS
  CONFIGURATION
```

Use the UP and DOWN keys to move the asterisk * to CONSTANT INPUT and thereafter press S to enter into the constant input mode.

The display will show Im > and is ready for inputs. Before attempting any changes read the next paragraph on how calibration constants are stored.

Constants are stored in the Inframatic in a certain order starting with "constant" N for the product name.

Constant	**Description**	
N	Product name (max 13 characters)	
M	Parameter name	(max 13 characters)
P	Product number	(1-999)
C	Parameter number	(1-15)
0	C_0 = Offset	(Constant unique for each instrument)
1	C_1 = Calibration constant for filter 1	
2	C_2 = Calibration constant for filter 2	
.	.	
.	.	
.	.	
6	C_6 = Calibration constant for filter 6	
7	C_7 = Calibration constant for filter 7	
S	Slope factor	
L	Low limit	(Results exceeding limits are displayed
H	High limit	and printed with an ! after the result)
T	Sign to be presented after result, e g %	(1 character)
D	Decimal places (normally 0 - 3. See also log and result storage)	

Selecting Product, parameter and constant to change

The display must show Im >

In order to change or list constants, the correct password must be entered. Thereafter select which product and which parameter to change and which constant to start with.

Press (that is press the left parenthesis key and key in the password. If no password is used, just press Enter.

Press X and select product. For example key in 1 and press Enter.
Press Y and select parameter. For example key in 1 and press Enter.

```
CONSTANT INPUT
Im >(
PASSWORD: a
Im >X
PROD NUMBER: 1
Im >Y
PAR. NUMBER: 1
Im >
```

a) password characters are not displayed but are exchanged by **.

Press Z and select the constant to start with. For example key in N for product name and press Enter.
Press C for constant change.

```
CONSTANT INPUT

Im >Z
CONSTANT (0-7,S,N,M,L,H): N
Im >C
1/1 N Wheat              >
```

The product name presently stored in the selected product is displayed. A new product name may be entered by keying in the new name and pressing Enter or the stored name can be kept by pressing Enter only.

By pressing the Enter key you can step through all constants. The same procedure applies to all constants, you may either key in a new constant followed by Enter or keep the old constant by pressing Enter only. The meaning of the constants are explained in the example below.

Example for input:

```
Im > (
PASSWORD: ******                    ;Enter password to enable constant change
                                    ;or just press Enter if no password is used
Im >X
PRODUCT NO. >1                      ;Select product

Im >Y
PARAMETER NO. >2                    ;Select parameter

Im >Z
CONSTANT (0-7,S,N,M,L,H)>N          ;Select constant

Im >C                               ;Enter constant input mode
1/1 N Wheat flour       >WHEAT      ;Change product name
1/1 M Protein           >SEDI       ;Change parameter name
1/1 P 1 >                           ;Only Enter does not change product no.
1/1 C 1 >                           ;Only Enter does not change parameter no.
```

NOTE: *Always check that the above product number and parameter number agrees with the product and parameter you desire, or you may accidentally change something else.*

```
1/1 0 23.00000 >12.5                ;Change C0 to 12.5
1/1 1 .0000000 >                    ;Filter 1 is not included in this parameter so is set to 0
1/1 2 -86.6700 >0                   ;Filter 2 is removed (constant set to zero)
1/1 3 .0000000 >-34.5               ;Constant set to -34.5
...
1/1 7 -131.300 >                    ;Only Enter does not change constant
1/1 S 1.234000  >1                  ;Change slope to 1
1/1 L .0000000  >8                  ;Min limit to 8
1/1 H 100.0000  >18                 ;Max limit to 18
1/1 T & >%                          ;Output sign (within limits) is set to %
1/1 D 2 >1                          ;Decimal places changed to 1

1/2 N                   > [Esc]     ;Exit (in next calibration to store preceding)
```

Leave the constant input procedure be pressing the ESC key (CTRL-Ä)
All changes will be automatically stored.

The display shows Im >. Press Q for quit and the display will return to the system support menu.

NOTE*: After ending the constant input, set the KEY switch back into its VERTICAL position. After this the display returns to the main menu showing available products.*

Entering Calibration Constants via the Computer

Calibration constants can also be transferred via computer using the Perten Instruments NIR Software. Set the key switch into its HORIZONTAL position. From the main menu in the Perten Instruments NIR Software, select service programs and then list/change constants.

Select transfer constants - then receive for importing constants from the Inframatic to the computer or transmit to send constants from the computer. Select RS-232 and Inframatic. Choose the products for which you want to send the calibration constants. See also the program manual.

ADJUSTING AN EXISTING CALIBRATION

The following steps are required:

Select at least 20 samples. (ICC recommendation No. 202)
Prepare samples (grind if necessary)
Analyze samples by reference method
Measure all samples in Inframatic
Adjust calibration constants
Set (store) calibration constants in Inframatic

Sample selection

Select samples to cover the range as evenly as possible. For example, if protein is to be analyzed use 7 samples of low, 7 of medium and 7 of high protein content. Be careful about old, stored samples. The storage may have dried all samples to a similar moisture content, and there will be no moisture variation. Try to include other variations such as moisture content, different varieties or classes, different geographical origin etc.

Preparation of samples

The same sample preparation as was used for the calibration must be used. Supplied calibrations have generally been developed using Perten Instruments Laboratory Mills 3100 or 120 fitted with an 0.8 mm sieve. See also Directions for use.
Divide the samples - preferably using a sample divider - so that one portion is used for the Inframatic and one portion is used for the reference analysis. Mark and store samples carefully. Note that the moisure content will change if samples are stored in paper bags or similar. Use glassware and seal samples carefully to avoid that they change.

Reference analysis

It is essential to use an established reference analysis, such as ICC or AACC methods. Samples should be analyzed in duplicate. Preferably blind duplicates should be used so that the quality of the reference analysis (the difference between the duplicates) can be judged.

Measuring samples in the Inframatic

Check or enter the calibration constants as described in that section. Note that C_0 is not supplied in a factory standard calibration. The purpose of the adjustment of an existing (factory) calibration is to **determine** the C_0. You may start by setting the C_0 to 10 or use 1 sample to set the C_0 approximately (see below). Note that the slope constant (S) should generally be set to 1 (one).

Do not run samples in order of increasing content, but run samples in random order.

Note the results in a similar manner as below:

Sample No.	Inframatic Result	Reference Result
1	15.0	15.5
2	14.8	15.1
3	12.4	12.6
4	13.9	14.1
5	12.5	12.8
6	13.1	13.3
7	16.1	16.6
8	11.7	11.8
9	13.9	14.2
10	13.7	14.0
11	13.1	13.3
12	16.1	16.6
13	11.7	11.8
14	13.9	14.2
15	13.7	14.0
16	15.0	15.5
17	14.8	15.1
18	12.4	12.6
19	13.9	14.1
20	12.5	12.8
Sum	274.2	280.0
Average	13.71	14.0
Difference	0.29	

Adjustment of calibration constants

Calculate the sum and the average of both the Inframatic results and the reference results as in the above example. Calculate the difference between the averages.

In the above example the Inframatic is on average 0.29 too low. The C_0 should therefore be increased by 0.29. If the original C_0 was 10.0 it should be changed to 10.29.

If the Inframatic was on average too high the C_0 should have been decreased accordingly. If it had been 0.29 too high, the C_0 should have been changed to 9.71.

In the above example the instrument was adjusted for average difference only. This is called a bias adjustment. If high content samples are predicted (measured by the Inframatic) as too high and low content samples are predicted too low, adjusting the bias only, is not adequate. In this case, a skew correction - a correction of the slope constant is required.

The Inframatic 8600 has a built-in calibration test program to make adjustments to an existing calibration including a correction of the slope constant. See the Calibration test section of this manual. Also, the Perten Instruments NIR software includes a Calibration Test Programme for this purpose. Contact Perten Instruments or your local representative for additional information.

Storing calibration constants

Enter the new C_0 constant and also the slope constant if this has been changed according to the procedure described in the section Entering or changing calibration constants.

Make sure you have a written copy of all constants in case constants should be accidentally erased. See Printer operation for printing of calibration constants.

CALIBRATION TEST

The built-in calibration test program is used to make adjustments to an existing calibration, so that the Inframatic results (NIR) agree as well as possible to the reference analysis (LAB).

Specifically, it is used to determine the correct C0 and slope (S) constants.

The procedure and calculations agree with ICC recommendation No. 202.

Set the KEY switch into the HORIZONTAL position.

The display will show SYSTEM SUPPORT and a selection menu of five different choices. Use UP or DOWN keys to move the asterisk * to CALIBRATION TEST and press ENTER.

When the option is selected, the following menu appears.

Data input

```
CALIBRATION TEST

INPUT VALUES:

Rec   1   LAB =          NIR =

F3=CHANGE  F6=END INPUTS  (ESC)=EXIT
```

(Press the ESC key (CTRL-Ä) on the keyboard if you want to exit back to the System Support menu.)

The record number is shown and the Inframatic awaits data input of laboratory and NIR results for the test samples. Key in data and press Enter after each entry.

To change the latest value or latest pair, press the F3 key and key in new values.

Key F6 terminates data input. Note that at least three pairs of data are necessary. At least 20 pairs of data, i e 20 samples are recommended to get meaningful results.

Entered values will also be printed.

```
1   L = 12.5  N = 12.3
2   L = 11.6  N = 11.8
....
```

Input of actual C_0 and slope

```
CALIBRATION TEST

INPUT VALUES:

Actual C0          =
Actual slope       =

F3=CHANGE  F6=END INPUTS  (ESC)=EXIT
```

Enter the actual C_0 and slope (S constant), used in the calibration and press F6 to start the statistical calculations.

CALIBRATION TEST RESULTS

```
CALIBRATION TEST
Result - Records : 25
SEP = 0.256          R = 0.909

Bias and slope corrected:
New C0 = 13.14       T-C 0 = 3.84
New Slp = 0.943      T-Slp = 1.52
F2=CONTINUE  F3=MORE INPUTS  F6=END
```

Pressing key F2 will show the next display

```
CALIBRATION TEST
Result - Records : 25
Only C0:             No change:
  RMSD = 0.304         SD = 0.356
New C 0 = 12.87      Old C 0 = 12.50
Old Slp = 1.000      Old Slp = 1.000
          F3=MORE INPUTS  F6=END
```

There are 3 measures of the calibration analytical error

SD is the standard deviation between LAB and NIR values if no correction is made

RMSD is the root mean squared error which is the error after correction for the bias (or average error between LAB and NIR)

SEP is the standard error of prediction, which is here defined as the error calculated after bias and slope correction

Upon pressing F6, the results will also be printed:

Calibration test result
25 Records
Corrected values:
R = .909 SEP = 0.256
C_0 = 13.14
Slp = 0.943 T-Slp = 1.52

Only C_0 : RMSD = 0.304
C_0 = 12.87 T-C 0 = 3.84

No change: SD = 0.356
C_0 = 12.5 Slp = 1

The interpretation of the statistical calculations are as follows (ICC No. 202)

1. Check first the t-value of the slope. The t-value is a measure on how significant a change of the slope is. The greater the t-value the more significant or certain is the requirement to change the slope.

   If the t-value for the slope, T-Slp, is greater than plus or minus 2 to 2.5 then preferrably a new calibration should be made, but alternatively the new slope (new slp) and new C_0 can be entered. (In the example New Slp = 0.943 **and** new C0 = 13.14). Note that you can not change the slope only, but changing the slope, you must also change the C_0.

2. If the t-value for the slope was smaller than plus or minus 2 to 2.5 then the old slope can be kept. In this case, check the t-value for only changing C_0. If T-C_0 is greater than plus or minus 2 to 2.5 then change only C_0 (In the example new C_0 = 12.87 and **keep** old Slp = 1.00).

3. If neither T-C_0 nor T-Slp is greater than plus or minus 2 to 2.5 then keep the old C_0 and the old slope.

4. In the above example the T-Slp was smaller than 2 to 2.5. There was no need to change the slope. The T-C_0 was larger than 2 to 2.5. The C_0 should be changed. The result was a new C_0=12.87 and the old slope 1.000.

The Inframatic returns to the System Support menu.

Select Calibration test again for the next parameter.

Change the constants if necessary according to the section Entering or changing calibration constants.

NOTE: *Be sure to set the KEY switch back to its VERTICAL position.*

SYSTEM SUPPORT MODE

When the KEY switch on the back panel is set to the HORIZONTAL position, the following menu appears on the LCD display

```
03.06.96    SYSTEM SUPPORT     13:45:35

            *  SET PARAMETERS
               CONSTANT INPUT
               CALIBRATION TEST
               TEST OPTICS
               CONFIGURATION
```

Select the desired function with the UP and DOWN keys, which move the asterisk and then activate the function with the S key.

***NOTE**: To exit the System Support Mode set the KEY switch back to the VERTICAL position.*

SET PARAMETERS

The following menu appears

```
03.06.96    SET PARAMETERS     13:45:35
* SET DATE
  SET TIME
  DATE FORMAT        : G
  OUTPUT FORMAT      : LOGS ID LABS
  PRINT AVERAGE      : 1
  BAUDRATE           : 4800
  EXIT
```

Set date

When the option is activated by pressing S, a cursor appears at the first digit in date (upper left corner). With the UP and DOWN keys, the digit can be changed. To move the cursor to the next digit, press S. After the last digit in the date, the cursor disappears and the * can again be moved with the UP and DOWN keys.

Set time

Use the same procedure as for "Set date". Only hours and minutes can be changed. Seconds are set to 00 after the minute change.

Date format

Three different date formats can be displayed and/or printed

A = mm/dd/yy
G = dd.mm.yy
S = yy-mm-dd

S steps through the three possibilities.

Output format

This option is used to change the output from the RS-232 interface after an analysis.

The following possibilities exist

LOGS	Log values
LABS	Product number + Product name + Parameter names with results
LOGS LABS	Combination of LOGS and LABS
ID LABS	S/N + Seq.Number + Date + Time + Product number + Product name + Parameter names with results
LOGS ID LABS	Combination of all

S steps through the five possibilities.

See also Appendix V for the RS-232 output format.

Print average and print logs

An automatic averaging of results is available. Normally the result is displayed and printed after each measurement - print average is set to 1. If the print average is set to 2, the display will show NEXT READING - and after the next measurement the average result is presented on the printer.

It is possible to select 1-4 samples to be averaged. This is selected using the S key.

If a value larger than 1 is selected, it will not be possible to change product until the selected number of analysis are made. The LCD display will show NEXT READING.

Both results and log values are averaged before print-out. However, individual results are shown on the LCD display and transmitted over the RS-232 output.

To print log values use the S key to select logs

Baudrate

S steps the following possible baudrates for the built-in RS-232 serial communication interface

150, 300, 600, 1200, 2400, 4800, 9600 or 19200 bits per second.

8 data bits and 2 stop bits with no parity check is always set.

NOTE: *For proper communication with the PerCon Inframatic software the baudrate should be set to 4800.*

Exit

S returns to the main System support menu.

CONSTANT INPUT & CALIBRATION TEST

The constant input routine is previously described under the section Entering or changing calibration constants. Calibration test is also previously separately described.

.

TEST OPTICS

This is intended for service purposes.
When selected the following menu appears

```
03.06.96    TEST OPTICS          13:48:12
            A/D-READING          : 0.0
        *   LAMP                 : OFF
            REFERENCE            : IN
            GAIN                 : 00
            FILTER               : 01
            AUTO-TEST
            EXIT
```

The asterisk * is moved with the UP and DOWN keys, and options are activated by pressing the S key.

A/D reading

The A/D reading is the detector signal with the conditions shown (lamp on or off, etc.). The A/D reading is continuously updated. The values range between approx. 0 (dark) and 13071 (overflow).

Lamp

S sets lamp ON or OFF.

Reference

Each time S is pressed, the reference disc position in the optics is toggled in or out, enabling to measure the signal against the reference or the sample.

Gain

Each time S is pressed, the amplifier gain increases one unit (range 0-15). After position 15, the gain returns to 0.

Filter

Each time S is pressed, the filter wheels are indexed one step.

Position 8 = No filter (dark value)

Auto-test

When this option is selected and the clock option is installed, the Inframatic 8600 will perform a measurement cycle once a minute on the selected product and print the result of the first parameter on the printer. Activating the UP or DOWN key during the pause between the measurements will quit the auto-test.

Exit

S returns to the System Support menu.

CONFIGURATION

When selected, the following information appears

```
03.06.96    CONFIGURATION    13:58:02

            PRG : 8600v6.01
            S/N : 1001
            DAT : 03.06.96
            MAX : 106
            CAL : 15
              N : 35
```

PRG = Software version
S/N = Serial number of Inframatic
DAT = Date of latest constant changes
MAX = Total calibration capacity
CAL = Calibrations (No of parameters) presently in memory
N = Sequential number of analysis presently made

S returns to the main System support menu.

SPECIAL TECHNIQUES

Correction to a constant moisture basis

In some cases it is required to express a protein result on a constant moisture basis. For example protein on a 12.5 % moisture basis is sometimes used. Also other results may be corrected to a constant moisture basis. This feature is available in the Inframatic.

Example:

If wheat is measured using a protein (as is) calibration and a moisture calibration, the protein content at 12.5 % moisture is calculated by the following formula:

$$\text{Protein (12.5\%)} = \frac{\text{Protein (as is)} * (100-12.5)}{(100 - \text{Moisture})}$$

Example:

Parameter 1 is protein (as is)
Parameter 2 is moisture
Parameter 3 is protein (12.5% moisture)

Parameter 3 will be automatically by setting the following constants in parameter 3:

C_0	12.5	the required correction %
C_1	1	1 for parameter 1, protein (as is) , which should be corrected
C_2	2	2 for parameter 2, moisture, which is used for correction
C_3 ... C_7		set C_3 to C_7 to any value. They are not important.
S	0	set the slope constant to 0. This indicates that this parameter is used for correction only.

Product and parameter names should be entered correctly as also limits, sign and decimal places.

Example: Product 5 is wheat, parameter 1 is protein (as is) and parameter 2 is moisture

```
5/3 N Wheat          >          ;Product name
5/3 M Prot. 12.5 %   >          ;Parameter name
5/3 P 5              >          ;Product number
5/3 C 3              >          ;Parameter number
5/3 0 12.50000       >          ;Correction %
5/3 1 1.00000        >          ;Parameter number to be corrected
5/3 2 2.00000        >          ;Parameter number used for correction
5/3 3 123456         >          ;Not important
.
5/3 7 123456         >          ;Not important
5/3 S .000000        >          ;Must be set to 0
5/3 L  8.0000        >          ;Set correctly to min. limit
5/3 H  18.000        >          ;Set correctly to max limit
5/3 T %              >          ;Set correctly
5/3 D 1              >          ;Set correctly to no. of decimals
```

***NOTE**: This correction is not limited to correction for a constant moisture basis only, but may be used for any specific parameter correction. For example a bread volume result may be corrected to a specific protein content. The procedure is the same.*

Printing all calibration constants

Set the KEY switch to the HORIZONTAL position to enter into the System support menu. Make sure the printer switch is to the RIGHT (normal position). Select constant input.

Press X and select product number 1. Press Y and select parameter number 1. Press Z and select N. At Im> press f. All constants will be printed, including product and parameter names, low and high limits etc. Set the KEY switch back to the VERTICAL position to exit.

Auto range - Automatic selection of calibration

In some cases, the same calibration may not be appropriate over the entire range. For example analysing for ash, one calibration may be used for low ash in the range 0.3-0.7 % ash, and another calibration for high ash in the range 0.7-1.5 % ash.

It is possible to have the Inframatic automatically choose which calibration to use, depending on the result. This is achieved by setting the low and high limits appropriately and adding 100 to the decimal constant, in the respective calibrations.

Example:

Ash low range (0.3-0.7%)

Set product and parameter names and calibration constants for the low ash calibration appropriately, then:

Set L (low limit) to: 0.30
Set H (high limit) to: 0.70
Set D (no of decimals) to: 102 (normally 2 decimals, but add 100)

Ash high range (0.7-1.5%)

Set product and parameter names and calibration constants for high ash appropriately, then:

Set L (low limit) to: 0.71
Set H (high limit) to: 1.5
Set D (no of decimals) to: 101 (normally 1 decimal, but add 100)

If the result is for example 0.45 % ash, only the result for the low range ash will be shown, as 0.45 % is inside the range for this calibration, but outside the range for the high ash calibration.

If the result is for example 1.2 % ash, only the result for the high range ash will be shown, as 1.2 % is inside the range only for this calibration.

If ranges overlap, then both results will be shown.
You may also divide the range into more than 2 different parts, using the same procedure.

LIQUID SAMPLES

By using an optional liquid cell which is easily interchangeable with the standard powder door, the Inframatic system can be used for the analysis of liquids such as wine, spirits and high fructose corn syrups.

Mounting the liquid cell

Use a small screwdriver or similar to rotate upwards the red holder of the powder door. Remove the powder door by lifting upwards. Mount the liquid cell and fix it in place by rotating the red holder back to the lower position.

Principle of operation of the liquid cell

The liquid cell consists of a goldplated cavity, which is sealed with a glass window and an O ring. Light from the Inframatic system is transmitted through the liquid onto the gold surface and reflected back to the detecting system. The cell is mounted in a watercooled jacket for temperature control.

Temperature control

For liquid applications it is important to have an accurate temperature control.
A temperature controlled waterbath with an ability to maintain temperature to within approximately +/- 0.1^{o}C is recommended. Connect the waterbath to the large nozzles on the side of the liquid cell assembly.

For simplicity it is recommended to set the waterbath to a temperature close to but slightly above the room temperature. If the temperature is chosen below room temperature there is a risk of water condensation on the glass window - this may cause erroneous results. If the temperature is chosen well above room temperature the injected sample must have time enough to reach this temperature before measurement, or the sample must be preheated.

Also certain standard procedures may require that the analysis is performed at a certain temperature.

Injection of samples

Samples may be injected using a standard syringe. Inject the sample from the lower nozzle on the front to allow air bubbles to escape at the top. It is important to avoid air bubbles as these will lead to inconsistent results. Also particles should be avoided as they will affect results and may also block the cell. Centrifugation may be used to remove bubbles or particles.

After injecting the sample allow a delay time before starting the analysis to achieve temperature equilibrium as well as mechanical equilibrium in the cell. For analyzing wine samples at 20^{o}C a delay time of 7 seconds is recommended.

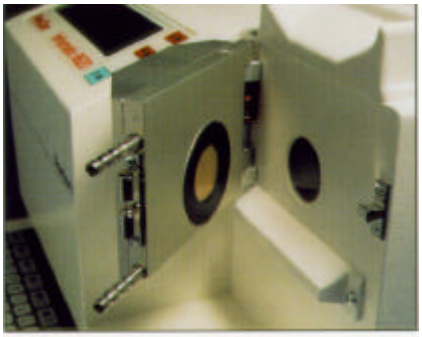
The cell may be cleaned out by flushing with a surplus of the next sample.

Maintenance and cleaning

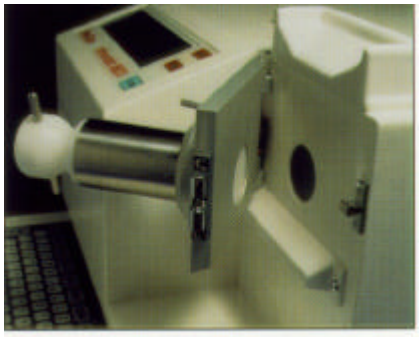
When not in use, clean out the cell with a suitable detergent and rinse it thoroughly with distilled water without dismantling. The cell should not be dismantled unless necessary.

If dismantling is required, remove the liquid cell from the Inframatic. Unscrew the two 3 mm Allen screws and lift off the large thermal insulation plate. Mark the ring and the housing with a felt tip pen or similar so that the ring can be screwed back on again in the same position. Unscrew the ring. Lift up the inner cell carefully as the glass may stick to the rubber ring. Loosen the glass carefully. Clean all parts carefully with a suitable detergent. Reposition the O ring. Put the glass on top of the ring and put the housing back over the inner cell making sure that the notch of the inner cell is correctly positioned in the housing. Screw on the ring tight until the marks coincide. Put back the thermal insulation plate and reposition the liquid cell on the Inframatic system.

The distance between the glass and the goldplated surface will determine the path-length in the cell. It is important to check that dismantling the cell has not caused a bias in the measurement by checking on one or several standard samples.



Liquid cell



Paste cell

PASTES

By using an optional paste system which is easily interchangeable with the standard powder door, the Inframatic system can be used for the analysis of for example butter or margarine or other semi-solid products.

Mounting of the paste system

Use a small screwdriver or similar to rotate upwards the red holder of the powder door. Remove the powder door by lifting upwards. Mount the paste system and fix it in place by rotating the red holder back to the lower position.

Using the paste system

The sample is either sucked into the wide syringe or cut out using the wide syringe. Start with an excess of sample and then push in the piston to its first stop position. Excess sample is cut off using a steel wire. The syringe is fitted to the very bottom of the hole of the paste system assembly and then locked by turning the fastening lever.

The surface of the sample remains at a distance of approximately 1 mm from the glass window - so cleaning between samples should not be necessary.
Remove the syringe and make a duplicate analysis by pushing in the piston to its next stop position. Cut off the excess and make a new analysis. Remove the syringe, withdraw the piston and empty the syringe by pushing in the piston to its innermost position.

Maintenance and cleaning

When not in use clean the syringe and piston with a suitable detergent.

APPENDIX I INFRAMATIC 8600 WAVELENGTHS

Filter No 8600	Wave-length (nm) 8600 Std	Response	Wave-length (nm) 8600 Ash
1	2336	Cellulose, fibre	Ash 1 (**)
2*	2310	Fat, fibre	2310
3*	2230	Reference	Ash 3 (**)
4*	2180	Protein	2180
5*	2100	Starch	2100
6*	1940	Water	1940
7*	1680	Reference	1680

(*) The 6 filter version uses filters 2-7.

(**) The Inframatic 8600 Ash has 2 special filters/wavelengths for ash. These wavelengths are different from the wavelengths in the 8600 Standard.

APPENDIX II ERROR MESSAGES

Message	Description
01 Arithmetic	Mathematical accuracy exceeded. Probably faulty constants.
02 Filter wheel	Filter wheel cannot find its start position. Probably filter wheel marker or filter motor error.
03 Overflow	Too large input signal from optics. Probably signal processing on A/D board.
04 Lamp or detector	No or too low signal. Check lamp and detector.
05 Reference	Log values too low. Check reference solenoid operation.
06 No constants	Analysis tried with a product without any constants C_1 - C_7. Check constants.
07 RS-232 Transmission	Indicates an external computer connected not ready to receive data. Remove the interface cable.
08 Constants not available	No EEPROM found on the CPU board.
09 Write Protect	Not possible to write into EEPROM due to enabled write protect or damaged IC. Set key switch into its horizontal position.
10 LCD	Badly connected or damaged LCD.
11 RAM	Error in RAM area after startup.
12 Clock	Bad or damaged clock crystal or IC.
13 Printer	Printer does not give synchronized signals.
14 Memory full	All available calibration memory in operation. Remove or change at least one calibration.
15 Storage memory full	All available data storage memory full. Transfer data to the Perten Instruments NIR Software.

A chopper error will cause the instrument to "hang" at analysis during the optics test (no signal displayed). In this case, only power-off will help.

To reset from an error, select any key (UP, DOWN or S), or send the character "1" via the RS-232 interface. On the alpha-numeric keyboard, press 1.

If an error occurs at power-on, it will be possible to investigate the reason if the KEY switch is set in its HORIZONTAL position before the instrument is switched on again.

APPENDIX III CONSTANT FORMAT

Constant	Description
N	Product name (max 13 characters)
M	Parameter name (max 13 characters)
P	Product number (1-999)
C	Parameter number (1-15)
0	C_0 = Offset (bias)
1	C_1 = Constant for filter 1
2	C_2 = Constant for filter 2
.	.
.	.
.	.
6	C_6 = Constant for filter 6
7	C_7 = Constant for filter 7
S	Slope factor
L	Low limit (Results exceeding limits are displayed
H	High limit and printed with an ! after the result)
T	Sign to be presented after result, e g % (1 character)
D	Decimal places (0-3 acceptable, see also log and result storage)

Example for input:

```
Im > (
PASSWORD: ******                    ;Enter password to enable constant change
Im >X
PRODUCT NO. >1                      ;Select product
Im >Y
PARAMETER NO. >1                    ;Select parameter
Im >Z
CONSTANT (0-7,S,N,M,L,H)>N          ;Select constant
Im >C                               ;Enter constant input mode
1/1 N Wheat flour      >WHEAT       ;Change product name
1/1 M Protein          >SEDI        ;Change parameter name
1/1 P 1 >                           ;Only Enter does not change product no.
1/1 C 1 >                           ;Only Enter does not change parameter no.
1/1 0 23.00000 >12.5                ;Change C0 to 12.5
1/1 1 .0000000 >                    ;Filter 1 is not included in this parameter
1/1 2 -86.6700 >0                   ;Filter 2 is removed (constant set to zero)
1/1 3 .0000000 >-34.5               ;Constant set to -34.5

1/1 7 -131.300 >                    ;Only Enter does not change constant
1/1 S 1.234000  >1                  ;Change slope to 1
1/1 L .0000000  >8                  ;Min limit to 8
1/1 H 100.0000  >18                 ;Max limit to 18
1/1 T & >%                          ;Output sign (within limits) is set to %
1/1 D 2 >1                          ;Decimal places changed

1/2 N                  > [Esc]      ;Exit (in next calibration to store preceding)
Im >Q                               ;Exit - LCD display will show new product names
```

NOTE: *Inputs are terminated with Enter. Commands without Enter! E g "(" for password input is a command (no Enter). The password input however must be terminated with Enter.*

APPENDIX IV RS-232 AND KEYBOARD COMMANDS

Command	Description
S	Enter into RS-232 from Run mode (Im > prompt returned)
Q	Exit from RS-232 or keyboard into normal operation mode
P	Run test on selected product (X must be selected)
p	Run test on selected product with print-out (X must be selected)
R	Run test with selected filters (Filter input 1234567)
X	Select Product Number (1-999)
Y	Select Parameter Number (1- 15)
Z	Select Constant (N,M,P,C,0 to 7,S,L,H,T or D)
(	Enter password to enable constant change or list (C,E,e,F,f,-,@)
C	Enter into constant change mode
0 (zero)	Simplified bias and slope change
@ (shift - 3)	Reset memory for new constant input
-	Delete selected parameter calibration (select with X and Y)
E	List all constants in selected parameter (select with X and Y)
e	List selected constants on printer
F	List all constants in memory starting from selected parameter
f	List all constants on printer (Return key to VERTICAL position to exit)
Esc (ctrl-ä)	Exit from constant change mode
1	Reset error alarm
!	Reset cycle counter *)
:	Display stored ID + Analysis results **)
;	Display stored ID + Log. values **)
9	Reset storage memory **)
T	Write text to LCD display ([Esc] to exit)
t	Write text to printer ([Esc] to exit)
?	Configuration information
.	Set command keys on (UP, DOWN, S)
,	Set command keys off (UP, DOWN, S)
I	Read status of command keys (Returns 0 if no key pressed, 1 = UP key, 2 = DOWN key, 4 = START key, 3,5-7 = combinations)
D	Set date (6 characters) *)
d	Read date *)
K	Set time (4 or 6 characters hhmmss) *)
k	Read time
&	Set baudrate for RS-232 communication
H	Set output format (option 0-4)
# (ctrl - e)	Change printer headlines (48 characters = 2 lines of 24 characters)

*) Clock option must be installed
**) Data storage module must be installed

Command	Description
W	Set filter wheel to start position
N	Select filter (to get accurate position, select W before)
L	Switch lamp on
M	Switch lamp off
U	Move reference out (activate solenoid)
V	Return reference (deactivate solenoid)
A	Read A/D value (W and N should have been selected first)
B	Set gain in A/D converter (0 to 15)
O	Update filter transmission table (read amplification)
*	Autotest of selected product with print of first parameter result once a minute ([Esc] to exit) *)
>	No text output on RS-232, except results
<	Text output on RS-232 active

CTRL-S (XOFF) will pause RS-232 output
CTRL-Q (XON) will resume

*) Clock option must be installed

APPENDIX V RS-232 OUTPUT FORMAT

Depending on the selected output format, the Inframatic 8600 is sending different information on the RS-232 interface after each analysis

To indicate start of transmission, the control character [SOH] = Chr$(1) = 01H is always sent, followed by [CR] [LF] (Chr$(13) = 0DH and Chr$(10) = 0AH).

The log values, if selected with option 0,3 or 5 are sent in the following format

[ENQ] = Chr$(5) = 05H as start character to define logs.
.00000 .65199 .55736 .58103 .61667 .60818 .39622 [CR] [LF]
[ETX] [CR] [LF]

All 7 log values are always sent, with the actual log value or .00000 if the filter is not selected for the product.

[CR] = Chr$(13) = 0DH and [LF] = Chr$(10) = 0AH is sent after the log values to enable readable format if a serial printer is connected.

[ETX] = Chr$(3) = 03H is sent to indicate end of text, followed by [CR] [LF].

If the clock option is installed and the ID option is selected (4 or 5), the sent format is the following

[STX] = Chr$(2) = 02H as start character to define ID.
Keyboard ID [CR] [LF] (if entered via the keyboard)
1234-00739 07/30/92 11:46 [CR] [LF]
[ETX] [CR] [LF]

"Keyboard ID" - Data input after F1 on the Inframatic keyboard
"1234" - the unique serial number of the Inframatic 8600
"00739" - the sequential number of analysis (if clock option inst.)
"07/30/92" - the date (in selected format)
"11:46" - the time of analysis

If the LAB option is selected (2, 3, 4 or 5), the format is as follows

[ACK] = Chr$(6) = 06H as start character to define prediction values.
12 Soybean Meal [CR] [LF]
Protein 34.5 % [CR] [LF]
Fat 1.5 % [CR] [LF]
...
[ETX] [CR] [LF]
[EOT] [CR] [LF]

The product number, followed by the product name and [CR] [LF] is transmitted, followed by all measured parameters with their respective results.

When a combination output is selected, LOGS are always transmitted first, followed by ID (if selected) and LABS.

The control characters are always sent at the beginning and in the end of the separate options LOGS, ID and LABS. LABS in this respect means Inframatic NIR prediction results.
End of transmission is always indicated with the control character [EOT] = Chr$(4) = 04H.

APPENDIX VI CONNECTION CABLES AND BASIC TERMINAL PROGRAMS

RS-232 CONNECTION CABLE

Inframatic 9-pin		IBM PC 25-pin	IBM AT 9-pin	EPSON HX-20 8-pin	
2	RXD	2	3	2	(TXD)
3	TXD	3	2	3	(RXD)
5	GND	7	5	1	(GND)

IBM PC/AT

```
 10  'IBM Dumb Terminal 92-01-26
 20  SCREEN 0:KEY OFF:VIEW PRINT:CLS
 30  COLOR 0,7:PRINT" Terminal communication - Press key F1 to stop ":COLOR 7,0
 40  VIEW PRINT 2 TO 24:KEY(1) ON
 50  CLOSE:OPEN "COM1:4800,N,8,2,RS,DS" AS #1
 60  F%=0:T%=NOT F%:P%=F%:XON$=CHR$(17):XOFF$=CHR$ (19)
 70  ON KEY(1) GOSUB 150
 80  B$=INKEY$:IF B$<>"" THEN PRINT#1,B$;GOTO 70
 90  IF EOF(1) THEN 70
100  IF LOC(1)>128 THEN PRINT#1,XOFF$;:P%=T%
110  A$=INPUT$(1,#1):PRINT A$;
120  IF LOC(1)>0 THEN 100
130  IF P% THEN P%=F%:PRINT#1,XON$;
140  GOTO 70
150  CLOSE:VIEW PRINT:CLS:END
```

APPENDIX CALIBRATION CONSTANTS

WHEAT

NOTE: *Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: WHEAT

Mill: Perten Instruments Laboratory Mill 3100/120, 0.8 mm sieve

PROTEIN (N x 5.7 dry basis)		**MOISTURE**		**HARDNESS ***	
C_0		C_0		C_0	
C_1	0	C_1	0	C_1	0
C_2	0	C_2	-72.03	C_2	401.66
C_3	0	C_3	0	C_3	82.18
C_4	482.88	C_4	0	C_4	283.3
C_5	-391.41	C_5	0	C_5	-102.76
C_6	14.12	C_6	74.33	C_6	-150.78
C_7	-131.3	C_7	0	C_7	-599.65
Slope	1	Slope	1	Slope	1
Dec	1	Dec	1	Dec	0
Range	10-15	Range	10-20	Range	35-65
SEP	< 0.30	SEP	< 0.25	SEP	< 4

NOTE: *Check that **all** constants are correct.*

NOTE: *The hardness calibration cannot be used on an Inframatic 8600 Ash as filters 1 and 3 are different in this instrument (see Appendix I).*

WHEAT 8600 ASH

***NOTE**:* *Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: WHEAT

Mill: Perten Instruments Laboratory Mill 3100/120, 0.8 mm sieve

GRANULARITY *
(Hardness)

C_0

C_1 0
C_2 915.66
C_3 0
C_4 -430.21
C_5 -566.2

C_6 102.48
C_7 0

Slope 1

Dec 0

***NOTE**: Check that **all** constants are correct.*

Range 45 - 67
SEP < 4

***NOTE**: This hardness calibration can be used on an Inframatic 8600 Ash.*

WHEAT FLOUR 8600 STANDARD

***NOTE**: Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: WHEAT FLOUR

Mill: No mill required

PROTEIN (N x 5.7 dry basis)		**MOISTURE**		**GRANULARITY *** (Hardness)	
C_0	_____	C_0	_____	C_0	
C_1	0	C_1	0	C_1	0
C_2	0	C_2	0	C_2	401.66
C_3	0	C_3	0	C_3	82.18
C_4	521.00	C_4	-63.94	C_4	283.3
C_5	-318.70	C_5	-77.87	C_5	-102.76
C_6	- 4.64	C_6	83.26	C_6	-150.78
C_7	-284.10	C_7	91.66	C_7	-599.65
Slope	1	Slope	1	Slope	1
Dec	1	Dec	1	Dec	0

***NOTE**: Check that **all** constants are correct.*

Range	7.7-15.6	Range	12.6-16.0	Range	35-65
SEP	< 0.30	SEP	< 0.25	SEP	< 4

***NOTE**: This hardness calibration cannot be used on an Inframatic 8600 Ash as filters 1 and 3 are different in this instrument (see Appendix I, and the listing of calibrations for the IM 8600 Ash).*

WHEAT FLOUR 8600 ASH

***NOTE**: Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: WHEAT FLOUR

Mill: No mill required

PROTEIN (N x 5.7 dry basis)		**MOISTURE**		**ASH *** (dry basis)	
C_0		C_0		C_0	
C_1	0	C_1	0	C_1	8.11
C_2	0	C_2	0	C_2	0
C_3	0	C_3	0	C_3	-5.84
C_4	521.00	C_4	-63.94	C_4	0
C_5	-318.70	C_5	-77.87	C_5	0
C_6	- 4.64	C_6	83.26	C_6	0
C_7	-284.10	C_7	91.66	C_7	0
Slope	1	Slope	1	Slope	1
Dec	1	Dec	1	Dec	2
Range	7.7-15.6	Range	12.6-16.0	Range	0.3-0.7
SEP	< 0.30	SEP	< 0.25	SEP	< 0.03

***NOTE**: Check that **all** constants are correct.*

***NOTE**: The ash calibration can only be used on an Inframatic 8600 Ash as filters 1 and 3 are different in this instrument (see Appendix I).*

WHEAT FLOUR 8600 ASH

NOTE: *Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: WHEAT FLOUR

Mill: No mill required

GRANULARITY *
(Hardness)

C_0

C_1 0
C_2 915.66
C_3 0
C_4 -430.21
C_5 -566.2

C_6 102.48
C_7 0

Slope 1

Dec 0

NOTE: *Check that **all** constants are correct.*

Range 45 - 67
SEP < 4

NOTE: *This granularity/hardness calibration can be used on an Inframatic 8600 Ash.*

BARLEY

***NOTE**: Calibrations are only valid for the type of product and type of mill stated below. Also note that protein content is given directly on dry basis.*

Product: BARLEY

Mill: Perten Instruments Laboratory Mill 3100/120, 0.8 mm sieve

PROTEIN (N x 6.25 dry basis)		**MOISTURE**	
C_0	_____	C_0	_____
C_1	0	C_1	0
C_2	152.7	C_2	-87.76
C_3	0	C_3	0
C_4	470.6	C_4	0
C_5	-587.9	C_5	0
C_6	17.8	C_6	90.85
C_7	- 65.4	C_7	0
Slope	1	Slope	1
Dec	1	Dec	1

***NOTE**: Check that **all** constants are correct.*

Range	8-16	Range	8-20
SEP	< 0.30	SEP	< 0.25