

Agilent Cary 5000 UV-Vis-NIR Spectrophotometer

Complete English Technical Compendium — independently prepared reference document

Scope. This document consolidates technical information relevant to the Agilent Cary 5000 UV-Vis-NIR spectrophotometer from manufacturer literature and application-oriented technical documentation. It is an independently prepared technical compendium and is not an Agilent-issued brochure or a reproduction of copyrighted documents.

1. Instrument Overview

The Cary 5000 is a high-performance double-beam UV-Vis-NIR spectrophotometer designed for measurements extending from the ultraviolet through the near-infrared region. Its broad spectral range makes it suitable for conventional absorbance and transmission measurements as well as demanding optical-material applications involving reflectance, coatings, films, photovoltaic devices, filters, glass and other advanced materials.

A major characteristic of the Cary 5000 platform is its emphasis on optical measurements beyond the conventional UV-Vis range. The instrument architecture supports high-resolution work in the UV-Vis region while providing dedicated NIR detection and optical performance for measurements extending to 3300 nm.

2. Core Technical Specifications

Parameter	Cary 5000
Instrument type	Double-beam UV-Vis-NIR spectrophotometer
Spectral range	175–3300 nm
Photometric range	Up to 8 Abs
Spectral bandwidth — UV-Vis	0.01–5.00 nm
Spectral bandwidth — NIR	0.04–20 nm
Maximum scan speed — UV-Vis	Up to 2000 nm/min
Maximum scan speed — NIR	Up to 8000 nm/min
NIR detector	PbSmart detector technology
UV/Vis source	Deuterium arc and tungsten halogen lamp architecture
Monochromator	Double Littrow monochromator
Optical design	High-performance double-beam optical system
Sample compartment	Large sample compartment supporting a broad range of accessories
Software	Cary WinUV software environment
Gas purge	Separate sample-compartment and monochromator purge capability

The exact performance achieved in an application depends on spectral bandwidth, scan parameters, optical accessory, sample geometry, detector configuration and measurement conditions. Specifications should therefore be interpreted together with the selected measurement configuration.

3. Optical Architecture and Measurement Concept

The Cary 5000 uses a double-beam configuration to compare the sample and reference optical paths. This architecture helps compensate for temporal changes in source intensity and supports stable quantitative measurements across a broad wavelength range.

The instrument uses a double Littrow monochromator architecture. The optical system is designed to provide the resolution and wavelength coverage required for measurements ranging from the deep UV through the NIR. Schwarzschild optical elements are used in the optical design to support efficient collection and handling of radiation in relevant spectral regions.

For demanding NIR measurements, detector and optical configuration become especially important. The Cary 5000 uses PbSmart NIR detector technology and is designed to address stray-light and detector-response considerations that can affect measurements at longer wavelengths.

4. Spectral Coverage and Resolution Strategy

The 175–3300 nm range places the Cary 5000 in a class of instruments intended not only for routine UV-Vis absorbance but also for NIR spectroscopy and optical characterization. In the UV-Vis region, narrow spectral bandwidth settings can be selected for high-resolution measurements, while broader bandwidth settings can be used where speed and signal level are more important.

In the NIR region, the available bandwidth range is wider because detector sensitivity, source characteristics and the nature of broad molecular overtone and combination bands differ from the requirements of conventional UV-Vis spectroscopy.

The maximum scan rates are configuration- and method-dependent. The stated limits of up to 2000 nm/min in UV-Vis and 8000 nm/min in NIR should be regarded as instrument capability figures rather than universal recommended method settings.

5. Photometric Performance and Stray-Light Considerations

A wide photometric range is important when a single instrument must measure both relatively transparent materials and strongly absorbing samples. The Cary 5000 provides a photometric range extending to approximately 8 Abs under specified conditions.

Stray light becomes increasingly important when measurements approach high absorbance or when samples contain strong spectral features. In the NIR, filter selection, spectral bandwidth, optical path length and detector characteristics can all influence the effective stray-light behavior of a measurement.

For thin films, optical coatings and other materials where small differences in transmission or reflectance are analytically meaningful, accessory alignment and sample geometry can be as important as the base spectrophotometer specification.

6. Sample Compartment and Accessory Ecosystem

The large Cary sample compartment is designed to accommodate a broad family of accessories. This modular approach allows the same spectrophotometer platform to be configured for liquids, solids, films, optical components, reflectance measurements and fiber-optic applications.

Important accessory families include solid-transmission holders, specular-reflectance accessories, diffuse-reflectance assemblies, integrating-sphere systems, liquid-sample holders, fiber-optic interfaces and specialized material-characterization accessories.

For optical materials, the Universal Measurement Accessory (UMA) can extend the instrument toward measurements such as transmission, absolute reflectance, variable-angle measurements and polarization-related characterization, depending on the configuration.

7. DRA and Diffuse-Reflectance Measurements

Diffuse reflectance is relevant to powders, rough surfaces, ceramics, pigments, coatings, catalysts and other materials where conventional transmission geometry is not appropriate. Cary 5000 configurations can be combined with integrating-sphere and diffuse-reflectance accessories to characterize the optical response of such samples.

The DRA family is particularly relevant when measurements require collection of reflected radiation over a defined geometry. Accessory selection should consider sample dimensions, reflectance level, wavelength range, angular requirements and whether the objective is relative or absolute reflectance.

8. UMA for Advanced Optical Materials

The Universal Measurement Accessory is intended for demanding optical characterization where the sample cannot be treated as a conventional liquid or cuvette sample. Depending on configuration, UMA-based measurements can include transmission, specular or absolute reflectance, variable-angle measurements and polarization studies.

Typical targets include optical coatings, thin films, glass, filters, semiconductor-related materials and other engineered surfaces. Measurement quality depends strongly on optical alignment, sample flatness, surface condition and correct accessory configuration.

9. Photovoltaic and Solar-Cell Characterization

The Cary 5000 is suitable for optical characterization of photovoltaic materials and solar-cell structures when combined with appropriate reflectance and transmission accessories. Measurements can include spectral reflectance and transmission across the UV-Vis-NIR region, allowing the optical response of photovoltaic structures to be examined over a broad wavelength interval.

An external DRA-2500 configuration and small-spot accessories have been documented for photovoltaic-cell measurements. Such configurations are useful when the active region is spatially limited or when the measurement requires a defined illumination and collection geometry.

10. Thin Films, Coatings and Optical Components

For thin films and coatings, spectral transmission and reflectance can be used to investigate interference structures, optical attenuation and wavelength-dependent behavior. With appropriate modeling and accessory geometry, measured spectra can support evaluation of coating and multilayer structures.

The Cary 5000 is also applicable to filters, windows, optical substrates and other components where transmission or reflectance must be characterized over UV, visible and NIR wavelengths.

11. Building Materials and Solar Optical Properties

UV-Vis-NIR measurements can be used to characterize the solar optical behavior of building materials such as glazing, coated surfaces and other construction materials. Relevant parameters can include spectral transmittance, spectral reflectance and, where the measurement method supports it, derived solar or thermal characteristics.

For these applications, the broad wavelength range of Cary 5000 is valuable because a material's interaction with solar radiation cannot always be represented adequately by visible wavelengths alone.

12. NIR Measurements and PbSmart Detection

The NIR region presents different detector, source and optical challenges compared with conventional UV-Vis measurements. Cary 5000 uses PbSmart detector technology for NIR measurements and extends coverage to 3300 nm.

When working in the NIR, users should evaluate spectral bandwidth, scan speed, path length, sample absorbance and detector response together. High absorbance, strong water features and optical interference can all influence the measured spectrum.

13. Gas Purging and Atmospheric Absorption

Long-wavelength measurements can be affected by atmospheric absorption, especially from water vapor and carbon dioxide. The Cary 5000 provides purge capability for the sample compartment and monochromator so that controlled gas

conditions can be used when the application requires reduced atmospheric interference.

Purge requirements depend on the wavelength interval, optical path length, measurement sensitivity and environmental conditions. For demanding NIR work, controlled purge conditions can improve spectral quality and reproducibility.

14. Cary WinUV Software Environment

Cary WinUV provides the software environment used with Cary UV-Vis-NIR systems for instrument control and measurement workflows. Depending on the installed modules, workflows can cover spectrum acquisition, photometric measurements, quantitative analysis, kinetics and other application-specific functions.

Method development should preserve the relationship between wavelength range, bandwidth, scan speed, baseline procedure, sample geometry and accessory configuration. For regulated laboratories, software configuration and data-management practices should be evaluated against the laboratory's applicable quality requirements.

15. Measurement Modes and Typical Applications

Parameter	Cary 5000
Absorbance / transmission	Liquids, films, filters, glass, optical components
Specular reflectance	Mirrors, coatings, polished surfaces, optical materials
Diffuse reflectance	Powders, pigments, ceramics, rough and opaque materials
Absolute reflectance	Optical materials and calibrated reflectance measurements with appropriate accessory
Variable-angle measurements	Thin films, coatings and optical surfaces with suitable accessory
NIR spectroscopy	Materials characterization and broad-band optical response
Photovoltaic characterization	Solar-cell transmission/reflectance and optical response
Building-material characterization	Solar transmission, reflectance and related optical properties
Fiber-optic measurements	Remote or geometrically constrained optical measurements with compatible interfaces

16. Practical Configuration Matrix

Parameter	Cary 5000
Routine liquid UV-Vis	Standard sample holder / cuvette configuration
Low-transmission solids	Solid-transmission accessory selected for sample geometry
Thin films	Transmission or reflectance accessory; UMA may be appropriate
Coatings	Specular reflectance, transmission or variable-angle configuration
Powders	Diffuse-reflectance / integrating-sphere configuration
Photovoltaic cells	External DRA and/or small-spot configuration where appropriate
Optical filters	Transmission and reflectance accessories according to geometry
Glass and glazing	Transmission/reflectance configuration covering required solar range
Advanced optical materials	UMA or integrating-sphere system according to measurement objective

17. Method-Development Checklist

- Define the required wavelength range before selecting the accessory and detector configuration.
- Select spectral bandwidth according to the width of the spectral feature being measured.

- Use a suitable path length; strongly absorbing samples may require shorter optical paths.
- For NIR work, evaluate atmospheric absorption and determine whether purge is required.
- Match the accessory geometry to the physical dimensions and surface characteristics of the sample.
- For reflectance measurements, distinguish between specular and diffuse components.
- For thin films, document sample orientation, surface condition and incidence geometry.
- For photovoltaic samples, ensure that the measured area represents the intended device region.
- Use baseline and reference procedures appropriate to the selected accessory.
- Record instrument configuration, accessory, bandwidth, scan speed and sample geometry as part of the analytical method.

18. Technical Reference Summary

The information consolidated in this compendium is based on publicly available Agilent literature associated with the Cary 5000 and the Cary UV-Vis-NIR accessory ecosystem. Key source categories include the Cary 4000/5000/6000i brochure, Cary UV-Vis-NIR accessory selection documentation, Cary 5000 application notes, technical overviews covering NIR resolution and stray light, UMA documentation, photovoltaic optical-property applications and building-material characterization.

This compendium intentionally summarizes technical information rather than reproducing any original manufacturer document. It should be used as a technical reference and not as a substitute for the latest official specification sheet when a contractual or regulated specification is required.

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