NOVO-GLOSS IQ GONIOPHOTOMETER

Instrument Manual

Novo-Gloss IQ Operation Manual

Table of Contents

Novo-Gloss IQ
Specular Goniophotometer

***Goniophotometer** is derived from Greek;*
***Gonio-Angle, Phos-Light, Metron-Measure***

Gloss describes the perception of a surface appearing "shiny" when light is reflected from it.

When viewing glossy surfaces it is found that a sudden increase in brightness occurs when the angle of observation equals the angle of incidence of the illuminating light. This condition is termed as specular reflection.

The Novo-Gloss IQ uses a diode array to measure the distribution of reflected light +/- 6° from the specular reflection angle.

Each measurement consist of a 256 point profile of the reflected light. Using this information the instrument calculates Gloss, Rspec, Haze (HU or HU_{LOG}) and Distinctness of image values.

These values are used to assess the visual impact and reflective quality of many coated, painted and polished surfaces.
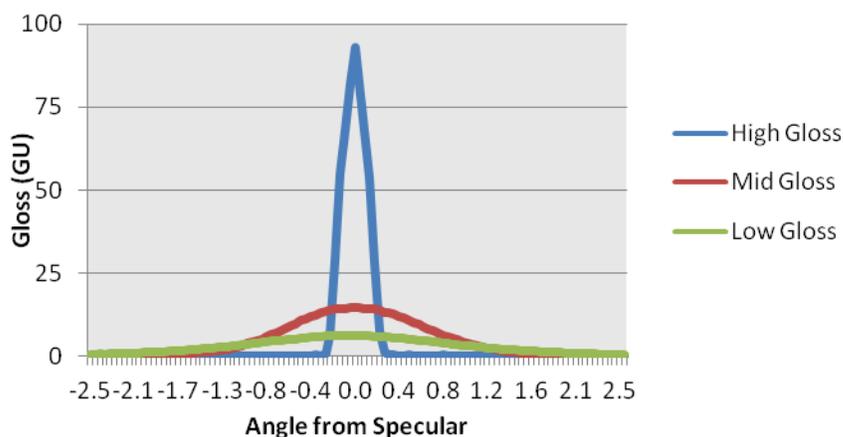
Goniophotometric output from the Novo-Gloss IQ analysed in MS Excel. This example shows three papers with different gloss levels.

Why is specular appearance important?

A crucial factor in assessing the appearance of any manufactured product is the "glossiness" of its finish.

Gloss finishes are often used make products visually appealing. Highly reflective, extremely smooth finishes are used to enhance the aesthetics of cars, luxury yachts and high end consumer electronics. Matt finishes are used for contrast furniture and architectural features.

The Novo-Gloss IQ measures standard gloss within existing standards, and uses new technology to examine in more detail the distribution of light around the specular angle.

The instrument provides goniophotometric profiles, gloss, haze and distinctness of image values which can be used to assess the visual qualities of a surface.

As well as assessing the visual impact of a surface, the Novo-Gloss IQ can also be used to identify problems with coating formulation and application.

Coating problems such as dry spray, orange peel, poorly dispersed or flocculated pigments, micro bubbles, resin incompatibilities and additive migration all results in reduced DOI, Haze or gloss values and therefore can be measured with this instrument.
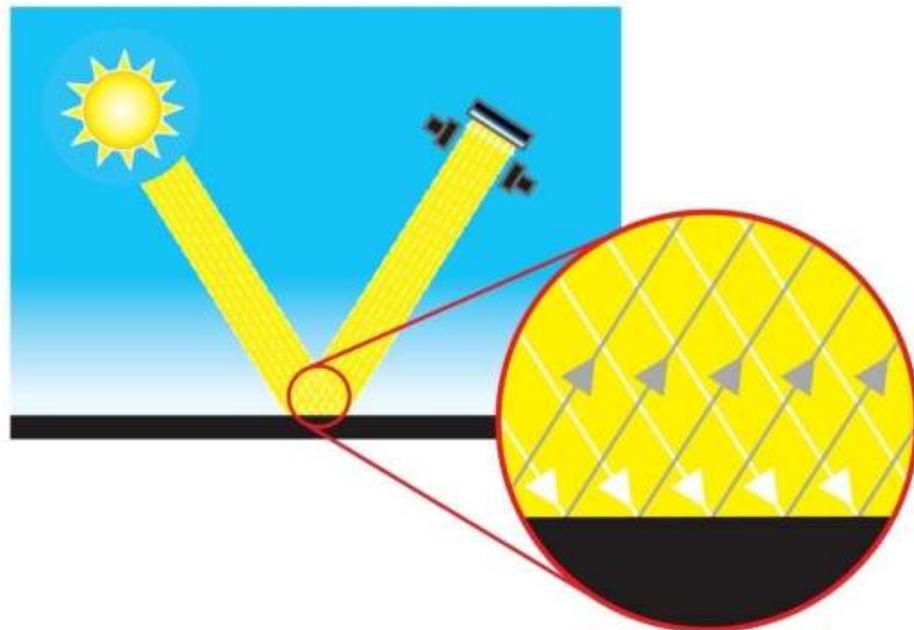
Specular reflectance from a "perfect mirror" surface- all light is reflected in the specular direction

Disadvantages of standard gloss measurement

In 1925 Pfund described a simple method for measuring specular reflectance; this method has since been refined and standardised but the basic design for a glossmeter has remained unchanged.

The conventional glossmeter is widely used to assess the visual quality of test panels and product surfaces; however the human eye can see certain surface defects that are not detected with this instrument. This is a particular problem where finishes are given high gloss values but rated by observers as having a poor appearance.

The reason for differences between observed quality and measured gloss is because light entering a glossmeter is recorded as one value without the detection of variation. In the human eye the reflected image activates a compact array of light sensors known as cones, the detailed signal from these cones allows the eye to see subtle textures on a surface that are not recorded with a glossmeter.

The Novo-Gloss IQ, with its array of light sensors mimics the effect of reflected light in the human eye. More detailed information from this instrument allows the user to measure and control surface defects that are undetectable with a standard glossmeter.

Specular reflection and surface texture
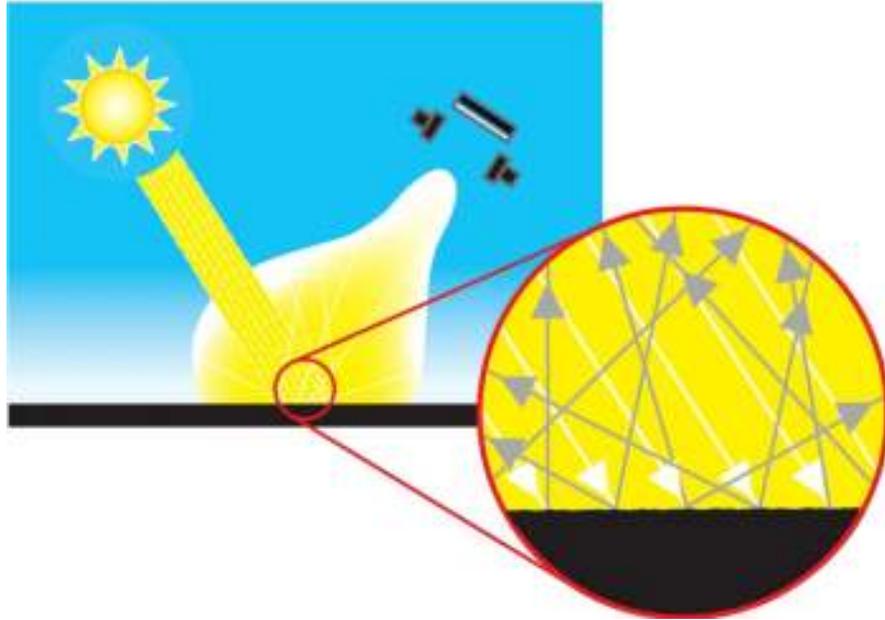
The reflection from a paint film contains includes a mixture of specular and diffuse light.

There are several factors that influence the gloss and appearance quality of a coating;

- The chemical composition of the coating/topcoat/varnish vehicle, the refractive index of this component largely determines how light is reflected from the surface.

- The size and frequency of structures on the surface, these can be deliberate in the case of matting additives which scatter light, or unintentional and unwanted such as additive bloom, orange peel, reticulation etc.

- Uneven substrates may cause texturing to the coating surface. For transparent coatings the reflective nature of the substrate is also important.

- Metallic and Effect Pigments, the size, distribution and alignment of these larger size particles have an effect on the reflective characteristics of a coating.

By measuring Gloss, Haze and DOI, the Novo-Gloss IQ quantifies the visual impact of a product and the nature and frequency of textures on its surface.

Most painted and coated objects have some degree of surface texture which impacts their visual appearance. These textures can be described by their size and the visual effect they have on the paint surface or the quality of a reflected image.

The smallest textures (< 0.01mm) result in gloss reduction, the largest can result in visible ripples on the coated surface (> 1mm).

The Novo-Gloss IQ is sensitive to surface structures up to 10mm in length.
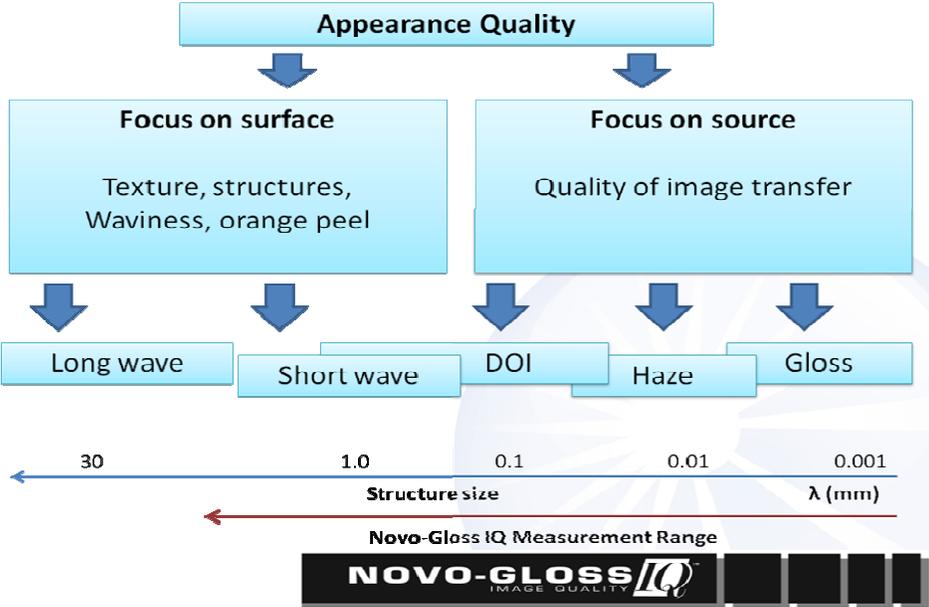
A diagram showing the effect of structures on surface appearance. The smallest structures cause gloss reduction, larger texturing causes haze, the largest structures such as waviness and orange peel reduce the DOI of a surface.

Measuring Standard Gloss with the Novo-Gloss IQ

The Novo-Gloss IQ calculates gloss using the parts of the goniophotometric profile that corresponds to the angles described in ISO 2813 and ASTM 523.

Gloss results measured with the IQ have been verified using BAM traceable gloss tiles and conform to this standard throughout the measurement range.

Haze

Haze describes the milky halo or bloom adjacent to the reflected image.

Reflection haze on a vehicle body causes a "milky" finish and a drop in reflection contrast.

Surface haze can be problematic in most coating applications including automotive manufacture, powder coatings and other high gloss coatings. It can be attributed to a number of causes including incompatible materials in a formulation, difficulties in application and problems encountered during drying/curing/stoving.

Reflected light sources in surfaces with medium and high haze values.

Coatings without haze can be seen to have a deep reflection and have high reflected contrast. Those with a lower level of reflection haze exhibit a slight "milky" finish which can be seen at the surface.

When viewing the reflection of a strong light source in a surface with high haze the image "blooms" and has a bright halo around it.

Haze is an important measure for highly polished metals and is often associated with polishing marks and machining direction.

Gloss-haze meters are traditionally used to measure this parameter and use a standard glossmeter design with additional light stops and diodes to measure the haze component 2° either side of the specular.

Gloss-haze instruments have not found mainstream acceptance in the coating industry because to take repeatable measurements the sample surface needs to be completely flat and un-textured. The relative high cost of these instruments has also been found to be prohibitive.

Measuring Haze with the Novo-Gloss IQ

The Novo-Gloss IQ automatically compensates for sample surface flatness and texturing allowing haze measurements to be taken on most product surfaces.

Gloss Haze values are calculated using the angular tolerances described in ASTM E430. The instrument can display the natural haze value (HU) or Log Haze Value (HU$_{LOG}$). When measuring haze values, higher numbers indicate a lower quality surface. A high gloss surface with zero haze has a deep reflection image with high contrast.

Log Haze Values are commonly quoted for paints and coatings as this scale has increased resolution at the haze levels commonly seen on this type of surface.

Distinctness of Image (DOI)

Distinctness of image is, as the name implies a function of the sharpness of a reflected image in a coating surface.

Two surfaces finished with similar coatings may exhibit identical gloss values but visually the quality of one coating can be seen to be very poor. Upon closer inspection the visually substandard poor coating has a highly textured dimpled appearance known as "orange peel". When a reflected object is viewed in such a coating the image becomes fuzzy and distorted.

The automotive industry was the main driver to increased quality gloss coatings. Orange peel drastically reduces the perceived quality of automotive finishes.

Orange peel, waviness, texturing, pin holing and similar effects can be problematic in many high gloss coating applications including automotive, powder coating and any other industries that requires a smooth homogenous finish. All these effects can be measured with the Novo-Gloss IQ.

DOI has been measured instrumentally and subjectively in the automotive industry for many years. Instruments that measured this value in the past were bulky expensive and some had poor repeatability. DOI measurement was not common

outside of automotive because of the cost of equipment was high and the demand for high quality gloss finish was not as crucial.

The Novo-Gloss IQ measures the DOI of a surface by quantifying the way a reflected measurement beam is spread and distorted around the specular angle.

An example of test panel with low and high DOI values. Orange peel, texture, flow out and other key parameters can be assessed in coating applications where high gloss quality is becoming increasingly important.

The DOI value of a surface is number between zero and one hundred; a surface that exhibits a perfect undistorted image returns a value of 100, as the values decrease and as the image becomes less discernable.

Measuring DOI with the Novo-Gloss IQ

The Novo-Gloss IQ can measures DOI at 20° and 60° degrees,

20° is the prescribed angle for DOI measurement in ASTM D5767.

Due to the larger measurement spot size at 60°, tests have shown that this angle is more sensitive to longer wave length ripples than 20°.

RSpec- Peak Specular Reflectance

Peak specular reflectance is a measure of the peak gloss value of a surface; this value is obtained very close to the specular angle.

Goniophotometric Profile

The Gloss, Haze, Rspec and DOI values given by the IQ can be used to assess the visual quality of any surface. Alternatively the full Gonio-curves can be downloaded to a PC and overlaid for a detailed understanding of specular reflectance.
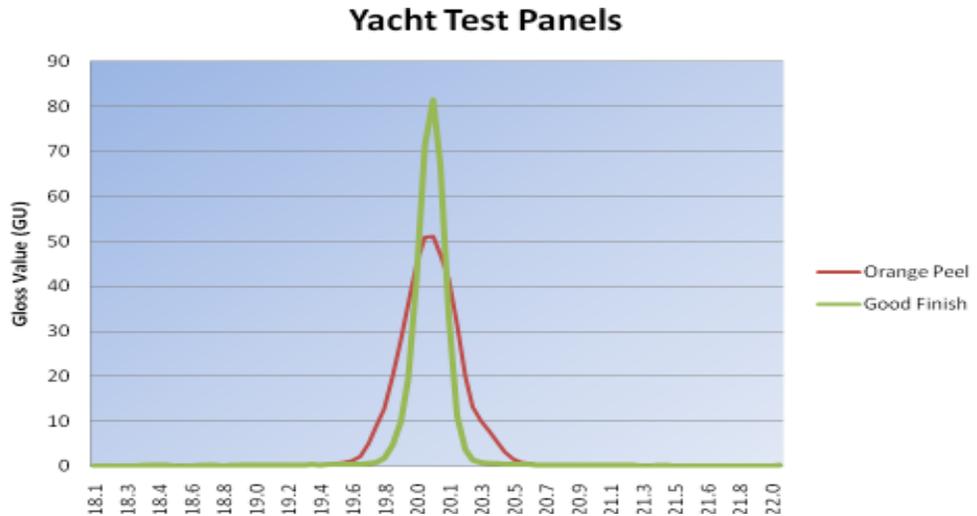
Goniophotometric curve and specular indices for two painted yacht panels

Sample	Orange Peel.	Good Finish
Angle	20.0	20.0
Gloss	87.2	89.0
Rspec	54.7	88.2
Log Haze	37.6	32.5
DOI	84.3	97.1

The yacht panel example perfectly demonstrates the need for additional appearance information than that supplied with a glossmeter as the panels have virtually identical gloss when measured with this instrument. Visual inspection however, shows the first panel to have a very high degree of orange peel.

When measured with the Novo-Gloss IQ, the instrument measures gloss identically to a standard glossmeter (87.2 GU-89.0 GU). It also quantifies the orange peel finish on the substandard coating with a low DOI reading of 84.3.

Calculating Gloss, Haze, RSpec and DOI from a Goniophotometric profile

For the above example at 20°, Novo-Gloss IQ calculates the Gloss value by summing the gloss values +/- 0.9° from the specular angle. These tolerances are specified in ASTM D523/ISO 2813.

The RSpec value is the peak gloss value at the specular angle.

Haze is measured by summing the gloss values between 18-19° and 21-22°, the angles described in ASTM E430.

The DOI value is a function of the slope of each curve, the sharper the gloss response, the higher the DOI value (100 DOI is a perfect reflecting surface). More detail of this method can be found in ASTM D5767.

| Haze Component | Gloss Component | Haze Component |

20°
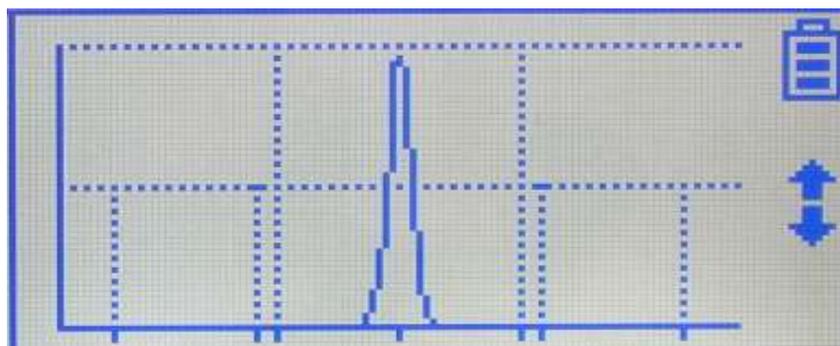
The Novo-Gloss IQ screen displays a low resolution gonio-curve for comparison.

The instrument uses the angular tolerences from ISO 2813 & ASTM D523 to calculate gloss values at 60°. The angular tolerances used at 20° to calculate Haze, and DOI are also used at this geometry.

Accessories

The Novo-Gloss IQ is supplied with the following kit

- Novo-Gloss IQ 20/60° goniophotometer

- BAM traceable high gloss calibration tile with certificate

- BAM traceable mirror reflectance calibration tile with certificate

- USB-PC data cable

- Software disk

- Glass-standard cleaning cloth

- Instrument carry case

- Screwdriver

- 4 x AA High power dry cell batteries

Power

Novo-Gloss IQ is powered with 4 x AA batteries, dry cell or rechargeable may be used.

To install or replace the batteries remove the battery panel by unscrewing the two screws. Insert the new cells in the battery cartridge and place in the battery compartment, replace the lid and replace the screws.

The battery compartment cover should be removed using the supplied screwdriver. The instrument uses 4 x AA batteries.

Having installed the batteries press the centre button to power up the instrument.

The Novo-Gloss IQ has an automatic power down function that will switch off the after approximately two minutes.

The bar underneath the menu indicates the time remaining until power off.

On the top right of the information screen there is a remaining battery power icon.

Control Panel

The Novo-Gloss IQ is controlled using a menu navigation switch, with four way direction buttons and a central READ button.

The four directional buttons are used to navigate the menus; the center button takes a measurement.

Press the center button to power up the instrument.

To enter the main menu, PRESS and HOLD the center button for two seconds.

To shortcut to the four most important menus, PRESS and HOLD each of the four direction buttons for two seconds.

Navigating the Menus

Accessing the Main Menu

To access the main menu simply PRESS and HOLD the center button
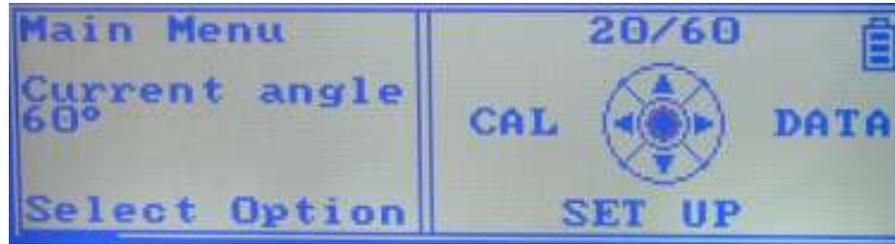
The main menu screen, the right window contains navigation information, press the corresponding button to access the indicated function.

As indicated on the Navigation Screen the following buttons access the following functions

- LEFT BUTTON- Calibration Menu

- UP BUTTON- Change between 20⁰ and 60⁰ angles

- RIGHT BUTTON- Enter the Data Menu

- DOWN BUTTON- Enter Set up menu 1

The left hand information screen indicates the current menu and a summary of any relevant data.

Using Short Cuts

The four most important menus can be entered at any time during the operation of the instrument without the need to enter the main menu.

For quick access to these functions simply press and hold the corresponding button.

For example; to quickly change angles, simply PRESS AND HOLD the UP BUTTON from any menu screen.

- PRESS AND HOLD LEFT BUTTON- Calibration Menu

- PRESS AND HOLD UP BUTTON- Change between 20° and 60° angles.

- PRESS AND HOLD RIGHT BUTTON- Enter the Data Menu

- PRESS AND HOLD DOWN BUTTON- Enter Set up menu 1.

Measurement Screen

The read screen is the default position for the instrument. To return to this screen from any of the MENU screens simply WAIT for 3 seconds.
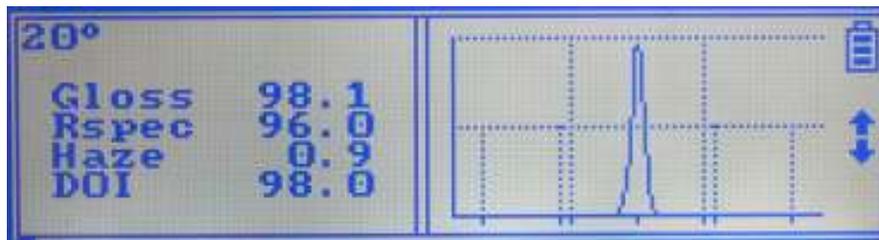
The left screen details the specular appearance indices for the last reading, on the right the goniophotometric profile is displayed.

Statistics and Memory

The instrument stores up to 50 readings with complete goniophotometric data.

Statistics can be displayed for Gloss, RSpec, Haze, and DOI values.

To display the first page of the statistics menu, press the DOWN BUTTON on the keypad.

To display the second page of statistics menu press the DOWN BUTTON once more.
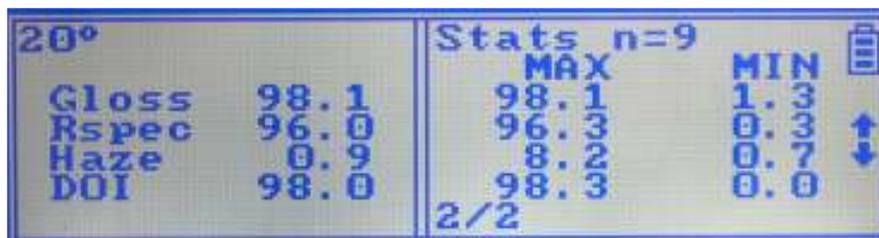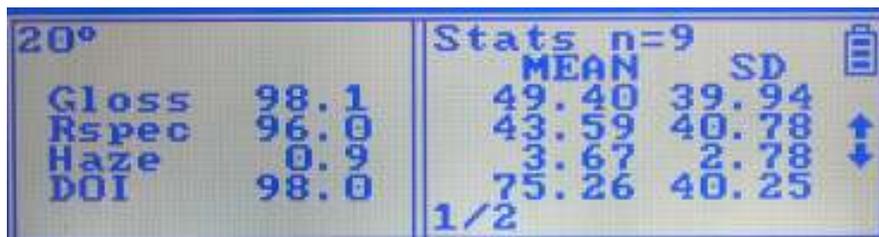
Statistics pages 1 & 2 for saved readings.

Calibration

It is necessary to inspect the condition of the calibration tile and instrument optics before each calibration.

Inspect the tile and instrument optics before calibration.

Inspecting and cleaning the instrument optics

Any dust or debris on the optic should be blown from the lenses using dry clean air, the optics must not be touched. If there are any permanent marks or scratches on the lenses, the instrument is no longer suitable for measuring and should be returned to an authorised Rhopoint service center.

Inspecting and cleaning the calibration tile

The calibration tile must be perfectly clean from smears and scratches before attempting calibration. Fingerprints and dust can be removed with the supplied optic cleaning cloth.

Scratched or damaged tiles

Scratched or damaged tiles are not suitable for calibration. The instrument and tile must be returned to an approved Rhopoint service center for tile replacement and recalibration.

Selecting the correct calibration tile

For polished metals it is often preferable to measure in percentage reflectance rather than gloss units. To measure in percentage reflectance, use the mirror standard rather than the black glass standard for calibration. Before use the internal calibration values will need to be adjusted and the instrument recalibrated. See page 19 for instructions.

Calibrate Instrument

To calibrate the instrument enter the calibration menu, this can be accessed via the main menu or by using a shortcut.

- To enter the main menu PRESS and HOLD the center button. Press the left button to access the calibration screen.

Alternatively,

- To shortcut to the calibration screen PRESS and HOLD the left button from any screen.
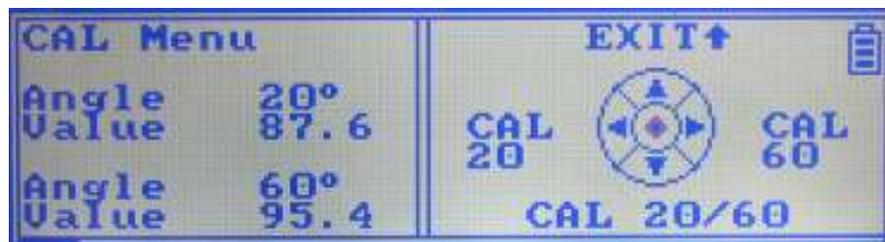
The calibration screen, details of the stored calibration values are displayed on the left screen.

Before calibration for the first time check the values displayed on the left match the calibration values printed on the calibration tile. If they are found to be incorrect they can be adjusted, see page 23 details of this procedure.

ALWAYS check that the calibration tile is clean and undamaged before calibration see page 19 for more details.

To calibrate place the instrument on the calibration tile, and press

-The LEFT button to calibrate 20° angle.

-The RIGHT button to calibrate 60° angle.

-The DOWN button to calibrate both angles
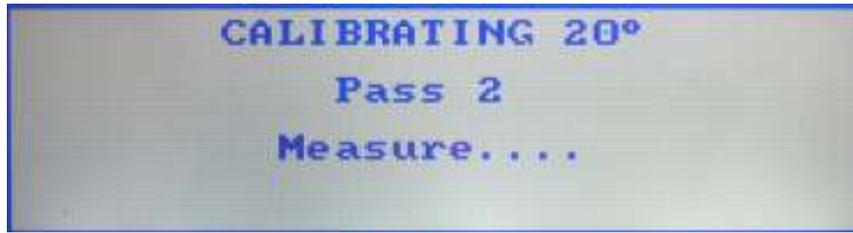
The instrument takes a few seconds to calibrate each angle, when it is completed the measurement screen will be displayed.

Taking a measurement
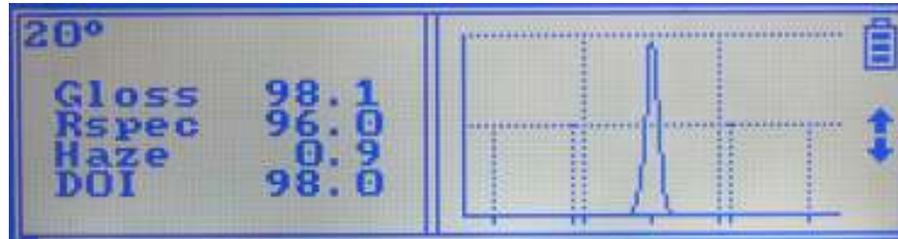
The instrument measurement screen

To take a measurement, simply press the center button. The instrument will take a few seconds to make each measurement.

To offer improved linearity over standard glossmeters, the instrument modulates the light source to provide the optimum amount of light for the detection array. This means that the instrument takes a little longer to measure matt surfaces in comparison to high gloss surfaces.

Selecting measurement angle

To use the angle change shortcut PRESS and HOLD the up button.

The 20° angle is traditionally used to measure high gloss surfaces (those measuring >70 GU when measured at 60°).

The 60° angle is used to measure all other surfaces. The larger measurement spot size means that 60° DOI measurements include information about longer wave length ripples and textures.

Using Statistics

Any surface that is not completely regular should be measured multiple times and the mean values used to assess surface quality. See page 17 for information on using statistics.

Instrument set up options

Set up menu 1

The set up menus can be accessed via the main menu or via a shortcut;

- To enter the main menu PRESS and HOLD the center button. Press the down button to access the set up menu.

Alternatively, to use the set up menu shortcut

- PRESS and HOLD the down button from any screen.
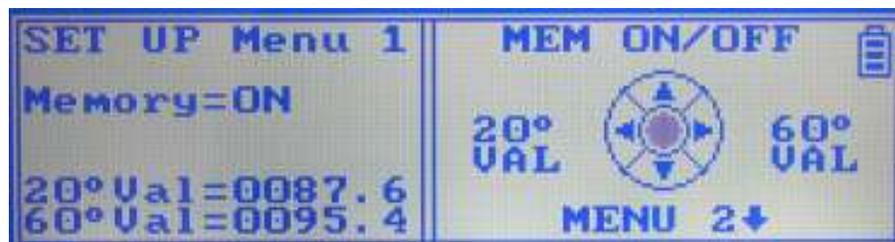
Adjusting the stored calibration values

- Press the left button to adjust 20⁰ Stored calibration value

- Press the right button to adjust 60⁰ Stored calibration value

- Press the down button to access set up menu 2

Switching the Memory on/off

If the instrument memory and statistics are not used, it is advisable to switch them off.

- Press the UP button to toggle memory ON/OFF.

Set up menu 2

Set up menu 2 must be accessed from Set up menu 1 see
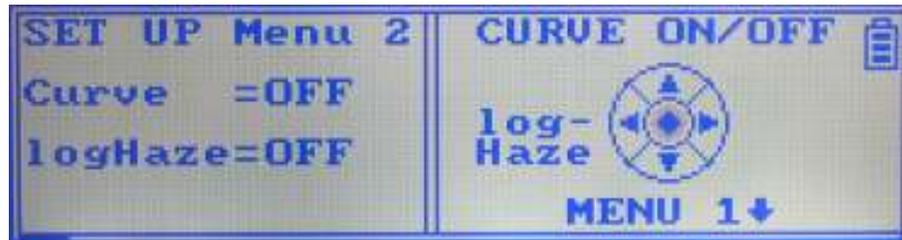
Switch the Goniophotometric curve on/off

To increase the download speed from instrument to PC the full Goniophotometric data can be toggled off. The gloss, haze, DOI and Rspec values are still downloaded with this option switched OFF.

Press the UP button in set up menu 2 to toggle between Curve=ON and Curve=OFF

Switch the Log Haze scale on/off

The instrument can be switched between natural Haze (HU) and log Haze (HU$_{LOG}$) values. natural haze is used for polished metals, log haze gives improved resolution when measuring paints, plastics and materials with similar gloss (<200 GU at 20⁰).

- Press the UP button to toggle between logHaze=ON and logHaze=OFF

Data Menu

The data menus can be accessed via the main menu or via a shortcut;

- To enter the main menu PRESS and HOLD the center button. Press the right button to access the set up menu.

Alternatively,

- PRESS and HOLD the right button from any screen.

Delete the last reading from statistics memory

- To delete the last reading from memory press the LEFT button.

Delete the all readings from statistics memory

- To delete the all readings from memory press the RIGHT button.

Output the saved memory to PC

- Press the DOWN button to initiate the PC download function.

Index