ISO/TR 9241-313:2025-07 (E)

Ergonomics of human-system interaction - Part 313: Optical measurement methods for reflective displays

Contents

Page

Foreword v

Introduction vi

1 Scope 1

2 Normative references 1

3 Terms, definitions and abbreviated terms 1
3.1 Terms and definitions 1
3.2 Abbreviated terms 3

4 Reflective display technology 3

5 General optical measurement methodology 4
5.1 Spectral radiance of display in ambient illumination 4
5.2 General concept of ambient illumination 5
5.2.1 Outdoor ambient illumination 7
5.2.2 Indoor ambient illumination 7
5.3 Theory of reflected spectral radiance of display in ambient illumination 8
5.4 Components of spectral radiance reflected by the display 10
5.4.1 General concept of reflection in paper, emissive displays and reflective displays 10
5.4.2 Coordinate system for illumination and viewing direction 11
5.4.3 Bi-directional reflection distribution function (BRDF) of the display 12
5.4.4 Reflection measurement geometries 14

6 Measurement methods for display reflection 16
6.1 General 16
6.2 Definitions and symbols 16
6.3 Calibration standards and measurement samples 17
6.3.1 Diffuse white reflectance standard 17
6.3.2 Specular reflectance standard 17
6.3.3 Diagnostic reflection samples 18
6.3.4 Reflective display samples 18
6.4 Measurement methods and examples of bi-directional reflection distribution function (BRDF) 18
6.4.1 General 18
6.4.2 Imaging sphere 19
6.4.3 Reflection conoscope 24
6.4.4 Gonioreflectometer 26
6.4.5 Conclusions of bi-directional reflection distribution function (BRDF) measurements 32
6.5 Measuring specular reflectance under illumination from a variable aperture source 33
6.5.1 General concept of variable aperture source 33
6.5.2 Theory of the extended source as superposition of point sources 34
6.5.3 Theory of separating specular and diffuse reflection using a variable aperture source (VAS) 36
6.5.4 Theory of separating the haze reflection using an annulus source 38
6.5.5 Measurement methodology of variable aperture source reflection 41
6.5.6 Measuring variable aperture source reflection of diagnostic reflection samples 44
6.5.7 Measuring variable aperture source reflection of EPDs 48
6.5.8 Separating the specular and diffuse reflection components 54

6.5.9 Estimating the source-size dependence of haze ... 56
6.5.10 Conclusions of reflection measurements using variable aperture and annulus sources ... 64
6.6 Measuring off-specular reflectance under directional illumination ... 65
6.6.1 Reflectance under directional illumination ... 65
6.6.2 Viewing direction dependence of reflectance under directional illumination ... 65
6.7 Measuring reflectance under hemispherical-diffuse illumination ... 67
6.7.1 Reflectance under hemispherical-diffuse illumination ... 67
6.7.2 Viewing direction dependence of reflectance under hemispherical-diffuse illumination ... 69
6.8 Measuring reflectance under off-specular directional and hemispherical-diffuse illumination ... 73
6.8.1 General ... 73
6.8.2 Deriving photometric parameters from measured spectral distributions ... 73
6.8.3 Reflectance and contrast ratio (CR) of electrophoretic displays (EPDs) ... 74

7 Prediction of display contrast in ambient illumination ... 77
7.1 Components of reflected spectral radiance ... 77
7.2 Prediction of display contrast ... 78
7.2.1 Display contrast under ambient illumination without unwanted reflection ... 78
7.2.2 Display contrast under ambient illumination in the presence of unwanted reflection ... 83

8 Conclusions ... 88

Bibliography ... 89