

MATERIALS ANALYSIS

FAST, SIMPLE, AUTOMATED ANALYSIS OF SUNGLASSES TO MEET THE REQUIREMENTS OF BS EN ISO12312-1

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Authors

Rob Wills

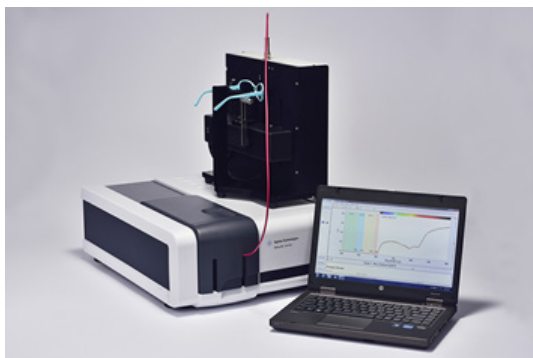
Product Specialist Molecular Spectroscopy

Agilent Technologies UK Ltd

ABSTRACT

This solution note details how the Agilent Cary 60 UV-Vis spectrometer, equipped with fibre-optic coupled, automated sunglass testing accessory and operated by dedicated sunglasses analysis software, is perfectly suited to meet the transmission and lens uniformity testing requirements of BS EN ISO12312-1:2013

The system is simple to operate, and can be applied to testing both adults' and childrens' sunglasses, in a wide variety of shapes, styles and sizes, (including styles with gradient lenses), without having to remove the lenses from the frame. The dedicated software package drives the automated accessory and typically a complete pair of sunglasses can be characterized in less than two minutes. The software also compiles a full report with pass/fail results for each criteria, and which includes the recommended ISO symbols



INTRODUCTION

Introduced in August 2013, ISO12312-1 sets forth the new industry requirements for characterization of sunglasses and related eyewear. Following concerns that the existing standards were not comprehensive enough, this new standard includes additional tests, and from 1st March 2015 completely replaces the old European standard BS EN 1836:2005. From this date, all sunglasses sold within the EU, Norway, Iceland and Liechtenstein must comply.

In addition to measurement of lens transmittance, the new standard now requires the measurement of lens coating uniformity, and the transmittance of the left and right lenses must be closely matched – these additional tests are designed to identify issues with ineffective lenses caused by poor coating quality, and potential problems with the wearer's depth perception caused by poorly matched lens pairs.

The measurement of lens transmittance is a task that can be done by most UV-Visible spectrophotometers, provided they can be equipped with a suitable sample holder capable of mounting the lenses in the sample compartment. However, the measurement of lens uniformity poses a problem because it requires measurement of multiple points on the lens, and to do this manually would be incredibly time consuming and therefore impractical. It is a task that really lends itself to an automated approach.



Agilent Technologies

For many years the Agilent Cary 60 (and its predecessor the Cary 50) have been in widespread use for measurement of sunglass transmittance according to BS EN 1836:2005 using the dedicated Cary Sunglasses measurement application. The Cary 60 is a unique instrument in the market offering a variety of benefits that stem from the fact that it uses a Xenon flash lamp source. The source and optical geometry of the spectrometer provide a very high intensity, focused beam of light, and clever electronic design enables the instrument to make measurements in ambient light conditions with the lid open without affecting the accuracy of measurement (a feature known as “room light immunity”). The combination of these features enable the user to make measurements outside of the instrument, using fibre optics to guide the beam to the sample, and this then opens up a World of possibilities for measurement automation.

To meet the requirements posed by the ISO method, a dedicated accessory was developed by PIKE Technologies (USA) specifically for use with the Cary 60. Light from the spectrometer is guided to the accessory using a fibre-optic cable with integrated collimating lens, and a mirror mounted inside the accessory deflects the beam through 90° and directs it to a detector which is mounted on a fixed stanchion. A pair of sunglasses can be mounted on a motorized stage which is capable of moving and positioning the sunglass lenses in the plane of the beam with high accuracy and precision – see Figure 1 below.

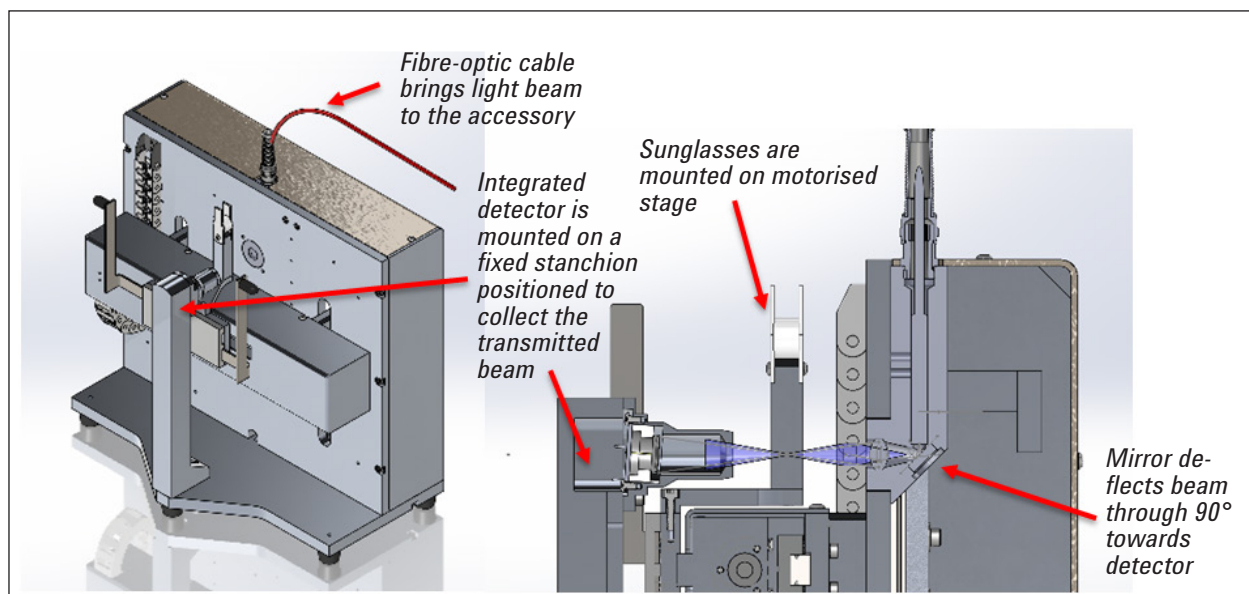


Figure 1 – Schematic of the Automated Accessory

The accessory is controlled and driven by a modified version of the Cary Sunglasses application developed by Star-Tek Pty (Australia). This program is simple to use, and retains the familiar look and feel of its predecessor, but now includes the additional features needed to enable the uniformity measurements and to report the results following the instructions laid out by ISO.

EXPERIMENTAL

First, the user must create a new “profile” corresponding to the size and shape of the sunglasses to be tested, or select an existing profile from the drop-down menu. To create a new profile, first determine the iris position of each lens using a headform (not supplied) and mark the horizontal and vertical positions on the edge of each lens or frame. Using a ruler or tape measure, the vertical size of the lens is then measured (in mm), followed by the distance from the iris to the centre of the bridge (see Figure 2), and these values are entered into the software as “Min Dimension” and “Reference Offset” respectively (see Figure 3). Next the Horizontal and Vertical sample collection separation settings are adjusted to ensure that all points to be measured for the uniformity determination lie within the inner circle as shown on the lens cartoon.

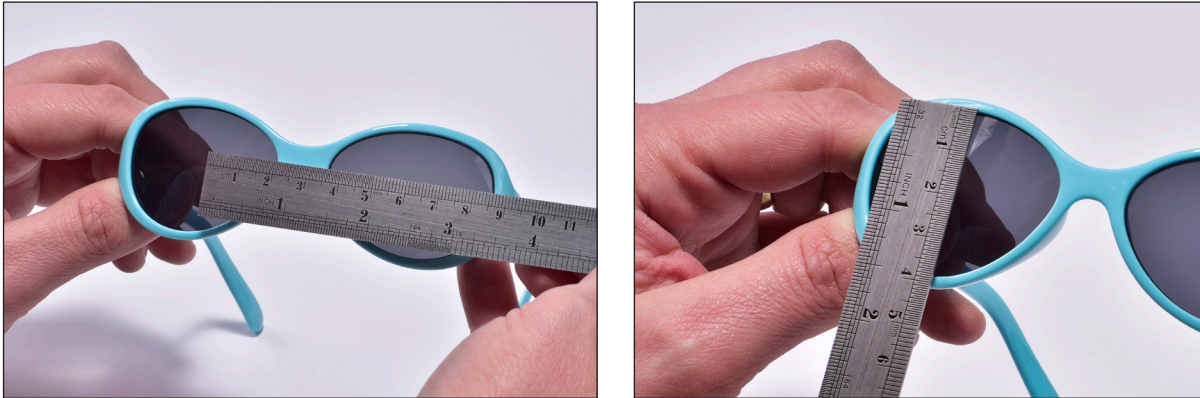


Figure 2 – Measurement of Min Dimension and Reference Offset Values

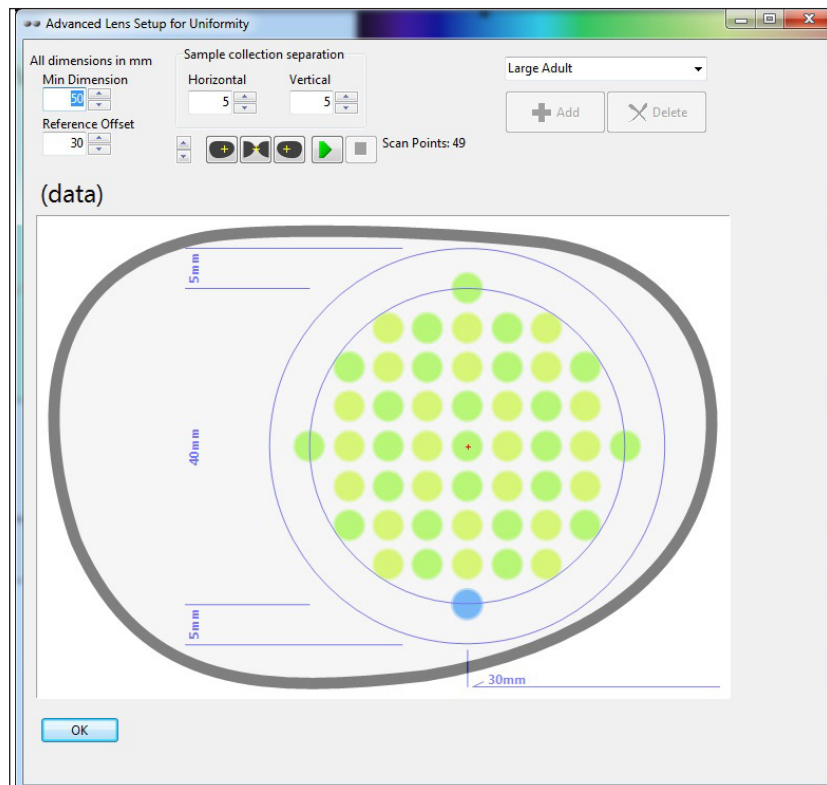


Figure 3 – Screenshot of Profile Setup Screen

Next, the sunglasses are mounted on the accessory and the variable arms adjusted to ensure that they are held firmly in place with the lenses upright and perpendicular to the plane of the light beam (see Figure 4). Setting the instrument to white light mode puts a small spot of light onto the lens and, by clicking on the uniformity measurement points, the user can drive the accessory to the selected points and check, using a piece of white card, to ensure that they all lie within the lens and that the beam is not clipping the frame at any point. Clicking the “Add” button allows the user to store the newly created profile for future use.



Figure 4 – Sunglasses Mounted on Accessory

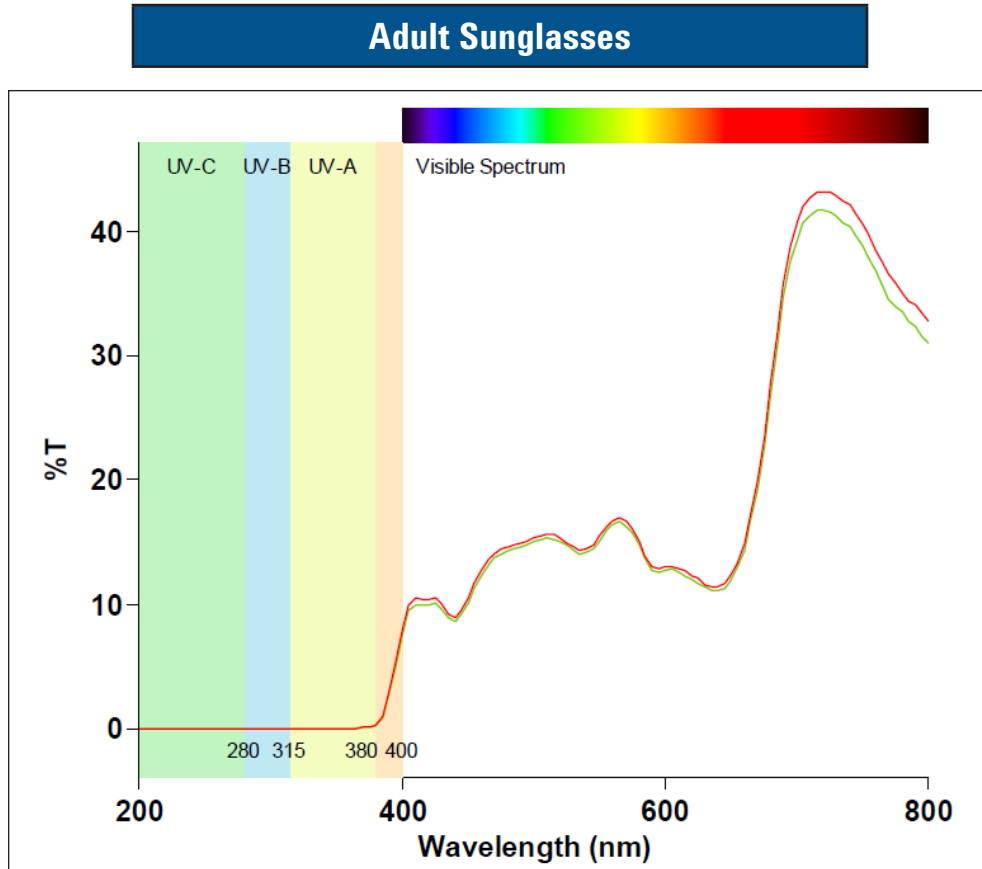
Following a baseline correction, the spectral transmittance (%T) data is collected on both lenses across the range from 800 – 200nm, using a 5nm data interval and a signal averaging time of 0.1 seconds, such that the total time per scan is around 12 seconds. Upon completion of each scan, the spectrometer automatically switches to single wavelength (555nm) mode for the uniformity measurement and systematically drives to each of the specified measurement points. The total analysis time required to scan both lenses and measure the lens uniformity depends on the size of the lens, as bigger lenses require more data points, but typically the automated measurement can be completed in less than two minutes. The setup for gradient lenses follows exactly the same overall procedure except that at the Sample Collection Separation step the Horizontal entry should remain fixed (typically at 5 or 6) and the Vertical entry should be increased until you get only a horizontal line of measurement points showing within the inner circle as shown below in Figure 5.



Figure 5 – Gradient Lens Profile

RESULTS AND DISCUSSIONS

At the end of the automated measurement, the Sunglasses software gives a full report on the sunglasses starting with the left hand lens transmission and uniformity data, and followed by the right hand lens transmission and uniformity data. At the foot of the report, the uniformity of both lenses is compared. Clear pass/fail results are reported as per the criteria set forth in the ISO12311 method. Example reports are shown here:-



Example 1 – Adult Sunglasses – Min Dimension = 35mm, Ref Offset = 26mm

Date & Time: 10/23/2015 10:27:14 AM

Filename: C:\Users\Public\Documents\Agilent\Cary WinUV\Old.BSG

Baseline Corrected: Yes

Software version: 5.2.0.1554

Instrument: Cary 60

SAT: 0.1000 s

Data Interval: 5.00 nm

Operator Name: I. C. You

Customer Details: Contract Testing Co. Ltd

Lens Data: Manufacturer: Sun Glasses Co.

Type: Adult

Optician: Seymour Clearly

Batch No: 123546

Scan Name: Adult Sunglasses [LEFT]

The following results were calculated using the methods described in the European Standard: EN ISO 12312-1:2013.

RESULTS:

Luminous Transmittance

Luminous Transmittance (Tv) 14.338%

These lenses transmit 14.338% of the visible light from the sun.

These lenses are rated filter category 3 (Dark tint)

Range: > 8% to 18%



Mean UV Transmittance

These lenses transmit:

Solar UVA (315-380 nm) 0.037%

Solar UVB (280-315 nm) 0.037%

Spectral Transmittance (315-350 nm) 0.016%

Total Solar UV (280-380 nm) 0.037%

These lenses provide adequate protection from UV radiation from the sun.

Blue Light Transmittance

These lenses transmit 11.046% of blue light (380-500 nm).

The European Standard identifies visible radiation from the blue light region as potentially hazardous.

Requirements for Road Use and Driving

Spectral Transmittance

Spectral Transmittance (475–650 nm) PASS (>2.868%)

Recognition of Signal Lights

Red Signal 0.886 PASS (≥ 0.8)

Yellow Signal 0.975 PASS (≥ 0.6)

Blue Signal 1.051 PASS (≥ 0.6)

Green Signal 1.027 PASS (≥ 0.6)

Driving in twilight or at night

Luminous Transmittance (Tv) 14.338%

These lenses are suitable for driving and road use during daylight but not suitable for driving in twilight or at night.

UNIFORMITY

Lens Variation: 15.40 to 16.06 = range: 0.65

Delta (Uniformity of luminous transmittance)= 4.07% PASS

Warning: Direct viewing of the sun is hazardous to your eyesight. Do not use these lenses to look directly at the sun.

Scan Name: Adult Sunglasses [RIGHT]

The following results were calculated using the methods described in the European Standard: EN ISO 12312-1:2013.

RESULTS:

Luminous Transmittance

Luminous Transmittance (Tv) 14.568%
These lenses transmit 14.568% of the visible light from the sun.
These lenses are rated filter category 3 (Dark tint)
Range: > 8% to 18%



Mean UV Transmittance

These lenses transmit:

Solar UVA (315-380 nm)	0.045%
Solar UVB (280-315 nm)	0.017%
Spectral Transmittance (315-350 nm)	0.020%
Total Solar UV (280-380 nm)	0.033%

These lenses provide adequate protection from UV radiation from the sun.

Blue Light Transmittance

These lenses transmit 11.372% of blue light (380-500 nm).
The European Standard identifies visible radiation from the blue light region as potentially hazardous.

Requirements for Road Use and Driving

Spectral Transmittance

Spectral Transmittance (475–650 nm) PASS (>2.914%)

Recognition of Signal Lights

Red Signal	0.888 PASS	(>= 0.8)
Yellow Signal	0.975 PASS	(>= 0.6)
Blue Signal	1.054 PASS	(>= 0.6)
Green Signal	1.027 PASS	(>= 0.6)

Driving in twilight or at night

Luminous Transmittance (Tv) 14.568%
These lenses are suitable for driving and road use during daylight but not suitable for driving in twilight or at night.

UNIFORMITY

Lens Variation: 15.63 to 16.15 = range: 0.52

Delta (Uniformity of luminous transmittance)= 3.24% PASS

First Lens "Adult Sunglasses [LEFT]" Transmittance = 14.338%

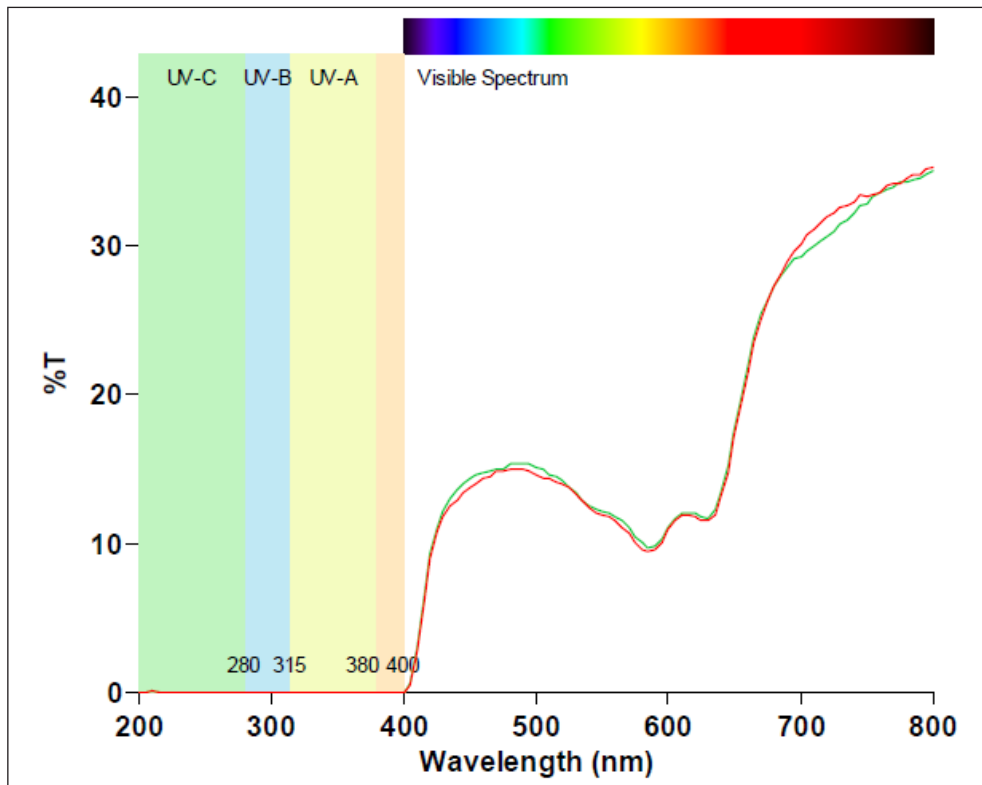
Second Lens "Adult Sunglasses [RIGHT]" Transmittance = 14.568%

Transmittance (Delta p) is within 1.580%

(<15%) PASSES requirements for the relative difference between the luminous transmittance

Warning: Direct viewing of the sun is hazardous to your eyesight. Do not use these lenses to look directly at the sun.

Children Sunglasses



Example 2 – Small Childrens Sunglasses – Min Dimension = 30mm, Ref Offset = 25mm

Date & Time: 10/23/2015 10:27:14 AM

Filename: C:\Users\Public\Documents\Agilent\Cary WinUV\BlueChildrens.BSG

Baseline Corrected: Yes

Software version: 5.2.0.1554

Instrument: Cary 60

SAT: 0.1000 s

Data Interval: 5.00 nm

Scan Name: Blue Childrens [LEFT]

The following results were calculated using the methods described in the European Standard: EN ISO 12312-1:2013.

RESULTS:

Luminous Transmittance

Luminous Transmittance (Tv) 16.113%

These lenses transmit 16.113% of the visible light from the sun.

These lenses are rated filter category 3 (Dark tint)

Range: > 8% to 18%



Mean UV Transmittance

These lenses transmit:

Solar UVA (315-380 nm) 0.019%

Solar UVB (280-315 nm) 0.012%

Spectral Transmittance (315-350 nm) 0.019%

Total Solar UV (280-380 nm) 0.018%

These lenses provide adequate protection from UV radiation from the sun.

Blue Light Transmittance

These lenses transmit 14.350% of blue light (380-500 nm).

The European Standard identifies visible radiation from the blue light region as potentially hazardous.

Requirements for Road Use and Driving

Spectral Transmittance

Spectral Transmittance (475–650 nm) PASS (>3.223%)

Recognition of Signal Lights

Red Signal 1.132 PASS (>= 0.8)

Yellow Signal 1.017 PASS (>= 0.6)

Blue Signal 1.078 PASS (>= 0.6)

Green Signal 0.995 PASS (>= 0.6)

Driving in twilight or at night

Luminous Transmittance (Tv) 16.113%

These lenses are suitable for driving and road use during daylight but not suitable for driving in twilight or at night.

UNIFORMITY

Lens Variation: 15.46 to 15.67 = range: 0.21

Delta (Uniformity of luminous transmittance)= 1.34% PASS

Warning: Direct viewing of the sun is hazardous to your eyesight. Do not use these lenses to look directly at the sun.

Scan Name: Blue Childrens [RIGHT]

The following results were calculated using the methods described in the European Standard: EN ISO 12312-1:2013.

RESULTS:

Luminous Transmittance

Luminous Transmittance (Tv) 15.021%
These lenses transmit 15.021% of the visible light from the sun.
These lenses are rated filter category 3 (Dark tint)
Range: > 8% to 18%



Mean UV Transmittance

These lenses transmit:
Solar UVA (315-380 nm) 0.011%
Solar UVB (280-315 nm) 0.005%
Spectral Transmittance (315-350 nm) 0.010%
Total Solar UV (280-380 nm) 0.009%

These lenses provide adequate protection from UV radiation from the sun.

Blue Light Transmittance

These lenses transmit 13.567% of blue light (380-500 nm).
The European Standard identifies visible radiation from the blue light region as potentially hazardous.

Requirements for Road Use and Driving

Spectral Transmittance

Spectral Transmittance (475–650 nm) PASS (>3.004%)

Recognition of Signal Lights

Red Signal	1.128 PASS	(>= 0.8)
Yellow Signal	1.015 PASS	(>= 0.6)
Blue Signal	1.083 PASS	(>= 0.6)
Green Signal	0.996 PASS	(>= 0.6)

Driving in twilight or at night

Luminous Transmittance (Tv) 15.021%
These lenses are suitable for driving and road use during daylight but not suitable for driving in twilight or at night.

UNIFORMITY

Lens Variation: 14.45 to 14.68 = range: 0.22

Delta (Uniformity of luminous transmittance)= 1.51% PASS

First Lens "Adult Sunglasses [LEFT]" Transmittance = 16.113%

Second Lens "Adult Sunglasses [RIGHT]" Transmittance = 15.021%

Transmittance (Delta p) is within 6.773%

(<15%) PASSES requirements for the relative difference between the luminous transmittance

Warning: Direct viewing of the sun is hazardous to your eyesight. Do not use these lenses to look directly at the sun.

CONCLUSIONS

This report clearly shows that the Agilent Cary 60 equipped with automated sunglass scanning accessory and software provides a complete, integrated solution capable of rapid, accurate measurement of the transmission and uniformity characteristics of sunglasses according to the requirements of BS EN ISO12312-1.

Sunglasses in a wide variety of different shapes, sizes and styles, can all be measured using this accessory, without the need to remove the lenses from the frame. Typical measurement time is less than two minutes and a comprehensive test report is produced for each pair.

REFERENCES

1. BS EN ISO 12311, "Personal protective equipment — Test methods for sunglasses and related equipment", 2013.
2. BS EN ISO 12312-1, "Eye and face protection — Sunglasses and related eyewear", 2013



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