

## ISO 21348 Definitions of Solar Irradiance Spectral Categories

| Spectral category      | Spectral sub-category                              | Wavelength range (nm)                                    | Wavelength range (SI pre-fixes from Table 2)         | Notes   |
|------------------------|--|--|--|---|
| Total Solar Irradiance |  |  |  | full-disk, 1 ua solar irradiance integrated across all wavelengths        |
| Gamma-rays             |  | $0.00001 \leq \lambda < 0.001$                           | $10 \text{ fm} \leq \lambda < 1 \text{ pm}$          |   |
| X-rays                 |  | $0.001 \leq \lambda < 0.1$                               | $1 \text{ pm} \leq \lambda < 0.10 \text{ nm}$        | Hard X-rays   |
|                        | XUV  | $0.1 \leq \lambda < 10$                                  | $0.10 \text{ nm} \leq \lambda < 10 \text{ nm}$       | Soft X-rays   |
| Ultraviolet            | UV   | $100 \leq \lambda < 400$                                 | $100 \text{ nm} \leq \lambda < 400 \text{ nm}$       | Ultraviolet   |
|                        | VUV  | $10 \leq \lambda < 200$                                  | $10 \text{ nm} \leq \lambda < 200 \text{ nm}$        | Vacuum Ultraviolet  |
|                        | EUV  | $10 \leq \lambda < 121$                                  | $10 \text{ nm} \leq \lambda < 121 \text{ nm}$        | Extreme Ultraviolet   |
|                        | H Lyman- $\alpha$                                  | $121 \leq \lambda < 122$                                 | $121 \text{ nm} \leq \lambda < 122 \text{ nm}$       | Hydrogen Lyman-alpha  |
|                        | FUV  | $122 \leq \lambda < 200$                                 | $122 \text{ nm} \leq \lambda < 200 \text{ nm}$       | Far Ultraviolet   |
|                        | UVC  | $100 \leq \lambda < 280$                                 | $100 \text{ nm} \leq \lambda < 280 \text{ nm}$       | Ultraviolet C   |
|                        | MUV  | $200 \leq \lambda < 300$                                 | $200 \text{ nm} \leq \lambda < 300 \text{ nm}$       | Middle Ultraviolet  |
|                        | UVB  | $280 \leq \lambda < 315$                                 | $280 \text{ nm} \leq \lambda < 315 \text{ nm}$       | Ultraviolet B   |
|                        | NUV  | $300 \leq \lambda < 400$                                 | $300 \text{ nm} \leq \lambda < 400 \text{ nm}$       | Near Ultraviolet  |
|                        | UVA  | $315 \leq \lambda < 400$                                 | $315 \text{ nm} \leq \lambda < 400 \text{ nm}$       | Ultraviolet A   |
| Visible                | VIS  | $380 \leq \lambda < 760$                                 | $380 \text{ nm} \leq \lambda < 760 \text{ nm}$       | optical   |
|                        |  | $360 \leq \lambda < 450$                                 | $360 \text{ nm} \leq \lambda < 450 \text{ nm}$       | purple  |
|                        |  | $450 \leq \lambda < 500$                                 | $450 \text{ nm} \leq \lambda < 500 \text{ nm}$       | blue  |
|                        |  | $500 \leq \lambda < 570$                                 | $500 \text{ nm} \leq \lambda < 570 \text{ nm}$       | green   |
|                        |  | $570 \leq \lambda < 591$                                 | $570 \text{ nm} \leq \lambda < 591 \text{ nm}$       | yellow  |
|                        |  | $591 \leq \lambda < 610$                                 | $591 \text{ nm} \leq \lambda < 610 \text{ nm}$       | orange  |
|                        |  | $610 \leq \lambda < 760$                                 | $610 \text{ nm} \leq \lambda < 760 \text{ nm}$       | red   |
| Infrared               | IR   | $760 \leq \lambda < 1\ 000\ 000$                         | $760 \text{ nm} \leq \lambda < 1.00 \text{ mm}$      |   |
|                        | IR-A   | $760 \leq \lambda < 1400$                                | $760 \text{ nm} \leq \lambda < 140 \text{ mm}$       | Near Infrared   |
|                        | IR-B   | $1400 \leq \lambda < 3000$                               | $140 \text{ mm} \leq \lambda < 300 \text{ mm}$       | Middle Infrared   |
|                        | IR-C   | $3000 \leq \lambda < 1\ 000\ 000$                        | $3.00 \text{ mm} \leq \lambda < 1.00 \text{ mm}$     | Far infrared  |
| Microwave              |  | $1\ 000\ 000 \leq \lambda < 15\ 000\ 000$                | $1.00 \text{ mm} \leq \lambda < 15.00 \text{ mm}$    |   |
|                        | W  | $3.00 \times 10^6 \leq \lambda < 5.35 \times 10^6$       | $3.00 \text{ mm} \leq \lambda < 5.35 \text{ mm}$     | $(100.0 \geq \nu > 56.0) \text{ GHz}$                                     |
|                        | V  | $5.35 \times 10^6 \leq \lambda < 6.52 \times 10^6$       | $5.35 \text{ mm} \leq \lambda < 6.52 \text{ mm}$     | $(56.0 \geq \nu > 46.0) \text{ GHz}$                                      |
|                        | Q  | $6.52 \times 10^6 \leq \lambda < 8.33 \times 10^6$       | $6.52 \text{ mm} \leq \lambda < 8.33 \text{ mm}$     | $(46.0 \geq \nu > 36.0) \text{ GHz}$                                      |
|                        | K  | $8.33 \times 10^6 \leq \lambda < 2.75 \times 10^7$       | $8.33 \text{ mm} \leq \lambda < 27.5 \text{ mm}$     | $(36.00 \geq \nu > 10.90) \text{ GHz}$                                    |
|                        | X  | $2.75 \times 10^7 \leq \lambda < 5.77 \times 10^7$       | $27.50 \text{ mm} \leq \lambda < 57.70 \text{ mm}$   | $(10.90 \geq \nu > 5.20) \text{ GHz}$                                     |
|                        | C  | $4.84 \times 10^7 \leq \lambda < 7.69 \times 10^7$       | $48.40 \text{ mm} \leq \lambda < 76.90 \text{ mm}$   | $(6.20 \geq \nu > 3.90) \text{ GHz}$                                      |
|                        | S  | $5.77 \times 10^7 \leq \lambda < 1.93 \times 10^8$       | $57.70 \text{ mm} \leq \lambda < 193.00 \text{ mm}$  | $(5.20 \geq \nu > 1.55) \text{ GHz}$                                      |
|                        | L  | $1.93 \times 10^8 \leq \lambda < 7.69 \times 10^8$       | $193.00 \text{ mm} \leq \lambda < 769.00 \text{ mm}$ | $(1.550 \geq \nu > 0.390) \text{ GHz}$                                    |
| P                      | $7.69 \times 10^8 \leq \lambda < 1.33 \times 10^9$ | $769.00 \text{ mm} \leq \lambda < 1.33 \text{ m}$        | $(0.390 \geq \nu > 0.225) \text{ GHz}$               |   |
| Radio                  |  | $100\ 000 \leq \lambda < 100\ 000\ 000\ 000$             | $0.10 \text{ mm} \leq \lambda < 100 \text{ m}$       | measurements: $(1\ 000\ 000 \leq \lambda < 10\ 000\ 000\ 000) \text{ nm}$ |
|                        | EHF  | $1.00 \times 10^6 \leq \lambda < 1.00 \times 10^7$       | $1.00 \text{ mm} \leq \lambda < 10.00 \text{ mm}$    | Extremely High Frequency $(300 \geq \nu > 30) \text{ GHz}$                |
|                        | SHF  | $1.00 \times 10^7 \leq \lambda < 1.00 \times 10^8$       | $10.00 \text{ mm} \leq \lambda < 100.00 \text{ mm}$  | Super-High Frequency $(30 \geq \nu > 3) \text{ GHz}$                      |
|                        | UHF  | $1.00 \times 10^8 \leq \lambda < 1.00 \times 10^9$       | $100.00 \text{ mm} \leq \lambda < 1.00 \text{ m}$    | Ultra-High Frequency $(3000 \geq \nu > 300) \text{ MHz}$                  |
|                        | VHF  | $1.00 \times 10^9 \leq \lambda < 1.00 \times 10^{10}$    | $1.00 \text{ m} \leq \lambda < 10.00 \text{ m}$      | Very-High Frequency $(300 \geq \nu > 30) \text{ MHz}$                     |
|                        | HF   | $1.00 \times 10^{10} \leq \lambda < 1.00 \times 10^{11}$ | $10.00 \text{ m} \leq \lambda < 100.00 \text{ m}$    | High Frequency $(30 \geq \nu > 3) \text{ MHz}$                            |

### ISO 21348 Process for Determining Solar Irradiances Compliance Criteria

#### Rationale

The compliance criteria for this standard consist of activities that are common to solar irradiance product types (section 5) and solar irradiance spectral categories (section 6). These criteria specify a compliance process for the determination of solar irradiances that includes the reporting, documenting, publishing, and archiving of solar irradiance products.

## Reporting

Solar irradiances shall be reported in SI units,  $W m^{-2}$  and solar spectral irradiances shall be reported in SI units,  $W m^{-3}$ . The conversion to other appropriate conventional units such as  $W m^{-2} nm^{-1}$  can be additionally applied. The reported irradiances shall be described as to whether or not they are corrected to 1 ua. It is recommended, though not required, that reported irradiances are corrected to 1 ua. If applicable, the wavelength bins (spectral sampling) and spectral resolution (bandpass) shall be reported for solar irradiance products.

## Documenting

The method of determining solar irradiances shall be documented and, as appropriate, shall include data collection, retrieval, processing, calibration, validation, verification, accuracy, and precision methodology and/or algorithms, as well as archiving information.

**Measurements.** For measurements, including spacecraft observations, rocket experiment data sets, and ground-based observations (including balloons), a description of the responsible agent or institution and the instrumentation used to collect and retrieve the irradiances shall be provided. The data processing algorithms, the instrument calibration techniques and heritage, the method of determining accuracy and precision, the validation and verification methodology, as well as the archival processes shall be documented.

**Reference spectra.** For reference spectra, including the mean of spectra over several solar cycles or spectra for a variety of solar activity conditions, the rationale for specifying a spectrum as a reference shall be described. The measurement set(s) used to derive the reference spectrum, the method of resolving discrepancies between multiple data sets, the data processing algorithms, the method of determining accuracy and precision, the validation and verification methodology, as well as the archival processes shall be documented.

**Empirical models.** For empirical models, including those based on one or many space- or ground-based measurement sets, or for hybrid models, a description of the rationale for developing the model, its areas of application, and the rationale for selecting proxies shall be described. The measurement data sets used in the derivation, the mathematical formulation of the model, the method of resolving discrepancies between multiple data sets, the derivation algorithms, the method of determining accuracy and precision, the validation and verification methodology, as well as the archival processes shall be documented.

**Theoretical models.** For theoretical or first-principles models of solar processes, a description of the physical principles that are used as the basis of the model, the rationale for developing the model, and its areas of application shall be described. The numerical algorithms that produce solar irradiances, the mathematical formulation of the model, the method of determining accuracy and precision, the validation and verification methodology, as well as the archival processes shall be documented.

**Solar irradiance proxies.** For solar irradiance proxies, a description of the rationale for developing the proxy and its areas of application shall be described. Where appropriate, the data sets used in the derivation, the mathematical formulation of the proxy, the method of resolving discrepancies between multiple data sets, the derivation algorithms, the method of determining accuracy and precision, the validation and verification methodology, as well as the archival processes shall be documented.

## Publishing

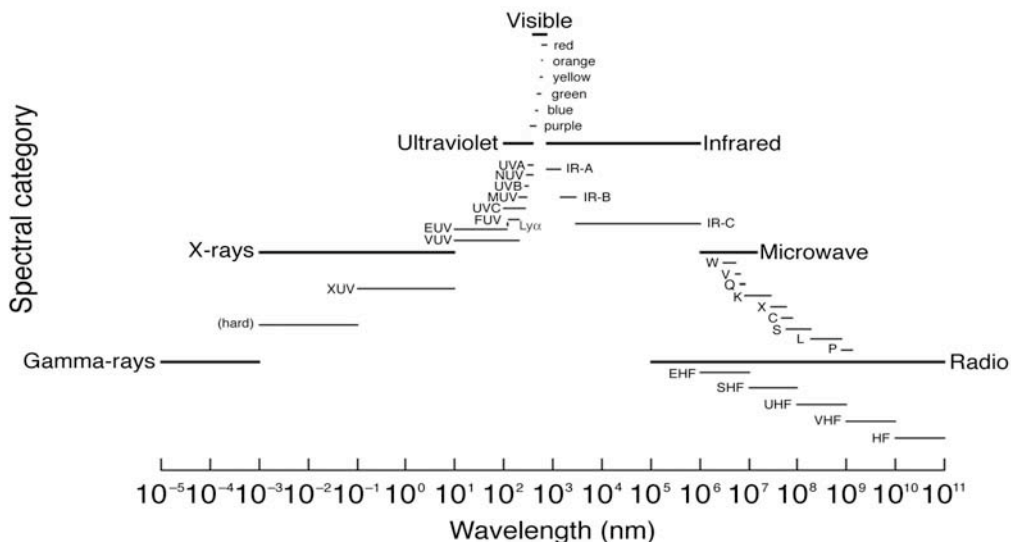
The documented solar irradiance product shall be published in an internationally-accessible journal which uses scientific or discipline-area peer review in the publication process. For any irradiance product, the published article may point to a permanent electronic archival location where the archived measurements, spectra, models, or proxies can be found, accessed, or recreated by an international community.

## Archiving

The documented and published solar irradiance product shall be archived in a method consistent with any contemporary technology that ensures long-term international accessibility.

## Certification

Certification of compliance with this standard shall be achieved by complying with the criteria listed in section 7. Self-declaration of compliance in an archival publication as part of section 7.4 can be accomplished by using the statement “The process used for determining solar irradiances reported herein is compliant with ISO International Standard 21348: Space Environment (Natural and Artificial) – Process for determining solar irradiances.” The type designation (section 5) and the solar irradiance spectral category (section 6) shall be identified along with the self-declaration of compliance.



**Solar irradiance spectral categories from gamma-rays through radio wavelengths.**