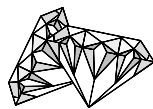


Gran
Computer
Industries Ltd.

Model DC3000 Diamond Colorimeter

User Guide

Revision 1.5



Machine S/W Version from 1.10 and up

File: DC3000user15. DOC

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CE

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LVD: 73/23/EEC as amended by 93/68/EEC and 93/465/EEC

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Chapter 1

Setup and Installation

Please read this chapter carefully before using the Colorimeter for the first time.

GCI has invested significant effort in making the DC3000 Colorimeter user friendly. All the information displayed by the instrument was designed to be self-explanatory. Nevertheless, you should spend a few minutes reading this manual with the Colorimeter placed in front of you.

Unpacking

Unpack the Colorimeter from its shipping carton. You should keep the packing material in case you need to ship the unit back for maintenance.

The carton should contain:

- The Diamond Colorimeter itself.
- A power cord suitable for your area.
- This User Guide.
- A Ring Holder for measuring mounted diamonds.

If any of these items is missing, call your dealer immediately.

Site Location

A little care in the placement of the Diamond Colorimeter ensures the most accurate results and long term reliability, as follows:

1. The Colorimeter is designed for convenient operation from a sitting position in front of a normal height office desk or standing in front of a display counter. For safety, you should place it at least 5 cm (2") from any table edge.
2. Keep the Colorimeter away from water and from very humid environments.
3. Shield the Colorimeter from sources of heat and from direct sunlight. It is designed to work

in normal room light and temperatures at which you feel comfortable.

4. Do not block the ventilation input underneath the Colorimeter. The Colorimeter's feet are made from a soft rubber, which will not scratch your desk or display case surface. **Do not use a soft pad under the Colorimeter** as it could block the airflow.
5. Use the Colorimeter on a grounded (3-pin) electrical power line. Avoid using it on a line that also feeds large electrical motors or welding equipment. The Colorimeter is designed to operate on any AC line voltage from 100 to 240 volts, 50 - 60 hertz. **No adjustments are necessary when changing from one line voltage to another.**

Important Safety Instructions

The Diamond Colorimeter incorporates many safety features. Nevertheless, for your own safety and for long term reliable use of your Colorimeter, please follow these simple rules:

1. Never push any objects through openings in the Colorimeter housing. Doing this may cause contact with parts that have dangerous electrical voltages.
2. Do not remove the Colorimeter housing cover because this will expose you to dangerous voltages and may damage the instrument.
3. The Colorimeter housing has openings at the back and at the bottom. These are for ventilation. Do not block these openings by placing the Colorimeter on a cushion, rug or similar soft surface, or by blocking them with papers and the like. The Colorimeter may overheat if ventilation is blocked.
4. If the Colorimeter beeps continuously and indicates over-temperature it should be turned off immediately to prevent damage. The internal fan may have stopped or the input air vents may have become blocked. When an over-temperature condition ($>40\text{ }^{\circ}\text{C}$) is detected, the lamp is turned off automatically until the internal temperature drops to below $35\text{ }^{\circ}\text{C}$.

First Use

It is very simple to install the Diamond Colorimeter. Verify that the electricity supply in your area is within the range specified on the back of the instrument and plug it in! Turn on the power switch located on the rear panel and the Colorimeter display should light up and show the following message almost immediately.

SELF TEST
PLEASE WAIT

The Colorimeter starts by checking its own proper operation, including the integrity of the internal software. If it detects an error at this stage, it beeps in code to describe the nature of the problem and attempts to display the error condition. If the colorimeter is very cold it may remain in WARMUP for a short time. Chapter 3 contains a full description of the error codes.

After the initial self-test, the Colorimeter waits for the lamp and spectrometer to stabilize, which may take a few minutes, displaying a indication in the meantime. During this time the keypad is deactivated except for the SERVICE menu. However, if the measurement chamber lid is not properly closed before warm-up, or is opened during warm-up, the Colorimeter senses it, beeps and displays an appropriate message. The warm-up procedure continues after the lid is closed.

System Alignment

After normal shipping vibration, or when a lamp has aged, you may get an INTENSITY LOW or HIGH warning message, or an erroneous REMOVE DIAMOND message when no diamond is in the chamber. If this occurs, perform the **following SYSTEM ALIGNMENT** procedure:

1. The colorimeter should have been on for at least 20-30 minutes before continuing.
2. Repeatedly press the *MENU* key until **SERVICE** appears on the top line of the display. Then use the *SELECT* key until **ALIGN SYSTEM** appears on the second line. Press the *EXECUTE* key.
3. The display now indicates how many dark pattern scans have been read until it reaches 4. This will take 5 to 15 seconds

The DC3000 is based on a spectral-photometer that requires a stable operating temperature for the most accurate and repeatable results. Be sure to allow the Colorimeter to warm up at least 20-30 minutes before use. If there has been an internal temperature change

in of more 3 °C (or 5.4 °F) since the last System Alignment, the Colorimeter will insist that you perform a new System Alignment to assure full accuracy. If you always allow the Colorimeter to warm up fully (30-40 minutes) before use and performing an ALIGN SYSTEM, you will seldom have to do additional System Alignments during the day. If, however, you do an ALIGN SYSTEM while the Colorimeter is still cold inside, you may have to perform another ALIGN SYSTEM every few measurements, until the Colorimeter internal temperature has stabilized

Once the Colorimeter has successfully warmed up, the keypad is activated and the display shows the **Ready to Measure** message, referred to as the "normal screen". Your last menu selections are remembered so you can immediately start using the Colorimeter without reconfiguring.

When you are finished using the Colorimeter, it can be turned off using the power switch on the rear panel.

It is recommended that you turn off the colorimeter at the end of each day and that you allow the colorimeter to warm up at least 30-40 minutes at the beginning of your work day. You can leave your colorimeter on all day except when you know you will not be using it for extended periods, but leaving it on all night is not recommended.

The next section describes the operation of the Colorimeter in detail.

Chapter 4, Theory of Operation, gives a detailed explanation of the basis for the Colorimeter operation. While it is not necessary to read this chapter to use the Colorimeter, this chapter may be informative and useful.

Chapter 2

Operation

Keypad and Display

The keypad and display are used to operate the Colorimeter. The keys are located on the sloped front panel of the instrument.

The keypad has six keys arranged as shown in figure 1. These keys function as described later in this chapter.

The display serves to:

- Show the results of color grading, and
- To display information and error messages.

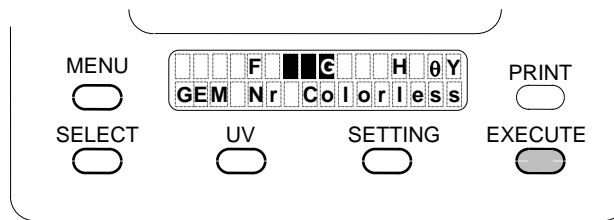


Figure 1 - Keypad and Display

Measuring Chamber

The Colorimeter works by measuring the light absorbed by diamonds in the wavelengths that correspond to human vision. It simulates the perception of these colors by the human eye in conjunction with a fluorescent grading lamp and, therefore, grades diamonds in a way that resembles that of a human expert. Because it uses a full spectrum of light, it is able to grade diamonds of all tints (Hues).

To gain access to the Measuring Chamber lift the lip on the front edge atop the UV viewing chamber.

The Colorimeter includes a precisely controlled White light source, which injects light into the diamond crown through a Sapphire disk.

The diamond to be graded is placed on the center of Sapphire disk. This arrangement makes it easy to mount and center the diamond to be measured. A polished stone must be placed with its table (crown side) facing downward.

Light enters the diamond, is reflected out again, and is collected in the measuring chamber where it is detected by a fiber optic light guide extending into the chamber

behind the small white barrier. While the Sapphire disk and its support are designed to accept the small forces normally associated with measuring mounted stones and rings, it is important that you **DO NOT EXERT FORCE ON THE SAPPHIRE DISK OR ITS SUPPORT**.

The measuring chamber is the heart of the Diamond Colorimeter. It has unique mechanical and optical properties and must be treated with care. Dirt and stains can seriously affect the accuracy of the Colorimeter. Do not touch the sphere or cone surfaces and keep the lid closed while the instrument is not in use as well as between measurements. Always use tweezers to remove a ring or stone, which may have fallen into the bottom of the measuring chamber. Minor scratches from falling stones or tweezers will not affect the measurement accuracy, but colored stains on any of the white surfaces could cause measurement errors. Because of the requirement for cleanliness, please refrain from touching the white surfaces or sapphire window with your fingers.

The diamonds you measure should be clean, and it is suggested that you clean the sapphire disk with a cotton swab moistened with clear isopropyl alcohol occasionally. **WARNING – DO NOT USE ACETONE OR METHYL ALCOHOL FOR CLEANING.**

UV Viewing Stage

A UV light source is built into your Colorimeter to allow you to visually classify diamond fluorescence. This stage is recessed into the optical chamber, and located immediately above the Colorimeter display. To use it simply place a diamond on the black glass surface and press the UV key. The UV light can be turned off by pressing the same UV key a second time, or it automatically goes off when the measuring chamber lid is lifted, or after a 2 minute delay.

Power Switch

The power switch is located on the rear panel of the instrument. **IT IS BEST TO ALLOW THE INSTRUMENT TO WARM UP FOR AT LEAST A HALF-HOUR BEFORE USE.**

Grading Loose Diamonds

Place the diamond to be graded on the Sapphire disk in the measuring chamber *using tweezers*. A polished stone must be placed with its table facing downward. For best results, carefully center the stone over the light source. It helps to observe the light and shadows on the lower sphere surface while shifting the stone. A symmetrical, well-formed pattern is a good indication of proper centering.

After placing the diamond in position, close the lid, and press the **Execute** key. After a few seconds the grade and tint (Hue) will appear in the center of the display. A typical measurement result is shown in figure 2.

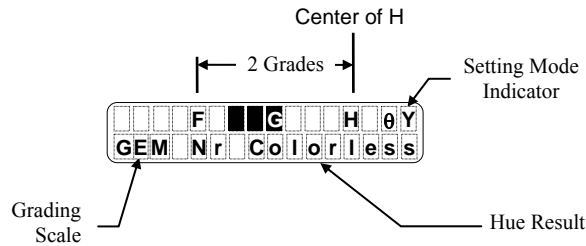


Figure 2 - Typical Measurement Display

The colorimeter grade letters, D, E, F, etc. represent the **center** of each grade. The grade letters of diamond masterstones, however, represent the edge of the grade nearest white. For example an F masterstone would ideally read between E and F (or EF) on the colorimeter display.

Black rectangles on the display indicate the grade result. If the black rectangles are centered exactly between two letters it is a split grade. For example, if the black rectangles are exactly between the letters **L** and **M**, the grade is a split grade of **L-M**. Incidentally this would be equivalent to an M masterstone.

For Yellow and Lt. Brown diamonds all grades of **F-G** or better are given a Hue of *Colorless*, because it is not possible to visually observe Hue accurately this close to White. *Colorless* for Fancy colored stones other than *Yellow* or *Lt Brown* is much closer to White.

The *Hue* names displayed are in accordance with the CIE Chromatically Diagram at the back of this manual. Some Hue names have a small letter modifier and these have the following meanings:

Table I - Hue Name Modifiers

Hue Modifier	Meaning
Y	Yellowish
B	Brownish when near Yellow or Orange, Bluish when near Blue.
O	Orangish
R	Reddish
P	Purplish
G	Greenish

Keep the diamond and the mounting table clean. Finger oils on the diamond and mounting table surfaces can significantly affect the measurement, especially of diamonds in the D to F range. For best results, wipe each diamond before measurement and regularly clean the mounting table with alcohol using a delicately applied cotton swab.

Average key (Select + Execute)

Occasionally, a 'multi measurement' operation is required. This, for example is typical when measuring a fancy shape diamond. A diamond may be measured several times. Each measurement is taken with light source pointing at different color zone of the stone.

After regular measuring, make a second measurement by pressing and holding *SELECT* and then press also *EXECUTE*. Now the shown result is based on last two measurements. You may repeat the combined pressing to get averaging of unlimited count of measurements. When using *EXECUTE* only, again, the effect of all previous measurements is cleared.

Setting key

The *SETTING* key is used when measuring small or mounted stones. The current setting is shown in the upper right corner of the display as in figure 2. This area is blank when for normal loose stone measurements. More details about using the *SETTING* key are contained in later sections of this chapter.

Reset of White Reference key (Select + Menu)

Used if none of the white reference measuring indications appears (neither audible 'tick' nor blinking sign on display). The white reference can be reset by pressing SELECT followed by MENU simultaneously. This is useful in measuring of mounted stone or when the message REMOVE DIAMOND TO RESET WHITE appears.

Menu Operation

The *MENU*, *SELECT* and *EXECUTE* keys provide a simple mechanism to select from a variety of modes and options.

To enter the Menu mode press the *MENU* key and the first of several menu options will appear, in this case **Grading Scale**. You may now step through the various alternatives by pressing the *SELECT* key until the scale you desire appears. When the scale you want appears, you can **set** it by pressing the *EXECUTE* key.

In a similar manner you can sequence through a variety of menu categories and selections using the *MENU* and *SELECT* keys.

After you have stepped through all the available menu categories or set an option with the *EXECUTE* key, the Colorimeter will automatically return to the normal screen.

Each of the available menus are described below:

Grading Scale Selection

You may select from a variety of different grading scales using the *SELECT* key. When you see the grading scale desired you can select it for use by pressing the *EXECUTE* key. At the present time the DC3000 is supplied with four scales, GEM, IGI, HRS and AGI. These scales are GCI's equivalent to the scales used by GIA[®], IGI[®], HRD[®] and AGS[®] gemological institutes, respectively.

It should be noted that the scales used in the DC3000 are a result of GCI's interpretation of field data collected over a long period, and that none of referred institutes endorse DC3000 measurement results.

Display Modes

The DC3000 can display grading results in two different formats; *Normal* and *Numeric*. One more, *CIE*, is activated when in 'ADVANCED MENU' menu mode.

The *Normal* display mode shows the results as indicated in figure 2 and is the default factory setting.

The Numeric grade for cape yellow and light Brown stones is a number ranging from 1.0 for perfect White, to 23.0 for the beginning of grade Z. The number changes by 1 for each grade. For example a numeric grade of 4.0 corresponds to a grade FG (the border between F and G), while a grade of 4.5 would correspond to the exact center of grade G.

The *Numeric* display mode also shows the tint (or hue) as a separate number on the second line of the display. The Numeric Grading system is described in more detail later this chapter.

The relation between the numeric and the normal display is shown in the table below.

Table II - Results Display Variations

Grade	Display	Remarks
4.00 < Grade < 4.10	F ■■■ G ■■■ H	Split FG
4.10 ≤ Grade < 4.35	F ■■■ G ■■■ H	Best G
4.35 ≤ Grade < 4.65	F ■■■ G ■■■ H	Middle G
4.65 ≤ Grade < 4.90	F ■■■ G ■■■ H	Poorest G
4.90 ≤ Grade ≤ 4.99	F ■■■ G ■■■ H	Split GH

The third display mode, CIE, is available if advanced menu was selected through configuration menu. (See there). In this mode the color is displayed in units as given on the CIE Chromaticity Chart, relative to white point.

After observing the required display mode on the second line of the display, you may press the *EXECUTE* key to select this mode.

Output Modes

You may select from among four different output modes; Printers: Seiko **SmartPrinter** EZ30 SLP-100 and SLP-200, Dymo **LabelWriter** EL, XLT and LW300 series types, PC, or Diagnostic.

- Printer modes allow printing labels on the corresponding Dymo or Seiko label printer.
- The PC mode is for communication with personal computer running third party application software with the DC3000.
- The Diagnostic mode is for use by a trained service technician.

When you see the desired output mode you can select it by pressing the *EXECUTE* key.

Only one Output Mode may be used at any one time. Thus enabling **PC** mode forces **Diagnostic** mode to OFF, and inhibits label printing. Other colorimeter functions remain unaffected.

Configuration Selections

This menu allows you various operation mode of the machine. All configuration settings are non volatile and will be kept even after switching the machine off and on again. Note that a '>' sign is displayed left to each of active selection.

Configurations are:

- CAL BEEPER: ON, OFF or AUTO.

The Colorimeter sounds a short beep each time it measures the reference light source (the measuring chamber closed and no diamond inside). The measuring chamber should be closed between measurements to assure that the reference is correct for each measurement. The CAL beeper assists in keeping you informed of this process.

ON sounds the beep, continuously, although turn quieter after 4 beeps.

OFF disables the beep sound at all time.

AUTO sounds the first 4 beeps only.

- BEEPER: ON or OFF.

Enable/Disable of sound echo to keypad pressing.

- FORCE CALIB: ON or OFF

Setting this option to ON will disable sequential measuring without reference light measuring in between each two stone measurements.

- MENU: STANDARD or ADVANCED

Advanced menu enables selection of next configuration options. It also add options to other menus selections, such as DISPLAY and SERVICE - TEST DISPLAY. (See there).

- AUTO DARK CALIB

Check for change in measurement level due to temperature drift. When a change is detected a dark calibration is performed automatically, same as dark pattern reading during SERVICE - ALIGN SYSTEM calibration. Default: Active

- AUTO LAMP CALIB

When 'LAMP LEVEL HIGH' condition is detected, an automatic calibration of integration time will be performed. Default: Active

- SPECT GAIN

Controls the spectrometer signal sensitivity. This allows maintaining a reasonable integration time duration, 0.4 to 2.5 seconds. It also may extend the use of lamp when it becomes weakened. Default: x2.

- SLCT+EXEC: AVRГ or LAMP

Selecting the operation which done when pressing both, SELECT and EXECUTE keypads.

AVRG (average): Performing normal measurement except that the displayed result is based on last measurement together with previous ones. (Default)

LAMP: measuring the color of source lamp itself. This measurement may be required for service purposes.

Service

This menu allows you to view certain Colorimeter operating characteristics, and to perform a System Alignment.

The initial service display shows the unit serial number and software version. Other selections include System Alignment and displaying Test data. Refer to chapter 1, for a detailed explanation of the System Alignment operation.

The Test Data display allows you to view important internal parameters. Should you be in contact with a service technician he may request that you view this display and tell him the values shown. The data displayed include:

TMP is the internal temperature in degrees centigrade, which is normally ranged between 28 and 37°C. The Colorimeter cannot leave the warm-up phase until this value is above 20.

IMIN is the spectrometer offset and will vary from as low as 100 to over 500, temperature dependent. The Colorimeter cannot leave the warm-up phase until this value is above 50.

IMAX is the maximum spectrometer output level, which should be between 3600 and 4000 for accurate measurements. Performing a System Alignment will restore IMAX to approximately 3800.

LMP is the lamp voltage, which should be between 115 and 125, corresponding to 11.5 and 12.5 volts respectively.

Other test data are revealed if ADVANCED MENU is selected.

INTG – Integration time duration

LmPk – Lamp peak reading, measured at approx. 600 nm. (Measured with an empty chamber)

LmIR – Lamp infra red wave length level.

MsPk – Last peak reading.

MsIR – Last I.R. reading.

Slope, Ofst (offset) - Spectrometer characteristics.

Print Label - Title of printing labels. This title, up to 19 characters, may be modified via PC program.

Under normal circumstances you do not have to know or examine these readings, but sometimes this information may be very useful to help your service technician to better understand the internal condition of the unit, make recommendations or assist you in understanding what may be happening.

Fluorescence

Fluorescence is far more complex than most people realize. When a diamond is fluorescent it typically appears whiter when exposed to sunlight than under incandescent light. This is because UV light (less than 380 nm in wavelength) contained in natural sunlight stimulates a fluorescent diamond to typically emit blue light thus making the diamond appear whiter.

Most fluorescent lamps generate a small amount of UV in their output which can also make a diamond viewed under such a lamp appear whiter.

The fluorescent phenomena can be observed by holding something fluorescent (most white paper for example) in the Colorimeter UV viewing chamber after pressing the UV key. The UV chamber injects long wave UV (365 nm) into the area above the black glass window.

Because most visual diamond grading is done using a fluorescent lamp the grading results for fluorescent diamonds can change depending on the characteristics of the lamp as well as how close the diamond is held to the lamp.

Both visual grading and Colorimeter grading of strongly fluorescent stones can give misleading results and some caution is advised whenever you attempt to grade a strongly fluorescent stone.

Observing Diamond Fluorescence

A diamond is placed on the black glass surface of the UV chamber crown side down and the *UV* key is pressed. The UV lamp of the Colorimeter will turn on and flood the stone with long wave UV light, 365 nm. If the chamber is shaded, or the room light is dimmed, it is easy to observe the degree of fluorescence for a particular stone.

The UV lamp will remain on until:

- Two minutes have elapsed since using the *UV* key,
- The Optical Chamber is opened,
- The ***Execute*** key is pressed to initiate another measurement.

NOTE: The UV light flickers while being switched on. The flickering is synchronized to white light reference measurement. ('tick') of the machine and indicates a normal operation of UV lamp circuitry.

Please note that the same UV lamp is used for the UV chamber and for UV injection during measurement. Therefore the UV lamp will cycle on and off during measurement or System Alignment and any diamond placed in the UV chamber will be stimulated even though you did not use the *UV* key. For this reason **it is advised that you do not place any stone in the UV chamber if it can be damaged by UV light - such as CZ master stones.**

How Grade is affected by Fluorescence

Fluorescent Diamonds do not always emit the color blue. Sometimes they emit a variety of other colors such as green or yellow. Also some diamonds are so strongly fluorescent that they can be stimulated with any light containing wavelengths near 380 nm - for example, ordinary blue light at about 400-450 nm.

The result is that the perceived color of a fluorescent stone is very dependent on the light used to observe it, and it may be difficult to grade accurately under any circumstances.

Detecting Fluorescence

It is best to depend on the UV viewing chamber to detect whether a diamond is fluorescent.

The light source of the DC3000 has a very limited amount of UV content and should give reasonably correct grading results even for strongly fluorescent stones. It should be noted that accurate grading of fluorescent stones, visually or by colorimeter, is very difficult due to the dependence of the results on the characteristics of the light source.

Small and Very Small Stones

Grading stones smaller than 0.4 carats is affected by reflections from the mounting table. This typically causes small stones to be graded slightly worse than their actual grade.

By using the *SETTING* key you may select **SS** or **VS** modes for grading small (0.25ct - 0.4ct), or very small (less than 0.25ct) stones respectively. If these settings are used, the grading results for small stones should be as accurate as for larger stones.

Grading Mounted Stones

To grade mounted stones the Colorimeter must be set up differently. For rings having narrow shanks use of the *Ring Holder* is recommended to hold and position the ring on the mounting table. For solitaire pins, or larger shank rings, it is easier to simply balance the ring/pin on the table for measurement

Only rings which have a center diamond can be measured because other ring types are impossible to balance. ***Be very careful when balancing a large ring as a falling ring could damage the support table.***

Measuring mounted stones is done in three steps:

1. Prepare the colorimeter.
2. Prepare the ring or pin for measurement.
3. Make the measurement.

If you are using the Ring Holder:

1. The *Ring Holder* should be inserted into the measurement chamber. The stainless steel pin of the holder is pressed into the hole on the left side of the chamber rim, and pushed all the way down until the holder rests on the shoulder washer surface.
2. The Ring Holder should be rotated so it is near the light source, but not centered over it, and the measurement chamber should be closed to allow the DC3000 to measure the reference light spectrum. The white reference can be reset by pressing SELECT followed by MENU simultaneously.

3. You should press the **SETTING** key until the type of alloy used in the mount is shown. The letters P, W, Y, and R correspond to Platinum, White Gold, Yellow Gold, and Red Gold. If a digit, either 4 or 6 is preceding the letter, select the one to meet number of prongs that holds the diamond.
4. The ring/pin should be wrapped in ordinary aluminum foil, dull side out, so that **only the diamond crown and pavilion and ring prongs are exposed**.
5. The measuring chamber is opened and the wrapped ring is inserted into the *Ring Holder* and positioned so that the diamond crown is centered over the light source. ***Do not exert force on the sapphire disk and its support.***

Your base metal *SETTING* selection will be indicated on the display and on printed label.

If you are not using the Ring Holder:

1. The ring/pin should be wrapped in ordinary aluminum foil, dull side out, so that only the diamond crown is exposed.
2. Place the foil wrapped ring into the side of the lower hemisphere, using tweezers, and close the lid until at least 3 clicks are heard. This allows the DC3000 to measure the reference light spectrum.
3. Open the chamber, lift the wrapped ring/pin from the bottom of the sphere, and balance it carefully over the light source with the crown of the diamond carefully centered.
4. Close the measuring chamber and press the **Execute** key to take a reading. ***Be careful not to vibrate the instrument or the work table on which it is placed, when balancing a ring on the table.***

Your base metal *SETTING* selection will be indicated on the display and on printed label.

Printing Labels

The Colorimeter can print labels by connecting it to one of variety label printers including wide (2") and narrow (1"). Plugging the supplied printer cable into the COM connector at the back of the Colorimeter does this.

To print labels, the Output Mode must be set for the correct printer model, actually connected to the DC3000. For list of supported label printer and how to select one, see Chapter: 'Menu Operation – Output Mode'. To print a label, have the colorimeter displaying

its last measurement result. Then Press the *PRINT* key to print the result of last measurement.

You may customize the first line of the printed label, for example, to show your company name. This is accomplished by using the program *GCILABEL*, available from your local distributor, together with a standard RS-232 Null-Modem interface cable. Simply connect your DC3000 to your PC using a Null-Modem Cable, and run the program *GCILABEL*.

The customized label information is stored in your DC3000 so you do not need to keep you PC connected to the DC3000 after using this feature. You may have to use this feature a second time to restore the label information should your DC3000 memory be changed while being serviced.

PC Communication

The Colorimeter has the ability to communicate with a personal computer connected to its serial port. This requires the use of a standard RS-232 Null-Modem interface cable and a PC program capable of using the protocol described in Appendix B.

Select the PC output mode using the *MENU*, *SELECT* and *EXECUTE* keys.

Each time a measurement or error is made while in PC mode, the result will be sent to the connected personal computer.

Note that only **PC**, **Diagnostics** or **Printer** output mode may be used at any one time. Enabling **PC** mode forces **Diagnostics** to OFF and inhibits label printing. Other Colorimeter functions remain unaffected.

Diagnostic Mode

When in **Diagnostic** mode, the Colorimeter transmits measured results to an external computer for each measurement. This mode is used for servicing or scientific and engineering purposes and requires that special software be installed in the PC.

Numeric Display Mode

Measurement results are normally displayed as variations of grade designations such as **D**, **E**, etc. indicating distance from white (saturation) along with a key word such as **YELLOW**, **Lt BROWN**, etc. indicating *Hue* or tint. Hue refers to the dominant wavelength of the diamond's color as perceived by the eye.

The Colorimeter permits the display of the same information more precisely in a numerical way, as follows:

1. If the diamond measured is Cape Yellow or Light Brown, its grade is displayed by a number, where 1.0 represents perfect colorlessness or standard *white*, corresponding to the top end of grade **D**, 2.0 represents the border between **D** and **E** grades, etc. In this scheme, the value 3.5, for example, would mean the center of grade **F**, and 10.0 would be the border between **L** and **M**. The numerical grade corresponds to the center of the grade cursor bar (black areas) in the Normal display mode.
2. If the diamond measured is a fancy color, the grade is indicated by a decimal number less than 1.0, which is the distance from white according to the CIE 1931 Color Chart on the inside rear cover of this manual..
3. Hue (the second display line) is shown as a number between 0° and 359°, which is the angle between the line connecting *white* and the measured color, and the X (horizontal) axis on a standard CIE 1931 Chromaticity Diagram. In this scheme, for instance, Cape Yellow is a line at approximately 60°, and diamonds with angles between 45° and 55° would be perceived as Light Brown.

The **Numerical** results are always for the last measurement made.

Helpful Hints and Limitations

To achieve the best performance from the Colorimeter observe the following:

- *Allow the Colorimeter to warm up properly.* Although measurements can be made almost immediately after being turned on by performing a System Alignment, this operation will have to be repeated as the unit warms. The best measurements are made after the Colorimeter has stabilized for about half an hour and a System Alignment has been performed before beginning a measurement session.
- *Keep the mounting table clean.* Dust and grease that may collect over a few days, though invisible to the eye, can cause significant measurement errors, particularly for better grades of stones. The Colorimeter identifies extreme cases when the light intensity drops to a level that prevents proper measurement, but

cannot detect small amounts of contamination, which could affect accuracy. Therefore, regularly clean the sapphire table gently using a soft cotton swab and **95% Ethanol Alcohol** or **Pure Isopropyl Alcohol**.

- *Center the stone carefully.* The culet should be above the fiber optic light source and a symmetrical pattern should appear on the white surface at the bottom of the measurement chamber. Centering is particularly important for fancy cut diamonds such as marquise, pear shaped, etc.
- *Keep your perspective.* Visual grading of loose diamonds typically provides an accuracy of about 1 grade. Experts using correct lighting can achieve an accuracy of about half a grade. The Colorimeter has consistency and repeatability of about 0.5 of a grade, so it is normal for repeated measurements of the same diamond on the same Colorimeter and on different Colorimeters to show variations of up to this value. This is still better than the variance often found when several different human observers grade a stone.
- *Use care when comparing Colorimeter results to grading certificates.* Certificates only indicate whole grades. They do not tell whether the stone is at the center, or edges of a grade. This certificate uncertainty may seem to indicate that the certificate and Colorimeter disagree by a whole grade, when in fact they may actually agree to within half a grade of each other.
- *Mounted diamonds can never be measured as accurately as loose stones.* The Colorimeter is able to grade mounted stones to an accuracy of 1 grade provided the ring is clean, the gold part is covered with aluminum foil, and the diamond is centered on the mounting table.
- *The Colorimeter measures color, you grade the diamond.* Diamonds often fall between grades. This means that you must decide, perhaps considering other qualities, which grade to finally assign.
- *Diamonds with Piqued/Damaged Culets may measure incorrectly.* The Colorimeter light source is designed to reduce the light passing through the culet. Nevertheless, a stone with a broken culet or color concentration near the culet may not measure correctly.
- *Very Dark Fancy colored stones may be difficult to measure.* The Colorimeter measures colors out to Intense Fancy. However, a very dark diamond

may reduce the light intensity in the optical chamber to a level that prevents correct measurement. A warning message may appear in such cases.

- *Take care when measuring small and large diamonds.* The Colorimeter is calibrated for diamonds from 0.25 carat to 10 carat in size. Experience shows that stones of up to 20 carats can be measured reasonably accurately and consistently. However, diamonds smaller than about 0.4 carat may be graded as much as one half grade worse than their true color due to secondary reflections from the table. For small diamonds, take special care to center diamonds smaller than 0.4 carat, and use the **SS** or **VS SETTING** modes to correct most of the error.
- *Fluorescent stones can give misleading results.* Always use the UV viewing chamber to observe if a diamond is fluorescent. Remember, visual grading of fluorescent stones is very dependent on the light source being used.

Chapter 3

Maintenance and Troubleshooting

The Colorimeter requires no maintenance other than cleaning the parts that are active during color measurement, i.e. the Sapphire table, the fiber optic sensing input and, occasionally, the optical sphere, and outer housing.

Cleaning the Colorimeter

Use a soft, slightly damp, cloth and mild detergent for cleaning outside surfaces of the display and housing.

Never clean the measuring chamber with solvents or cleaners - you may remove any visible dust particles on it with masking tape or a dry air spray.

The diamond-mounting table should be *gently* cleaned with a cotton swab using ethanol or isopropyl alcohol only. **Never use acetone!**

The spectrometer fiber optic sensing input, located just behind the reflecting barrier inside the measuring chamber, can be cleaned with a cotton swab and ethanol or isopropyl alcohol.

No other cleaning is necessary.

Lamp Replacement

Occasionally you may observe the message *TOO LOW TO MEASURE* or *TOO HIGH TO MEASURE*. This does **not** usually mean that the lamp requires replacement. What probably has happened is that the hot lamp filament may have moved slightly relative to the colorimeter optics, and simply performing a System Alignment will correct the situation.

Should the lamp fail completely, or show a substantial visual reduction in light level, you can have the lamp replaced by a qualified service technician. Colorimeter accuracy will be maintained if it is recalibrated to masterstones by your service technician when the lamp is replaced.

Under normal circumstances the lamp should last at least 1000 hours of use.

Self Test

The Colorimeter performs a self-test when first turned on. If this self-test detects a fault that prevents the proper operation of the Colorimeter, the instrument will beep in the following codes that will help a qualified service technician identify the problem:

Table III - Error Displays

Error	Beep Code	Display
RAM Memory Failure, Lower Bank	1 Short + 1 Long	RAM ERROR, U19 STOPPED
RAM Memory Failure, Upper Bank	1 Short + 2 Long	RAM ERROR, U18 STOPPED
Boot Block Checksum Error	1 Short + 3 Long	BOOT ROM ERROR STOPPED
Program Block Checksum Error	1 Short + 4 Long	PROGRAM ERROR REPROGRAM
Parameter Block Checksum Error	2 Short	PARAMETER ERROR REPROGRAM
+12 Volt Test Error	3 Short	12V ERROR STOPPED
Over Temperature	Cont. Long	OVER TEMPERATURE TURN OFF

Should an error condition persist or the Colorimeter exhibits some unusual behavior, please call your local distributor for service.

Error Messages

Following a successful warm-up the Colorimeter enters its normal operation mode. If the colorimeter was left overnight in a very cold room while off, it may take some time to leave the warm-up phase before becoming ready for measurements.

During normal operation the Colorimeter checks its own proper functioning. If an illegal operation or suspect result is detected, the Colorimeter will either warn the operator or permit resumption of use, or terminate operation, according to the type of error.

Traveling with Your Colorimeter

The Diamond Colorimeter is designed to be transportable. If you travel frequently, contact your local dealer regarding the optional, padded traveling case. For your own safety and for long-term reliable use of your Colorimeter, please follow these simple rules when you travel with it:

1. Make sure the measuring chamber lid is completely closed and the ring holder is removed from the optical chamber.
2. If a printer is connected to the Colorimeter, disconnect it.
3. Pack the instrument and its cable(s) in separate compartments of the carrying bag. If you have the GCI traveling case, it has a pocket for the User Guide and places for cable(s) and other accessories that you may need to use with you Colorimeter.
4. Unless the original packing carton is used, we recommend that you take the Colorimeter with you as hand carried luggage.

The Colorimeter is now prepared for travel. At your destination, simply unpack the Colorimeter, check that the electricity supply is within the allowed range, and plug in the instrument.

Chapter 4

Theory of Operation

Features

Your DC3000 Colorimeter is a sophisticated, yet simple to use, instrument for color grading diamonds. It uses a powerful computer driven by smart software, but allows you to use your knowledge of diamonds in the way you are accustomed without any special training.

The Colorimeter's main capabilities and features are as follows:

- The Colorimeter grades mounted and loose polished diamonds (any commercial cut stones from less than 0.25 carat to over 10 carats).
- It displays grade in accordance to popular scale designations.
- The Colorimeter grades most fluorescent diamonds correctly.
- It self-calibrates without need for Master Stones.
- It is compact, robust and transportable.
- The Colorimeter is easy to maintain.
- It is usable on any mains electricity supply without adjustment.

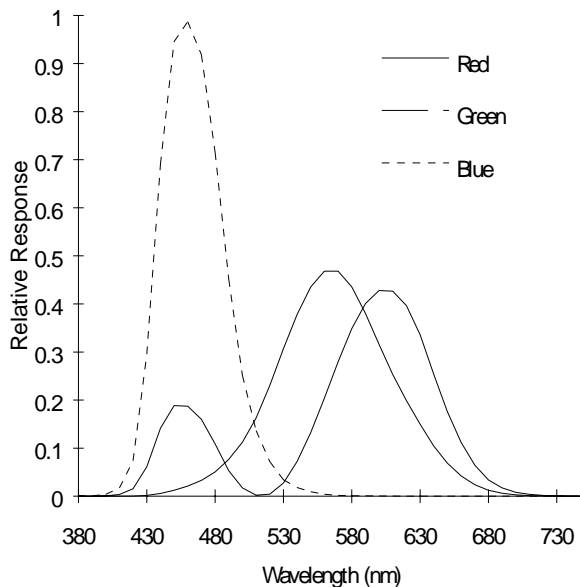
Theory

This section describes the technical theory behind the Colorimeter's operation. This description is included for completeness and is not required to operate the instrument. You may skip to the next chapter and return to this one later if you wish.

Human Color Response

The DC3000 Diamond Colorimeter is referred to as a *Full Spectrum Colorimeter*. More correctly it is a spectro-photometer based instrument. In this type of instrument the diamond is subjected to light covering the full spectrum of human color response from 380 nm to 780 nm, and its absorption over the entire spectrum is measured. The color grade and hue are determined from the absorption spectrum of the diamond.

A human observer perceives color in the brain after his eye has sensed a combination of light intensities from different parts of the visible spectrum. The photosensitive part of the human eye, the retina, is a mosaic of receptor cells known as rods and cones. The rods respond to very low light levels and are responsible for our ability to see under difficult conditions - for example by starlight. Rods normally convey only black and white information to the brain. On the other hand, cones respond to color and the relative sensitivity of a typical human observer to red, green and blue light is shown in figure 3.



Blue ← ————— ————— → Red
Figure 3 - Typical Human Color Response

Examination of figure 3 shows the sensitivity of a typical observer to various wavelengths of light from 380 nm (near ultra-violet) to 780 nm (near infrared). The three curves in figure 3 can be referred to as the blue, green and red responses of a human observer.

Light of different spectra (a combination of wavelengths) can stimulate the observer's three sensors identically, thereby producing the same perceived color

even though the source spectra are different. For example, if an observer were staring at a wall illuminated by a specific set of red, green (with a peak at 575 nm) and blue lamps, then he would perceive a particular color. If a different green lamp (say one having peak output near 550 nm), were substituted for the previous green lamp and its intensity adjusted so as to stimulate the observer's green sensor identically, the observer would perceive the same wall color as before. *While the spectrum of a light source does cause a particular color to be perceived, the same color perception can be caused by other, different, spectral sources.*

Wide band light, covering the entire spectrum from 380 nm to 780 nm, is injected into the crown of the diamond. The amount of light absorbed by the diamond is accurately measured every 3 nm along the entire spectrum, providing an absorption spectrum which completely defines the diamond color.

The color response of an observer and, to a very large extent the Colorimeter, is well defined by an international standard known as the CIE 1931 Chromaticity Chart. This chart, on the inside, rear cover of this guide, shows the color response of a typical human observer to various combinations of red, green and blue light sources when combined in various ratios. There is a direct mathematical relationship that allows computation of the XY coordinates on this diagram for any perceived color spectrum. When only one source is present, such as blue, the perceived color is pure blue as shown in the lower left corner. When the spectrum contains a mixture of red, green and blue, any other color shown can be perceived. And when the mixture is just right, white light is perceived. When the source is wide band, as in the DC3000, the XY coordinate is calculated by integrating the absorption spectrum of the diamond over the typical observer responses shown in figure 3.

The exact *white* used as a reference point by the diamond industry, and in the Colorimeter is located at the XY coordinate 0.3101 and 0.3161 on the CIE 1931 Chromaticity Chart. If one draws a line from *white* through any color and extends the line to the edge of the figure, then it will intersect at wavelength between 380 nm and 750 nm. This wavelength is called the *wavelength of the dominant perceived color*. The observer will perceive the same color either by being exposed to a particular spectrum of light, a mixture of red, green and blue, or by exposure to a monochromatic light source having the exact *wavelength of the dominant perceived color*.

Hue and Saturation

Two independent components of a diamond's color are measured by the Colorimeter:

- *Hue* or tint: Its dominant perceived color wavelength,
- *Saturation*: How far the color is from White.

For example, pink may have the same *Hue* as red, but has relatively low *Saturation* (closer to white) compared to red.

A third color component, *Tone*, indicates the overall transparency of a diamond for all colors, sometimes referred to as gray. Measurement of *Tone* is not possible with the Colorimeter, because factors such as cut and size interfere with the measurement of *Tone*.

A line drawn from *White* (0.3101, 0.3161) at an angle of 60° relative to the X axis on CIE 1931 Chromaticity Chart represents the *Hue* typically associated with Yellow or Cape diamonds. In fact, all Hues can be specified as an angle between 0° (horizontal) and 359° proceeding counter-clockwise.

The diamond industry has not yet standardized the names one should use for each *Hue*. The Colorimeter has been programmed to provide the names shown on the CIE 1931 Chromaticity Chart printed in this manual for the various *Hues* whenever the diamond is a *fancy* color, that is, not *Cape Yellow* or *Light Brown*. The Colorimeter classes all measurements having an angle of between 55° and 65° as *Cape Yellow*, and those between 45° and 55° *Light Brown*.

When any color is very close to *white* it is impossible to reliably perceive *Hue*. Therefore the Colorimeter is programmed to indicate *Colorless* for any measurement closer to *white* than FG (the border between F and G) for *Cape Yellow* and *Light Brown*, and somewhat closer to *White* for other Hues.

One can still measure *Hue* angles very close to *White* by using the **Numeric** Display mode described in Chapter 3 of this manual. Also, most diamonds are *Cape Yellow* or *Light Brown*. The Colorimeter is specifically programmed to use the standard *Hue* designations for *Cape Yellow* stones such as *Colorless*, *Near Colorless*, *Faint Yellow*, *Very Light Yellow* and *Light Yellow* as shown in figure 4. *Light Brown* stones are graded and indicated as *Lt Brown*. For *Hues* other than *Yellow* and *Light Brown*, the Colorimeter shows Grade as *Light Fancy*, *Fancy* or *Fancy Intense* as well as the *Hue* name such as *Pink*, *Blue*, etc.

Sometimes *Hue* is indicated as a small letter and a capitalized word, for example *p-Pink*. This format means that the small letter, *p*, is a modifier of the primary *Hue*, *Pink*. In this instance the modifier *p*

means *purplish*. Refer to Table I for the *Hue* modifiers used by the Colorimeter.

Saturation is a measure of the distance a particular XY color coordinate is from *white* along a given *Hue* line, and is directly related to diamond Grade. If one divides the line representing *Cape Yellow* diamonds (60°) into segments, each segment represents a Grade, starting with D for the segment nearest white. The 23 segments between *White* and the end of Grade Z span only about 20 percent of the distance from white to the most *Fancy Intense* possible. The remainder beyond Grade Z is broken into three larger segments called *Fancy Light*, *Fancy* and *Fancy Intense*. This concept is illustrated in figure 4.

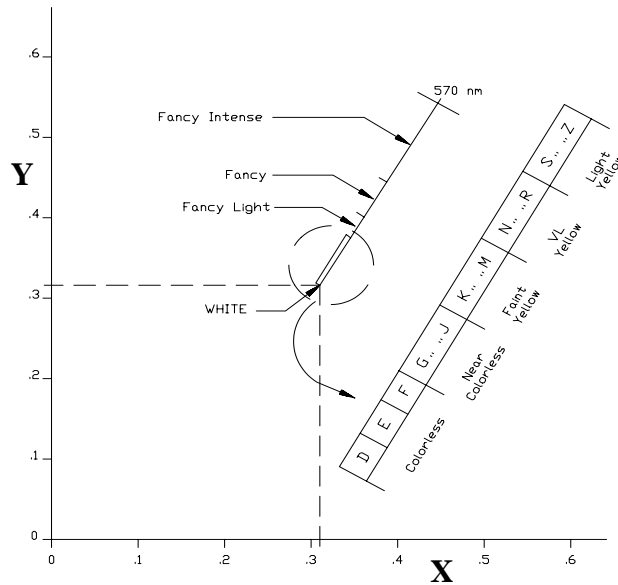


Figure 4 - Standard Grade/Hue Designations for Cape Yellow Diamonds

The exact size of each of the Fancy segments is not well specified, but the first 23 segments (D through Z) are much better understood and are generally defined by Master Stones. Furthermore, the lengths of the segments are not the same due to the nonlinearity of the human eye. GCI has measured a large number of laboratory grade Master Stones in order to determine the precise length of each grade segment.

Appendix A

Technical Specifications

Functional

Diamond types	Polished (mounted & loose).
Diamond size	0.25 to 10 carats to full accuracy, 0.15 to 20 carats with reduced accuracy.
White temperature	CIE 1931 Illuminant C
Phosphorescence and fluorescence	Excitation equivalent to using a 6500 °K fluorescent viewing lamp. Viewing chamber for observing fluorescence.
System Alignment	Semi-automatic without Master Stones
Security	Tamper proof computer-code and parameters
PC/Printer Interface	PC compatible serial RS-232

Performance

Grading Accuracy	± One grade for mounted stones, ± 1/2 Grade for loose polished stones.
Grading Range	D to Z and to Fancy Intense
Grading Scales	Space for up to 6 scales
Hue determination	All tints
Fluorescence	Grading is typically unaffected by fluorescence.
Grading time	<10 seconds after mounting
Lamp Life	1000 Hours minimum

Electrical

Operating voltage	90 - 260 VAC, 50 - 60 Hz
Operating power	50W maximum

Environmental

Ambient lighting	Normal office or shaded sunlight
Operating temperature	15°C to 35°C (50°F to 85°F)
Storage temperature	-10°C to 75°C (15°F to 167°F)

Mechanical

Dimensions	W	H	D	
	cm	15	15	26.5
	inches	5.9	5.9	10.4
Weight	3 Kg (6.6 lbs)			
Shock and Vibration	Rugged; transportable			

Options

Carrying case	Sturdy, padded, travel case
PC Interface Cable	Standard Null Modem cable allowing transfer of measurement data to a personal computer.
Label Printer	Seiko EZ30, or SLP series: 100,120,200,220,240. Dymo XLT, EL series or LW300 series,
Label Customizing	GCI supplied Software, GCILABEL

Appendix B

PC Mode Interface

Usage

The Colorimeter communicates with a personal computer when **PC** output mode is enabled as described in Chapter 2.

Your personal computer will require the following:

1. An IBM compatible personal computer with at least one available serial port, COM1 or COM2 running under MSDOS, or MS Windows 95/98.
2. A Null Modem Cable, available from your local computer supplier or Colorimeter distributor.

Protocol

All communications between the Colorimeter and the PC use the following mode:

9600 Baud,
No Parity,
1 Stop bit.

PC to Colorimeter Communication

Each record from the PC to the Colorimeter consists of a sequence of at least three characters:

<ESC> 'K' n0 [n1,n2...]

Where,

<ESC> is a standard escape character (decimal 27),

'K' is the character for capital K (decimal 75),

n0, n1, ... are numbers which specify the meaning of the command to the Colorimeter per the following tables.

**Table IV- PC to Colorimeter
Communication - Command**

Measurement command (Following 'ESC, 'K')

(n0)	Description
0	Perform measurement and send result

Keypad commands: (Following 'ESC, 'K' '1')

Key Id (n1)	Description
16	'Execute' Keypad
17	'Menu' Keypad
18	'Select' Keypad
19	'UV' Keypad
20	'Print' Keypad
21	'Setting' Keypad

Menu Setting Commands: (Following 'ESC, 'K' '2')

Menu (n1)	Item (n2)	Value (n3)	Description
16	0 - 5	0	Grading scales
17	0 - 2	0	Display mode: Normal, Numeric, CIE
18	0 - 6	0	Output mode: Printer types, PC, DIAGNOSTICS
21	0 - 11	<v>	Configuration mode: If <v> applicable: 0 = Disable; 1 = Enable or other applicable numeric value. If value is not applicable, zero must be sent to comply with protocol.
33	0	0	Activate 'ALIGN SYSTEM'
34	0	<v>	Show 'TEST DISPLAY' <v> = Display test number

Notes:

Item number designates its order through 'Select'

The Colorimeter will normally respond to each of the first two characters of the sequence, ESC and 'K' with an ACK (decimal 6). Should the Colorimeter fail to recognize the character, or sense it is out of sequence, the response will be a NAK (decimal 21)

The Colorimeter will typically send its response character immediately, but if the Colorimeter is busy (for example performing a System Alignment), the response could be delayed. The PC should wait at least 10 seconds for a response character before sending another character. If no response is received after waiting, the PC should assume the entire sequence was

lost, and start a new sequence with an <ESC> character.

When the Colorimeter is in **PC** or **DIAGNOSTICS** output mode and connected to a PC, the user may still operate the Colorimeter keypad directly for measurements, but the results will not be sent to the PC. Only measurements made under command from the PC are sent to the PC.

Colorimeter to PC Communication

In addition to the ACK and NAK responses described above, the Colorimeter will send a plain text record to the PC whenever:

- A measurement is performed under command from the PC.

Message format is:

“GCI” “MEASURE” s/n scale setting grade hue <CR> <LF>

- An error or warning condition is detected which displays a message on the Colorimeter screen.

Message format is:

“GCI” “ERROR” errortxt <CR> <LF>

Each item in the transmitted records is defined in the following table.

**Table V- Colorimeter to PC
Communication Formats**

Symbol	Remark
"GCI"	Start of record sync string that is always "GCI".
"MEASURE"	The string "MEASURE" indicating that the record is a measurement type record.
"ERROR"	The string "ERROR" indicating that the record is an error type record.
Sn	The Colorimeter's serial number presented as the characters SN, followed by a 5 digit number with leading zeros.
scale	The 3-character text representing the scale used for the measurement as shown on the Colorimeter screen.
setting	A quoted text string representing the current setting as it appears on the display, such as "OP". Note the character O is used instead of 0. No setting is indicated by sending the string "".
grade	A text number representing the grade as in the <i>Numeric</i> display mode. For example, middle G grade is 4.5. Note that White is 1.0, Fancy Light is sent as 100, Fancy as 200, and Fancy Intense as 300.
Hue	A text string containing the same text as shown on the display Hue result. For example: "FAINT YELLOW".
errortxt	The error message as displayed on the colorimeter screen. The messages enclosed in quotes with the break between lines represented by a '/' character. "CLEARED" will be transmitted when the error condition is removed

Examples of output records are:

"GCI" "MEASURE" SN30103 GEM " " 4.5 "Nr COLORLESS" <CR> <LF>

"GCI" "ERROR" "PLEASE/CLOSE CHAMBER" <CR> <LF>

"GCI" "ERROR" "CLEARED" <CR> <LF>

Getting diagnostics data

Introduction

DC3000, although is a complete device, meant for measuring colors of diamonds, has capability of sending intermittent data collected by unit before it is analyzed. The data is given in its raw format. GCI has no responsibility for any use, scientific, commercial or other, that will be done with the extracted data.

On the DC3000:

- Press 'MENU' until OUTPUT MODE displayed on the first LCD line.
- Press 'SELECT' until DIAGNOSTICS displayed on the second line.
- Press 'EXECUTE' to apply diagnostics mode.
- Perform a standard measurement, as described in DC3000 user manual.
- When measurement completed and displayed, press the PRINT button.

This will start data transfer from DC3000. The transfer involves no handshake protocol, meaning the transfer does not expect any response from receiver.

Data transfer format

Diagnostics data is 2660 bytes in length divided into 6 groups.

Each group consist of 1 or 4 blocks, prefixed by an identification code (I.D)

A block is constructed as shown in the following table:

Header 1	Header 2	Length	Data I.d.	Data bytes	2's compliment of Check sum
1 byte	1 byte	1 byte	1 byte	100 or 128 bytes	1 bytes
74	71	129 or 101	I.d.	D0...D127 or D0...D99	1 + Inv(Type + data0 + ... + dataN)

Header 1 Always 74
Header 2 Always 71
Length Number of data bytes +1.

I.d. Length Description (Version 1.07) *

Group 0 Internal data of DC3000 software. (Not Supported)

64 100 Single block

Group 1 Lamp only spectrum – Dark Spectrum.

128 128 1st Block

129 128 2nd Block

130 128 3rd Block

131 128 4th Block

Group 2 Last raw spectrum reading.

132 128 1st Block

133 128 2nd Block

134 128 3rd Block

135 128 4th Block

* See "Group interpretation Compatibility " paragraph.

Group 3		
<u>Last raw spectrum reading - Dark Spectrum.</u>		
136	128	1st Block
137	128	2nd Block
138	128	3rd Block
139	128	4th Block

Group 4		
<u>Sum of last 4 (Stone spectrum – Dark Spectrum).</u>		
140	128	1st Block
141	128	2nd Block
142	128	3rd Block
143	128	4th Block

Group 5		
<u>Dark spectrum.</u>		
144	128	1st Block
145	128	2nd Block
146	128	3rd Block
147	128	4th Block

When combined, each group contained a sequenced series of 256 WORD (WORD = 2 Bytes).

Each WORD value is: 1st byte + 256* 2nd byte. (Intel's 86 CPU family format.)

Each value is the Pixel response reading of corresponded Wave length (λ). The wave length is given by the formula: $\lambda = \text{Pixel No.} * \text{Pixel span} + \text{Pixel offset}$.

- Pixel No is the WORD order in the group.
- Pixel span and Pixel offset are specific to each unit hardware. (Approx. 3.0 for span and 250.0 for offset). The exact values may be restored by GCI according to unit serial number.

Group interpretation Compatibility

Versions 1.05, 1.06:

- Group 0** Internal data of DC3000 software. (Not Supported)
- Group 1** Lamp only spectrum – Dark Spectrum.
- Group 2** Same as group1.
- Group 3** Stone spectrum – Dark Spectrum.
- Group 4** Same as group3.
- Group 5** Dark Spectrum.

Version 1.07:

- Group 0** Internal data of DC3000 software. (Not Supported)
- Group 1** Lamp only spectrum – Dark Spectrum.
- Group 2** Last Raw spectrum reading.
- Group 3** Last Raw spectrum reading - Dark Spectrum.
- Group 4** Sum of last 4 (Stone spectrum – Dark Spectrum).
- Group 5** Dark Spectrum.