

Table of contents

- European foreword 12**
- Introduction 13**
- 1 Scope 14**
- 2 Normative references..... 15**
- 3 Terms, definitions and abbreviated terms 17**
 - 3.1 Terms from other standards 17
 - 3.2 Terms specific to the present standard..... 17
 - 3.3 Abbreviated terms 22
 - 3.4 Nomenclature..... 25
- 4 General..... 26**
 - 4.1 Overview 26
 - 4.1.1 Objective and organization 26
 - 4.1.2 Interfaces with other areas..... 28
 - 4.2 Physical properties 29
 - 4.3 Test and storage 29
 - 4.3.1 Test environment..... 29
 - 4.3.2 Test tolerances and accuracies 30
 - 4.3.3 <<deleted>> 31
 - 4.4 Critical materials..... 31
- 5 Photovoltaic assemblies 32**
 - 5.1 Overview 32
 - 5.1.1 Description..... 32
 - 5.1.2 Purpose and objective 32
 - 5.2 Conditions and method of test..... 33
 - 5.3 Photovoltaic assembly design 34
 - 5.3.1 Overview 34
 - 5.3.2 Parameters related to parts, materials and processes (PMP) 34
 - 5.3.3 Parameters related to design..... 35

5.4	PVA manufacturing	39
5.4.1	Process validation.....	39
5.4.2	Defect acceptability.....	39
5.4.3	In-process testing	39
5.4.4	Identification and traceability.....	41
5.4.5	Recording	41
5.5	PVA tests	41
5.5.1	Qualification tests	41
5.5.2	Acceptance tests for qualification coupons	50
5.5.3	Definition of tests and checks	51
5.6	Failure definition	62
5.6.1	Failure criteria.....	62
5.6.2	Failed qualification coupons.....	63
5.7	Data documentation	63
5.8	Delivery	63
5.9	Packaging, packing, handling and storage	63
6	Solar cell assemblies	64
6.1	General	64
6.1.1	Testing.....	64
6.1.2	Conditions and methods of test.....	64
6.1.3	Deliverable components	64
6.1.4	Identification and traceability.....	64
6.2	Production control (process identification document).....	65
6.3	Acceptance tests	65
6.3.1	General.....	65
6.3.2	Test methods and conditions	65
6.3.3	Electrical performance acceptance test (EPA).....	66
6.4	Qualification tests	66
6.4.1	General.....	66
6.4.2	Qualification.....	68
6.4.3	Test methods, conditions and measurements.....	69
6.5	Failure definition	85
6.5.1	Failure criteria.....	85
6.5.2	Failed SCAs.....	85
6.6	Data documentation	85
6.7	Delivery	85
6.8	Packing, dispatching, handling and storage.....	86

6.8.1	Overview	86
6.8.2	ESD Sensitivity	86
7	Bare solar cells.....	87
7.1	Testing, deliverable components and marking.....	87
7.1.1	Testing.....	87
7.1.2	Deliverable components	88
7.1.3	Marking.....	88
7.2	Production control (process identification document).....	88
7.3	Acceptance tests	89
7.3.1	General.....	89
7.3.2	Test methods and conditions	89
7.3.3	Documentation	90
7.4	Qualification tests	90
7.4.1	General.....	90
7.4.2	Qualification.....	92
7.5	Test methods, conditions and measurements	93
7.5.1	Visual inspection including ELM (VI).....	93
7.5.2	Dimensions and weight (DW).....	95
7.5.3	Electrical performance (EP).....	96
7.5.4	Temperature coefficients (TC)	96
7.5.5	Spectral response (SR).....	97
7.5.6	Optical properties (OP)	98
7.5.7	Humidity and temperature (HT).....	98
7.5.8	Coating adherence (CA)	100
7.5.9	Contact uniformity (CU)	100
7.5.10	Contact thickness (CT)	101
7.5.11	Surface finish (SF).....	101
7.5.12	Pull test (PT).....	101
7.5.13	Electron irradiation (EI)	102
7.5.14	Proton irradiation (PI).....	103
7.5.15	Photon irradiation and temperature annealing (PH)	105
7.5.16	Solar cell reverse bias test (RB).....	105
7.5.17	Thermal cycling (CY)	106
7.5.18	Active-passive interface evaluation test (IF).....	106
7.5.19	Flatness test (FT).....	106
7.6	Failure definition	107
7.6.1	Failure criteria.....	107

7.6.2	Failed components	107
7.7	Data documentation	107
7.8	Delivery	108
7.9	Packing, dispatching, handling and storage.....	108
7.9.1	Overview	108
7.9.2	ESD Sensitivity	108
8	Coverglasses	109
8.1	Overview	109
8.1.1	Purpose	109
8.1.2	Description.....	109
8.2	Interfaces	109
8.3	Testing, deliverable components and marking.....	109
8.3.1	Testing.....	109
8.3.2	Deliverable components	110
8.3.3	Marking (coating orientation)	110
8.4	Production control (Process identification document)	111
8.5	Acceptance test.....	111
8.5.1	Acceptance test samples	111
8.5.2	Acceptance test sequence	111
8.5.3	Test methods and conditions	112
8.5.4	Documentation	112
8.6	Qualification tests	112
8.6.1	General.....	112
8.6.2	Qualification.....	113
8.7	Test methods, conditions and measurements	115
8.7.1	Visual inspection (VI).....	115
8.7.2	Transmission into air (TA).....	116
8.7.3	Electro-optical properties (EO).....	117
8.7.4	Mechanical properties (MP)	117
8.7.5	Reflectance properties (OP)	118
8.7.6	Normal emittance (NE)	119
8.7.7	Surface resistivity (SC)	119
8.7.8	Flatness or bow (FT).....	120
8.7.9	Transmission into adhesive (TH)	120
8.7.10	Boiling water test (BW)	121
8.7.11	Humidity and temperature.....	121
8.7.12	UV exposure (UV).....	122

8.7.13	Electron irradiation (EI)	122
8.7.14	Proton irradiation (PI)	123
8.7.15	Breaking strength (BS)	123
8.7.16	Thermal cycling (CY)	123
8.7.17	Abrasion resistance (coated surface) (AE)	124
8.7.18	Coating adhesion (TD)	124
8.8	Failure definition	124
8.8.1	Failure criteria	124
8.8.2	Failed components	124
8.9	Data documentation	125
8.10	Delivery	125
8.11	Packing, dispatching, handling and storage	125
9	Solar cell protection diodes	126
9.1	Overview	126
9.2	Testing, deliverable components and marking	126
9.2.1	Testing	126
9.2.2	Deliverable components	127
9.2.3	Marking	128
9.3	Production control (process identification document)	128
9.3.1	Integral protection diodes	128
9.3.2	External protection diodes	128
9.4	Acceptance tests	128
9.4.1	General	128
9.4.2	Integral protection diodes	129
9.4.3	External protection diodes	129
9.4.4	External and integral diodes	129
9.4.5	Test methods and conditions	130
9.4.6	Documentation	130
9.5	Qualification tests	131
9.5.1	General	131
9.5.2	Integral protection diodes	131
9.5.3	External protection diodes	132
9.5.4	Integral and external protection diodes	134
9.6	Test methods, conditions and measurements	135
9.6.1	General	135
9.6.2	Visual inspection (VI)	135
9.6.3	Dimensions and weight (DW)	136

9.6.4	Thermal cycling (CY)	137
9.6.5	Burn in (BI)	137
9.6.6	Humidity and temperature.....	138
9.6.7	Contact uniformity (CU)	139
9.6.8	Contact thickness (CT)	139
9.6.9	Surface Finish (SF).....	139
9.6.10	Contact adherence (CA)	140
9.6.11	Pull test (PT).....	141
9.6.12	Electron irradiation (EI)	142
9.6.13	Temperature annealing (TA).....	142
9.6.14	Temperature behaviour (TB).....	143
9.6.15	Diode characterization (DC).....	143
9.6.16	Human body ESD (DE).....	144
9.6.17	Switching test (DS)	145
9.6.18	Long Duration – Life test (LT)	147
9.7	Failure definition	149
9.7.1	Failure criteria	149
9.7.2	Failed components	150
9.8	Data documentation	150
9.9	Delivery	150
9.10	Packing, despatching, handling and storage	150
9.10.1	Overview	150
9.10.2	ESD sensitivity.....	150
10	Solar simulators and calibration procedures	151
10.1	Solar simulators.....	151
10.1.1	Spectral distribution	151
10.1.2	Irradiance uniformity	153
10.1.3	Irradiance stability.....	154
10.2	Standard cell and Solar simulator calibration.....	155
10.2.1	Primary standards.....	155
10.2.2	Secondary working standards (SWS)	155
10.2.3	Standards cells documentation	157
10.2.4	Maintenance of standards.....	157
10.2.5	Recalibration and intercomparison.....	157
10.2.6	Solar simulator calibration and maintenance.....	157
11	Capacitance measurement methods	159

11.1	Single junction solar cell capacitance measurement.....	159
11.1.1	Overview	159
11.1.2	Signal measurement method	159
11.1.3	Measurement procedure.....	160
11.1.4	Measurement analysis	163
11.1.5	Measurement of the capacitance of a multi-junction cell	166
11.2	Time domain capacitance measurement	167
11.2.1	Overview	167
11.2.2	Measurement procedure.....	168
12	Planar Blocking Diodes	170
12.1	Overview	170
12.2	Testing, deliverable components and Marking.....	170
12.2.1	Testing.....	170
12.2.2	Deliverable components	171
12.2.3	Marking.....	171
12.3	Production control (process identification document).....	172
12.4	Acceptance test.....	172
12.4.1	General.....	172
12.4.2	Planar blocking diodes.....	172
12.5	Qualification tests	173
12.5.1	General.....	173
12.5.2	Blocking diodes	173
12.5.3	Production and test schedule.....	173
12.5.4	Qualification test samples	173
12.5.5	Qualification testing	174
12.6	Test methods, conditions and measurements	177
12.6.1	Visual inspection (VI)	177
12.6.2	Dimensions and weight (DW).....	177
12.6.3	Diode characterization (DC).....	178
12.6.4	Humidity and Temperature	178
12.6.5	Temperature Cycling (CY)	180
12.6.6	Contact Adherence (CA).....	180
12.6.7	Burn-in (BI)	181
12.6.8	Long duration-Life Test (LT)	182
12.6.9	Temperature behaviour test (TB)	182
12.6.10	Temperature robustness test (TR)	183
12.6.11	Total Dose Radiation Testing (RT).....	183

12.6.12	Temperature Annealing (TA)	185
12.6.13	Contact uniformity test (CU)	185
12.6.14	Surface Finish test (SF)	186
12.6.15	Human Body ESD test (ESD)	186
12.6.16	Pull test (PT) / Interconnector adherence test (IA)	187
12.6.17	Surge test (ST)	187
12.6.18	Thermo-optical data (TO)	188
12.7	Failure definition	188
12.7.1	Failure criteria	188
12.7.2	Failed Blocking Diodes	188
12.8	Data documentation	189
12.9	Delivery	189
12.10	Packing, despatching, handling and storage	189
12.10.1	Overview	189
12.10.2	ESD sensitivity	189
Annex A (normative) Source control drawing for photovoltaic assembly (SCD-PVA) - DRD		190
Annex B (normative) Source control drawing for solar cell assembly (SCD-SCA) - DRD		196
Annex C (normative) Source control drawing for bare solar cell (SCD-BSC) - DRD		201
Annex D (normative) Source control drawing for coverglass (SCD-CVG) - DRD		209
Annex E (normative) Source control drawing for External Protection Diodes (SCD-EPD) - DRD		215
Annex F (normative) Process identification document (PID) - DRD		219
Annex G (normative) Data documentation package (DDP) - DRD		221
Annex H (normative) Source control drawing for Planar Blocking Diodes (SCD-PBD) - DRD		224
Bibliography		229
Figures		
Figure 4-1:	Specification hierarchy	28
Figure 6-1:	Definition of cell defects	70
Figure 6-2:	Test points for electrical performance measurement	72

Figure 7-1: Definition of bare solar cell defects.....	94
Figure 8-1: Methods of defining coverglass orientation	111
Figure 8-2: Edge chip parameters.....	116
Figure 8-3: Corner chip parameters	116
Figure 8-4: Coverglass manufacturing tolerance limits	117
Figure 8-5: Schematic for calculating surface resistivity	120
Figure 8-6: Definition of coverglass flatness.....	120
Figure 9-1: Diode forward and reverse test profile.....	147
Figure 9-2: Diode switching test profile	147
Figure 11-1: Solar cell impedance measurement equipment.....	161
Figure 11-2: Channel balancing and reduction of the parasitic inductances	162
Figure 11-3: Measurement of the resistance value of the shunt in the measuring conditions (shunt in parallel with the input of the network analyser)	162
Figure 11-4: Small signal electrical schema biased with a DC voltage associated impedance	165
Figure C-1 : BSC front side	203
Figure C-2 : BSC rear side	203
Figure C-3 : BSC contact	203

Tables

Table 4-1: Test tolerances on temperature.....	30
Table 5-1: Qualification test plan for PVA.....	42
Table 5-2: Acceptance test plan	51
Table 6-1: Qualification test plan for SCA.....	67
Table 6-2: Maximum dimensions of corner chips, edge chips and surface nicks	70
Table 7-1: Acceptance test matrix.....	89
Table 7-2: Qualification test plan for bare solar cells	91
Table 7-3: Maximum dimensions of corner chips, edge chips and surface nicks	94
Table 8-1: Qualification test plan for coverglasses	114
Table 9-1: Acceptance test matrix IPD	129
Table 9-2: Acceptance test matrix EPD.....	129
Table 9-3: Qualification test plan for integral protection diode	132
Table 9-4: Qualification test plan for bare protection diodes	133
Table 9-5: Diode long duration-life test parameters	149
Table 10-1: <<deleted>>	152
Table 10-2: Classes of single and multi-source solar simulators (informative).....	152
Table 10-3: Classes of solar simulators with respect to nonconformity of irradiance uniformity (informative)	154

Table 10-4: Classes of solar simulators with respect to temporal instability of irradiance.....	155
Table 12-1: Acceptance test matrix planar blocking diodes	172
Table 12-2: Qualification test plan for bare blocking diodes	175
Table 12-3: Qualification test plan for connector integrated blocking diodes	176
Table 12-4: Diode Irradiation and bias conditions.....	184
Table B-1 : Minimum current requirement for solar assemblies (25 °C or operating temperature)	198
Table C-1 : Electrical performance pass-fail criteria	205
Table D-1 : Average transmission into air before test (%)	211
Table D-2 : Maximum average deviation of transmission into air after test (%).....	212