

TECHNICAL SPECIFICATION



Recommendations for renewable energy and hybrid systems for rural electrification –
Part 9-5: Integrated systems – ~~Selection of stand-alone lighting kits~~ Laboratory evaluation of stand-alone renewable energy products for rural electrification

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	15
INTRODUCTION.....	18
1 Scope.....	20
2 Normative references	20
3 Terms and definitions	22
4 System limits Product components and characteristics	27
4.1 Components	27
4.1.1 Overview	27
4.1.2 Component categories.....	28
4.1.3 Lighting parts definitions.....	30
4.1.4 Appliance definitions.....	31
4.1.5 Additional system elements	32
4.2 System measurements and observations	32
4.2.1 General	32
4.2.2 Product design, manufacture, and marketing aspects	33
4.2.3 Product durability and workmanship aspects.....	36
4.2.4 Lighting durability aspects	39
4.2.5 Battery performance aspects	40
4.2.6 Solar module aspects	41
4.2.7 Electrical characteristics	42
4.2.8 Performance aspects	43
4.2.9 Light output aspects	46
4.2.10 Battery charging circuit efficiency	47
4.2.10 Self-certification aspects.....	47
4.3 Constructions not specifically covered	48
5 Product specification	48
5.1 General.....	48
5.2 Applications	49
5.3 Quality assurance principles	49
5.4 Product specification framework description.....	49
5.4.1 General	49
5.4.2 Product specification template.....	50
5.4.3 Tolerances	53
5.4.4 Quality standards criteria.....	54
5.4.5 Warranty requirements criteria.....	59
6 Quality test method	60
6.1 General.....	60
6.2 Applications	60
6.3 Sampling requirements	60
6.4 Laboratory requirements	61
6.5 Testing requirements	61
6.6 Recommended tests programme.....	71
6.6.1 General	71
6.6.2 Test preparation	74
6.6.3 Batch A tests	74
6.6.4 Batch B tests	77

6.6.5	Batch C – potentially destructive tests	77
6.6.6	Report preparation.....	78
6.7	Reporting	78
7	Market check method	79
7.1	General.....	79
7.2	Applications	79
7.3	Sampling requirements	80
7.4	Laboratory requirements	80
7.5	Testing requirements	80
7.6	Recommended tests programme.....	81
7.7	Report requirements	81
8	Initial screening method.....	81
8.1	General.....	81
8.2	Applications	81
8.3	Sampling requirements	82
8.4	Laboratory requirements	82
8.5	Testing requirements	82
8.6	Recommended tests programme.....	85
8.7	Reporting	85
9	Accelerated verification method	86
9.1	General.....	86
9.2	Applications	86
9.3	Sampling requirements	87
9.3.1	General	87
9.3.2	Verification entry testing	87
9.3.3	Follow-up- QTM testing.....	88
9.4	Laboratory requirements	88
9.5	Testing requirements	88
9.5.1	General	88
9.5.2	Verification entry testing	88
9.5.3	Follow-up QTM testing.....	91
9.6	Recommended tests programme.....	92
9.7	Report requirements	92
Standardized specification sheets		
General		
Applications		
General		
Guidance		
Framework for SSS guidelines document		
10	Pay-as-you-go (PAYG) method.....	97
10.1	General.....	97
10.2	Applications	98
10.3	Sampling requirements	98
10.4	Laboratory requirements	98
10.5	Testing requirements	98
10.6	Recommended tests programme.....	100
10.7	Reporting	100

Annex A (informative) Recommended quality standards for off-grid lighting market support programme qualification Reserved	101
Annex B (informative) Reserved	105
Annex C (informative) Recommended SSS guidelines Reserved	106
Annex D (normative) Manufacturer self-reported information	115
D.1 Background	115
D.2 Outcomes	115
D.3 Solicited information	115
D.3.1 General	115
D.3.2 Confidential information (not released publicly)	115
D.3.3 Public information (may be released publicly)	117
D.4 Reporting	119
Annex E (normative) Product sampling	121
E.1 Background	121
E.2 Test outcomes	121
E.3 Related tests	121
E.4 Procedure	121
E.4.1 Retail sampling	121
E.4.2 Warehouse sampling	122
E.5 Reporting	123
Annex F (normative) Visual screening	125
F.1 Background	125
F.2 Test outcomes	125
F.3 Related tests	125
F.4 Procedure	125
F.4.1 Properties, features, and information	125
F.4.2 Specifications	131
F.4.3 Functionality and internal inspection	133
F.5 Reporting	136
Annex G (normative) Sample preparation	141
G.1 Background	141
G.2 Test outcomes	141
G.3 Related tests	141
G.4 Procedure	141
G.4.1 General	141
G.4.2 Equipment requirements	141
G.4.3 Test prerequisites	142
G.4.4 Procedure	142
G.4.5 Calculations	145
G.5 Reporting	145
Annex H (normative) Power supply setup procedure	146
H.1 Background	146
H.2 Test outcomes	146
H.3 Related tests	146
H.4 Equipment requirements	146
H.5 Setup procedure for photometric measurements and lumen maintenance tests	147
H.5.1 Test setup	147

H.5.2	DC voltage and current levels	148
H.5.3	Stabilization period	149
H.5.4	4-wire power supply measurements	149
H.5.5	Filtering electronic noise	150
H.5.6	Troubleshooting	150
H.6	Reporting	153
Annex I (normative)	Light output test	154
I.1	Background	154
I.2	Test outcomes	154
I.3	Related tests	154
I.4	Luminous flux measurement techniques	155
I.4.1	General	155
I.4.2	Calculation for lighting appliances tested according to IEC TS 62257-12-1	156
I.4.3	Luminous flux measurements with an integrating sphere or goniophotometer	156
I.4.4	Luminous flux measurements using the multi-plane method	156
I.5	Correlated colour temperature (CCT) measurement	159
I.6	Colour rendering index (CRI) measurement	159
I.7	Reporting	159
Annex J (normative)	Lumen maintenance test	161
J.1	Background	161
J.2	Test outcomes	161
J.3	Related tests	162
J.4	Procedure	162
J.4.1	General	162
J.4.2	Equipment requirements	166
J.4.3	Full screening	166
J.4.3	Test prerequisites	166
J.4.4	Test methods	166
J.5	Calculations	169
J.6	Alternate method for testing lumen maintenance using IESNA LM-80-08	169
J.6.1	Background	169
J.6.2	Equipment requirements	170
J.6.3	Test prerequisites	170
J.6.4	Procedure	170
J.6.5	DUT preparation and LED thermocouple attachment guidelines	171
J.6.6	Calculations	171
J.7	Reporting	172
Annex K (normative)	Battery test	174
K.1	Background	174
K.2	Test outcomes	174
K.3	Related tests	174
K.4	Procedure	174
K.4.1	General	174
K.4.2	Valve-regulated Lead-acid battery test	175
K.4.3	Nickel-metal hydride battery test	178
K.4.4	Lithium-ion battery test	180
K.4.5	Lithium iron phosphate battery test	181

K.5	Reporting	182
Annex L (informative)	Battery testing recommended practices	184
L.1	Background	184
L.2	Deep discharge protection specifications by battery type	184
L.3	Overcharge protection specifications by battery type	185
Annex M (normative)	Full-battery run time test.....	186
M.1	Background	186
M.2	Test outcomes	187
M.3	Related tests	188
M.4	Equipment requirements	189
M.5	Test prerequisites	189
M.6	Apparatus	189
M.7	Procedure	190
M.8	Calculations	197
M.9	Reporting	200
Annex N (normative)	Full discharge preparation.....	202
N.1	Background	202
N.2	Test outcomes	202
N.3	Related tests	202
N.4	Procedure	202
N.4.1	General	202
N.4.2	Equipment requirements	202
N.4.3	Test prerequisites	203
N.4.4	Procedure.....	203
N.4.5	Calculations.....	205
N.5	Reporting	205
Annex O (normative)	Grid charge test	206
O.1	Background	206
O.2	Test outcomes	206
O.3	Related tests	206
O.4	Procedure	206
O.4.1	General	206
O.4.2	Equipment requirements	206
O.4.3	Test prerequisites	207
O.4.4	Apparatus	207
O.4.5	Procedure.....	207
O.4.6	Calculations.....	207
O.5	Reporting	208
Annex P (normative)	Electromechanical charge test	209
P.1	Background	209
P.2	Test outcomes	209
P.3	Related tests	209
P.4	Procedure	209
P.4.1	General	209
P.4.2	Equipment requirements	209
P.4.3	Test prerequisites	210
P.4.4	Apparatus	210
P.4.5	Procedure.....	210

P.4.6	Calculations	210
P.4.7	Modifications for atypical products	210
P.5	Reporting	211
Annex Q (normative)	Photovoltaic module I-V characteristics test	212
Q.1	Background	212
Q.2	Test outcomes	212
Q.3	Related tests	213
Q.4	Procedure	213
Q.4.1	Testing using IEC 61215 (all parts) Substitution of IEC 61215-2 test results	213
Q.4.2	Test programme using a solar simulator	214
Q.4.3	Outdoor photovoltaic module I-V characteristics test	216
Q.5	Reporting	221
Annex R (normative)	Solar charge test	223
R.1	Background	223
R.2	Test outcomes	223
R.3	Related tests	224
R.4	Procedure	224
R.4.1	General	224
R.4.2	Test method using a resistor network	224
R.4.3	Test method using a solar array simulator (SAS)	231
R.4.4	Calculations	232
R.4.5	Alternative method to measure battery-charging circuit efficiency	240
R.5	Reporting	242
Annex S (normative)	Charge controller behaviour test	245
S.1	Background	245
S.2	Test outcomes	245
S.3	Related tests	246
S.4	Procedure	247
S.4.1	Active deep discharge protection test	247
S.4.2	Active overcharge protection test	248
S.4.3	Passive deep discharge protection test	253
S.4.4	Passive overcharge protection test	255
S.4.5	Standby loss measurement	257
S.5	Reporting	258
Annex T (normative)	Light distribution test	260
T.1	Background	260
T.2	Test outcomes	260
T.3	Related tests	261
T.4	Substitution of results from IEC TS 62257-12-1	261
T.5	Approved test methods	261
T.5.1	General	261
T.5.2	Goniophotometer	265
T.5.3	Multi-plane method	265
T.5.4	Illuminance on a plane method	270
T.5.5	Turntable method	273
T.5.6	Illuminance on a desktop method	275
T.6	Reporting	277
Annex U (normative)	Physical and water ingress protection test	281

U.1	Background	281
U.2	Test outcomes	281
U.3	Related tests	282
U.4	Procedure	282
U.4.1	General	282
U.4.2	IP testing at a laboratory that has been accredited to test according to IEC 60529	282
U.4.3	Simplified IP inspection for ingress of solid foreign objects	283
U.4.4	Simplified IP preliminary inspection for ingress of water with harmful effects	284
U.5	Reporting	287
Annex V (normative)	Level of water protection	288
V.1	Background	288
V.2	Test outcomes	288
V.3	Related tests	289
V.4	Laboratory requirements	289
V.5	Procedure	289
V.5.1	General	289
V.5.2	Level of water protection for enclosure only	290
V.5.3	Level of water protection from technical aspects	290
V.5.4	Overall level of water protection	293
V.6	Reporting	294
Annex W (normative)	Mechanical durability test	296
W.1	Background	296
W.2	Test outcomes	296
W.3	Related tests	297
W.4	Procedures	297
W.4.1	Drop test	297
W.4.2	Switch and connector test	299
W.4.3	Gooseneck and moving part test	300
W.4.4	Strain relief test	301
W.5	Reporting	303
Annex X (informative)	Reserved	305
Annex Y (informative)	Photometer box for relative luminous flux measurements	306
Y.1	Background	306
Y.2	Plans	307
Y.3	Instructions for construction	310
Annex Z (informative)	Photometer tube for relative luminous flux measurements Reserved	311
Annex AA (informative)	Field testing method Reserved	313
Annex BB (normative)	Battery durability test	319
BB.1	Background	319
BB.2	Test outcomes	319
BB.3	Related tests	319
BB.4	Procedure	319
BB.4.1	Durability storage test for valve-regulated lead-acid batteries	319
BB.4.2	Durability storage test for flooded lead-acid batteries	320
BB.4.3	Durability storage test for nickel-metal hydride batteries	321
BB.4.4	Durability storage test for lithium-ion batteries	322

BB.4.5	Durability storage test for lithium iron phosphate batteries	323
BB.5	Reporting	324
Annex CC (normative)	Equipment requirements	325
CC.1	Overview	325
CC.2	Requirements and recommendations for equipment and materials	325
CC.3	Guidelines for electrical power measurements	341
CC.3.1	Background	341
CC.3.2	Overview of DC power measurement	341
CC.3.3	Power measurement accuracy recommendations	343
CC.3.4	Additional guidelines and corrective measures	344
Annex DD (normative)	Protection tests	345
DD.1	Background	345
DD.2	Test outcomes	345
DD.3	Related tests	346
DD.4	Procedure	346
DD.4.1	Miswiring protection test	346
DD.4.2	Output overload protection test	349
DD.4.3	PV overvoltage protection test	352
DD.5	Reporting	357
Annex EE (normative)	Assessment of DC ports	360
EE.1	Background	360
EE.2	Test outcomes	360
EE.3	Related tests	361
EE.4	Procedure	361
EE.4.1	Preparation	361
EE.4.2	Measurement of steady-state port characteristics	363
EE.4.3	Dynamic measurement	373
EE.4.4	Summary calculations	378
EE.4.5	Pass/fail tests for functionality and truth in advertising	379
EE.5	Reporting	383
Annex FF (normative)	Appliance tests	385
FF.1	Background	385
FF.2	Appliance testing requirements	385
FF.3	Test outcomes	387
FF.4	Related tests	388
FF.5	Setup and determination of appliance operating voltage	388
FF.5.1	General	388
FF.5.2	Procedure using the power control unit	389
FF.5.3	Procedure using a power supply	390
FF.6	Power consumption test	391
FF.6.1	General	391
FF.6.2	General equipment requirements	391
FF.6.3	Procedure for appliances that have been previously tested according to a recognized test method	391
FF.6.4	Test procedure for LED or CFL lighting appliances without an internal battery	399
FF.6.5	Test procedure for television sets without internal batteries	401
FF.6.6	Test procedure for radios without internal batteries	401

FF.6.7	Test procedure for fans, motor-driven appliances, and other appliances without internal batteries.....	403
FF.6.8	Test procedure for appliances with an internal battery	404
FF.7	Charging efficiency test	405
FF.7.1	General	405
FF.7.2	Equipment requirements	405
FF.7.3	Test prerequisites	406
FF.7.4	Procedure.....	406
FF.7.5	Calculations.....	406
FF.8	Appliance operating voltage range test	407
FF.8.1	General	407
FF.8.2	Equipment requirements	407
FF.8.3	Test prerequisites	407
FF.8.4	Simultaneous testing for multiple products and applicability of previous test results.....	408
FF.8.5	Procedure for appliances without batteries that have been tested according to a recognized test method.....	408
FF.8.6	Procedure for appliances without an internal battery.....	411
FF.8.7	Procedure for appliances with internal batteries.....	411
FF.9	Appliance full-battery run time test with deep discharge protection measurement.....	412
FF.9.1	General	412
FF.9.2	Equipment requirements	412
FF.9.3	Test prerequisites	413
FF.9.4	Apparatus.....	413
FF.9.5	Procedure.....	414
FF.9.6	Calculations.....	416
FF.10	Reporting	417
Annex GG (normative)	Energy service calculations	419
GG.1	Background	419
GG.2	Test outcomes	420
GG.3	Related tests	422
GG.4	Procedure	422
GG.4.1	Full-battery run time energy service calculations	422
GG.4.2	Solar run time energy service calculations	439
GG.4.3	Grid or electromechanical run time energy service calculations	463
GG.4.4	Solar charging time calculation	463
GG.5	Reporting	465
Annex HH (normative)	Generic appliances	467
HH.1	Background	467
HH.2	Test outcomes	467
HH.3	Related tests	467
HH.4	Equipment requirements	467
HH.5	Procedures	468
HH.5.1	Constructing generic appliances	468
HH.5.2	Appliance reference values.....	470
HH.6	Reporting	470
Bibliography	471

Figure 1 – Fixed indoor components and PV module – Example	29
Figure 2 – Fixed outdoor components with an indoor light point – Example	29
Figure 3 – Portable separate components – Example	30
Figure 4 – Portable integrated components – Example	30
Figure 5 – Division of a lighting kit product into subsystems – Illustrative example	31
Figure 6 – Recommended sequence of testing for QTM for products without ports	72
Figure 7 – Recommended sequence of testing for QTM for products with ports	73
Figure G.1 – Connections with secondary set of wires to avoid battery disconnection	145
Figure H.1 – Power supply setup for powering a power control unit	147
Figure H.2 – Power supply setup for directly powering an appliance	147
Figure H.3 – 4-wire test configuration with input filter capacitors	150
Figure I.1 – Conceptual schematic of the light output test setup, including the 11 × 11 grid, Cartesian coordinate axes for rotation reference, and the DUT	158
Figure J.1 – Example lumen maintenance plot	173
Figure M.1 – Interior view of photometer box with suspended light	190
Figure M.2 – Plot of example results for a product with lighting appliances	198
Figure Q.1 – PV module I-V curve testing rack	217
Figure R.1 – Schematic of the power supply and DUT connection for the solar charge efficiency test	226
Figure R.2 – Example "true" and simulated I-V curves plotted with the deviation ratio	230
Figure R.3 – Example plots of current vs. time for four different DUT batteries	234
Figure R.4 – Example time series plot of the solar charging cycle showing the maximum power available from the PV simulator, actual power supplied by the PV simulator, and power delivered to the batteries	243
Figure R.5 – Example time series plot of the solar charging cycle showing the instantaneous battery-charging circuit efficiency and solar operation efficiency	244
Figure S.1 – Schematic of the DC power supply-DUT connection using a series protection resistor	250
Figure T.1 – Horizontal plane for determining FWHM angle and radial illuminance distribution, for an omnidirectional light point	263
Figure T.2 – Horizontal plane for determining FWHM angle and radial illuminance distribution, for a directed light point	264
Figure T.3 – Radial illuminance distributions in the horizontal plane for two example DUTs products, showing the calculation of the horizontal FWHM angle	269
Figure T.4 – Radial illuminance distribution in the vertical plane for an example omnidirectional ambient light with vertical FWHM = 108°	270
Figure T.5 – Schematic of a task light suspended above an illuminance meter	271
Figure T.6 – Schematic of turntable setup, with the DUT shown	274
Figure T.7 – Side view of desktop light measuring setup	276
Figure T.8 – Example plot of usable area as a function of minimum illuminance	278
Figure T.9 – Example of resulting surface plot of light distribution from the brightest "face" of the multi-plane method or illuminance on a plane method	279
Figure T.10 – Example of resulting a polar plot of the radial illuminance from the multi-plane or turntable method distribution	280
Figure U.1 – Side view of the apparatus for testing a DUT's an external solar module for protection against water ingress	286
Figure W.1 – Three-dimensional Cartesian coordinate system for drop test reference	298

Figure W.2 – Cable strain angle (γ) schematics for a PV module junction box (left) and a separate light point (right)	303
Figure Y.1 – Interior view of a completed photometer box	306
Figure Y.2 – Exterior view of completed photometer box	307
Figure Y.3 – Photometer box dimensions	308
Figure Y.4 – Photometer box assembly pieces and list of materials	309
Figure EE.1 – Schematic of the example DUT with DC port and USB port and variable resistors connected for the measurement of steady-state port characteristics	366
Figure EE.2 – Example of the plots of port characteristics	372
Figure EE.3 – Schematic of the DUT with DC port and USB port and variable resistors connected for the dynamic measurement	375
Figure EE.4 – Illustration of stepped current waveform for procedure 2	377
Figure EE.5 – Example time series plot of voltage and current showing a step increase in current and the resulting voltage undershoot	378
Figure EE.6 – Example time series plot of voltage and current showing a step decrease in current and the resulting voltage overshoot	378
Figure EE.7 – Illustration of functionality assessment	381
Figure EE.8 – Typical configuration of USB port data lines	383
Figure EE.9 – Pin configuration of type A receptacle	380
Figure FF.1 – Illustration of calculation of minimum and maximum values of port voltage for the appliance operating voltage range test	410
Figure GG.1 – Conceptual energy flow diagram for energy service estimates	420
Table 1 – Applications of product specifications	49
Table 2 – Qualification as separate PV module	50
Table 3 – Truth-in-advertising tolerance	51
Table 4 – Safety and durability standards	51
Table 5 – End user support standards	53
Table 6 – End user support requirements	53
Table 7 – Truth-in-advertising criteria for quality standards	55
Table 8 – Remarks on common truth-in-advertising aspects	56
Table 9 – Safety and durability criteria for quality standards	57
Table 10 – Recommended level of water protection by product category	59
Table 11 – End user support criteria for quality standards	59
Table 12 – Criteria for warranty standards	59
Table 13 – Applications of product specifications QTM results	60
Table 14 – QTM testing requirements	63
Table 15 – Applications of MCM results	79
Table 16 – Applications of product specifications ISM results	81
Table 17 – Applications of AVM results	87
Table 18 – Applications of PAYG method results	98
Table 19 – PAYG testing requirements	99
Table D.1 – Manufacturer self-reported information outcomes	115
Table E.1 – Product sampling outcomes	121
Table F.1 – Visual screening test outcomes	125

Table G.1 – Recommended minimum conductor sizes for copper wire	142
Table H.1 – Power supply setup test outcome.....	146
Table H.2 – Standard operating voltage for several common battery types	148
Table H.3 – Voltage and current reporting requirements	153
Table I.1 – Light output test outcomes	154
Table J.1 – Lumen maintenance test outcomes.....	162
Table J.2 – Measurement schedule for full screening test	163
Table J.3 – Measurement schedule for initial screening test	163
Table K.1 – Battery test outcomes	174
Table K.2 – Recommended battery testing specifications according to battery chemistry parameters	175
Table L.1 – Recommended battery deep discharge protection voltage specifications according to the battery chemistry	185
Table L.2 – Recommended battery overcharge protection voltage and temperature specifications	185
Table M.1 – Full-battery run time test outcomes.....	187
Table O.1 – Grid charge test outcomes.....	206
Table P.1 – Mechanical charge test outcomes	209
Table Q.1 – Outdoor Photovoltaic module I-V characteristics test outcomes	212
Table R.1 – Solar charge test outcomes	223
Table R.2 – Simulated solar day power supply settings.....	230
Table S.1 – Charge controller behaviour test outcomes	246
Table T.1 – Light distribution test outcomes.....	261
Table T.2 – Summary of testing options for characterizing lamp distributions	262
Table T.3 – Table of example illuminance measurements on the brightest "face" of the 1 m ² grid and usable area as a function of minimum illuminance	278
Table U.1 – Water exposure and physical ingress protection test outcomes.....	281
Table V.1 – Water exposure and physical ingress protection test outcomes	289
Table V.2 – Enclosure-only level of water protection requirements.....	290
Table V.3 – Adjusted level of water protection for products with additional technical water protection	291
Table V.4 – Example detailed assessment supporting technical level of water protection	293
Table V.5 – Overall level of water protection requirements.....	293
Table W.1 – Mechanical durability test outcomes.....	296
Table BB.1 – Battery durability test outcomes.....	319
Table CC.1 – Symbols used in test method column of Table CC.2	325
Table CC.2 – Specifications for all required test equipment	326
Table DD.1 – Protection test outcomes	345
Table DD.2 – Allowable port voltage limit by nominal voltage	354
Table DD.3 – Example table of miswiring protection test results	358
Table DD.4 – Example table of PV overvoltage test results	359
Table EE.1 – DC ports assessment outcomes.....	360
Table EE.2 – Current pairs for dynamic test.....	376

Table EE.3 – Recommended voltage and current ranges for port functionality assessment	380
Table FF.1 – Appliance testing requirements	386
Table FF.2 – Appliance power consumption test outcomes	387
Table FF.3 – Example table of nominal appliance operating voltage, measured voltage, measured current, and calculated power	418
Table GG.1 – Daily Energy service calculations outcomes	421
Table GG.2 – Examples of advertised combinations involving mobile devices	424
Table GG.3 – Required inputs to estimate the full-battery run time(s)	427
Table GG.4 – Example usage profile	430
Table GG.5 – Required inputs to estimate the solar run time	441
Table GG.6 – Representative case for appliance usage when solar charging	442
Table HH.1 – Power consumption chart for generic appliances without batteries	468
Table HH.2 – Energy consumption chart for capacity of generic appliances with internal batteries	470

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RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-5: Integrated systems –

~~Selection of stand-alone lighting kits~~ Laboratory evaluation of stand-alone renewable energy products for rural electrification

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-9-5, which is a Technical Specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This fourth edition cancels and replaces the third edition issued in 2016. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Replaced the term "stand-alone lighting kits" with "stand-alone renewable energy products" throughout the document (including the title) to reflect that the revised document is applicable to a broader range of products with a more diverse set of capabilities.
- b) Removed the distinction between Class A, Class B, and Class C procedures.
- c) Added an option for the AVM method in which the AVM-VE test can be conducted with a sample size of 6 and the follow-up test can be conducted with a sample size of 2.
- d) Provided guidance on how to accept test results from other approved test methods.
- e) Added test methods for flooded lead-acid batteries.
- f) Significantly revised the protection tests, assessment of DC ports, appliance tests, and energy service calculations based on field experience.
- g) Revised the voltage operating points at which testing is carried out to better reflect actual operation and to simplify the procedures for testing products without lights.
- h) Revised the energy service calculations to include the effect of multiple simultaneously connected loads on the port voltage and battery-to-port efficiency and to accommodate products with grid or electromechanical charging.
- i) Removed the restriction that all connections shall be "plug-and-play."
- j) Added discussion of measurement error and accuracy for DC power measurements.

This part of IEC 62257 is to be used in conjunction with IEC 62257 (all parts).

The text of this Technical Specification is based on the following documents:

Enquiry draft	Reports on voting
82/1346/DTS	82/1385A/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

IEC 62257 (all parts) provides support and strategies for institutions involved in rural electrification projects. It documents technical approaches for designing, building, testing, and maintaining off-grid renewable energy and hybrid systems with AC nominal voltage below 500 V, DC nominal voltage below 750 V and nominal power below 100 kVA.

These documents are recommendations to support buyers who want to connect with good quality options in the market:

- to choose the right system for the right place,
- to design the system, and
- to operate and maintain the system.

These documents are focused only on technical aspects of rural off-grid electrification concentrating on, but not specific to, developing countries. They are not considered as all inclusive to rural electrification. The documents do not describe a range of factors that can determine project or product success: environmental, social, economic, service capabilities, and others. Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems, and costs. The main objectives are to support the capabilities of households and communities that use small renewable energy and hybrid off-grid systems and inform organizations and institutions in the off-grid power market.

~~The purpose of this part of IEC 62257 is to specify quality assurance strategies for stand-alone lighting kits, including product specifications, tests, and a standardized specification sheet format. In addition to supporting the selection of products by project developers and implementers, quality assurance can help market support organizations, manufacturers, and governments achieve the goals they have for off-grid lighting projects.~~

The purpose of this document is to specify laboratory test methods for evaluating the quality assurance of stand-alone renewable energy products. This document is specifically related to renewable energy products that are packaged and made available to end-use consumers at the point of purchase as single, stand-alone products that do not require additional system components to function.

The term "stand-alone renewable energy product" is used in this document to describe this class of products. Other equivalent terms, including "off-grid solar" or "rechargeable," are often used by manufacturers, distributors, and other stakeholders to describe these products. Many of these systems meet the definition of type T₂I (individual electrification systems with energy storage) in IEC TS 62257-2.

The intended users of this document are: ~~In some clauses and subclauses of this part of IEC 62257, a description of the application of the subclause contents is offered to help provide context for each type of user.~~

- Market support ~~programmes are~~ programmes that support the off-grid lighting market with financing, consumer education, awareness, and other services. ~~Market support programmes often use quality assurance to qualify for access to services such as;~~
 - ~~— greenhouse gas reduction certifications or other incentives,~~
 - ~~— access to financing (trade or consumer finance),~~
 - ~~— use of a buyer seal and certification (government or non-governmental institutional backing, consumer or "business-to-business" seals),~~
 - ~~— participation in a public product information database (e.g. standardized specification sheets),~~

- ~~— access to a business network or trade group,~~
- ~~— business support and development services,~~
- ~~— access to market intelligence, and~~
- ~~— participation in consumer awareness campaigns.~~
- Manufacturers and distributors ~~that~~ need to verify the quality and performance of products ~~from different batches and potential business partners. Manufacturers and distributors often use quality assurance plans or requirements to:~~
 - ~~— support quality control processes at a manufacturing plant or upon receipt of goods from a contract manufacturer, and~~
 - ~~— choose products to distribute.~~
- Bulk procurement programmes ~~that~~ facilitate or place large orders ~~for devices from a distributor or manufacturer of products. Bulk procurement programmes may use quality assurance to;~~ and,
 - ~~— provide devices to a particular, relatively small group of end users whose needs are understood (e.g., project developers and implementers for an electrification project may include quality assurance requirements in the GS of an electrification project (see IEC TS 62257-3)), and~~
 - ~~— organize a subsidy, buy down, or giveaway programme that will serve a broad set of users.~~
- Trade regulators ~~are typically~~ such as government policymakers and officials who craft and implement trade and tax policy. ~~Regulators may use quality assurance requirements to:~~
 - ~~— qualify for exemption from tax or duties, and~~
 - ~~— establish requirements for customs.~~

This document establishes the framework for creating a product specification, the basis for evaluating quality for a particular context. Product specifications include minimum requirements for quality standards and warranty requirements. Products are compared to specifications based on test results and other information about the product. The product specification framework is flexible and can accommodate the goals of diverse organizations and institutions. ~~There is a range of tests outlined in this part of IEC 62257; some are simple enough to be completed in the field by project developers while others require laboratory equipment.~~ The tests and inspections are designed to be widely applicable across different markets, countries, and regions.

~~Standardized specification sheets are also defined that can be used to communicate the test results. Combined with a set of product specifications, the information in the standardized specification sheet can inform the use of a quality and/or performance label.~~

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-5: Integrated systems –

~~Selection of stand-alone lighting kits~~ Laboratory evaluation of stand-alone renewable energy products for rural electrification

1 Scope

This part of IEC 62257, which is a Technical Specification, applies to stand-alone ~~rechargeable electric lighting appliances or kits that can be installed by a typical user without employing a technician~~ renewable energy products having the following characteristics:

~~This part of IEC 62257 presents a quality assurance framework that includes product specifications (a framework for interpreting test results), test methods, and standardized specification sheets (templates for communicating test results).~~

- All components required to provide basic energy services are sold/installed as a kit or integrated into a single component, including at a minimum:
 - A battery/batteries or other energy storage device(s)
 - Power generating device, such as a solar panel, capable of charging the battery/batteries or other energy storage device(s)
 - Cables, switches, wiring, connectors and protective devices sufficient to connect the power generating device, power control unit(s) and energy storage device(s)
 - Loads (optional), such as lighting, load adapter cables (e.g., for mobile devices), and appliances (television, radio, fan, etc.).
- The PV module maximum power point voltage and the working voltage of any other components in the kit do not exceed 35 V. Exceptions are made for AC-to-DC converters that meet appropriate safety standards.

NOTE This voltage limit corresponds to the definition of decisive voltage classification A (DVC-A) for wet locations in Table 6 of IEC 62109-1:2010.

- The peak power rating of the PV module or other power generating device is less than or equal to 350 W.
- No design expertise is required to choose appropriate system components.

This document was written primarily for off-grid renewable energy products with batteries and solar modules with DC system voltages not exceeding 35 V and peak power ratings not exceeding 350 W. The tests contained herein are capable in many cases of adequately assessing systems at higher voltages and/or power ratings. In situations where the specifying organization agrees to apply these tests to products with higher voltages and power ratings, the test laboratory is responsible for ensuring that adequate safety measures are employed to protect technicians and test equipment. The specifying organization is also responsible for defining the consumer safety requirements of these products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60891:2009, *Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-V characteristics*

IEC 60904-1:2006, *Photovoltaic devices – Part 1: Measurement of photovoltaic current-voltage characteristics*

IEC 61056-1:2012, *General purpose lead-acid batteries (valve-regulated types) – Part 1: General requirements, functional characteristics – Methods of test*

IEC 61215 (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61427-1:2013, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1: Photovoltaic off-grid application*

~~IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*~~

IEC 61951-2:2014 2017, *Secondary cells and batteries containing alkaline or other non acid electrolytes – ~~Portable~~ Secondary sealed ~~rechargeable single~~ cells and batteries for portable applications – Part 2: Nickel-metal hydride*

~~IEC 61960:2011, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*~~

IEC 61960-3:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications – Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them*

~~IEC 62087-1:2015, *Audio, video, and related equipment – Determination of power consumption – Part 1: General*~~

IEC 62087-2:2015, *Audio, video, and related equipment – Determination of power consumption – Part 2: Signals and media*

IEC 62087-3:2015, *Audio, video, and related equipment – Determination of power consumption – Part 3: Television sets*

IEC 62087-6:2015, *Audio, video, and related equipment – Determination of power consumption – Part 6: Audio equipment*

IEC TS 62257-12-1:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems*

IEC 62509:2010, *Battery charge controllers for photovoltaic systems – Performance and functioning*

CIE 15:2004, *Colorimetry*

CIE 084, *The measurement of luminous flux*

CIE 13.3, *Method of measuring and specifying colour rendering properties of light sources*

CIE 127, *Measurement of LEDs*

CIE 177, *Colour rendering of white LED light sources*

IESNA LM-78-07, *IESNA approved method for total luminous flux measurement of lamps using an integrating sphere photometer*

IESNA LM-79-08, *IES approval method for electrical and photometric measurements of solid state lighting products*

IESNA LM-80-08, *Approved method: measuring lumen maintenance of LED light sources*

TECHNICAL SPECIFICATION

**Recommendations for renewable energy and hybrid systems for rural
electrification –
Part 9-5: Integrated systems – Laboratory evaluation of stand-alone renewable
energy products for rural electrification**

CONTENTS

FOREWORD.....	15
INTRODUCTION.....	18
1 Scope.....	19
2 Normative references	19
3 Terms and definitions	21
4 Product components and characteristics.....	25
4.1 Components	25
4.1.1 Overview	25
4.1.2 Component categories.....	26
4.1.3 Lighting parts definitions.....	28
4.1.4 Appliance definitions.....	29
4.1.5 Additional system elements	30
4.2 System measurements and observations	30
4.2.1 General	30
4.2.2 Product design, manufacture, and marketing aspects	30
4.2.3 Product durability and workmanship aspects.....	33
4.2.4 Lighting durability aspects	36
4.2.5 Battery performance aspects	36
4.2.6 Solar module aspects	37
4.2.7 Electrical characteristics	38
4.2.8 Performance aspects	39
4.2.9 Light output aspects	41
4.2.10 Self-certification aspects.....	42
4.3 Constructions not specifically covered	43
5 Product specification	43
5.1 General.....	43
5.2 Applications	43
5.3 Quality assurance principles	44
5.4 Product specification framework description.....	44
5.4.1 General	44
5.4.2 Product specification template	45
5.4.3 Tolerances	49
5.4.4 Quality standards criteria.....	50
5.4.5 Warranty requirements criteria.....	55
6 Quality test method	56
6.1 General.....	56
6.2 Applications	56
6.3 Sampling requirements	56
6.4 Laboratory requirements	57
6.5 Testing requirements	57
6.6 Recommended tests programme.....	64
6.6.1 General	64
6.6.2 Test preparation	67
6.6.3 Batch A tests	67
6.6.4 Batch B tests	67
6.6.5 Batch C – potentially destructive tests	67

6.6.6	Report preparation.....	68
6.7	Reporting	68
7	Market check method	68
7.1	General.....	68
7.2	Applications	69
7.3	Sampling requirements	69
7.4	Laboratory requirements	70
7.5	Testing requirements	70
7.6	Recommended tests programme.....	70
7.7	Report requirements	70
8	Initial screening method.....	71
8.1	General.....	71
8.2	Applications	71
8.3	Sampling requirements	71
8.4	Laboratory requirements	72
8.5	Testing requirements	72
8.6	Recommended tests programme.....	72
8.7	Reporting	72
9	Accelerated verification method	72
9.1	General.....	72
9.2	Applications	73
9.3	Sampling requirements	73
9.3.1	General	73
9.3.2	Verification entry testing	73
9.3.3	Follow-up testing	74
9.4	Laboratory requirements	74
9.5	Testing requirements	74
9.5.1	General	74
9.5.2	Verification entry testing	75
9.5.3	Follow-up QTM testing.....	75
9.6	Recommended tests programme.....	75
9.7	Report requirements	75
10	Pay-as-you-go (PAYG) method.....	76
10.1	General.....	76
10.2	Applications	76
10.3	Sampling requirements	76
10.4	Laboratory requirements	77
10.5	Testing requirements	77
10.6	Recommended tests programme.....	78
10.7	Reporting	78
Annex A (informative)	Reserved	79
Annex B (informative)	Reserved	80
Annex C (informative)	Reserved	81
Annex D (normative)	Manufacturer self-reported information.....	82
D.1	Background	82
D.2	Outcomes	82
D.3	Solicited information	82
D.3.1	General	82

D.3.2	Confidential information (not released publicly).....	82
D.3.3	Public information (may be released publicly)	84
D.4	Reporting	86
Annex E (normative)	Product sampling	87
E.1	Background	87
E.2	Test outcomes	87
E.3	Related tests	87
E.4	Procedure	87
E.4.1	Retail sampling.....	87
E.4.2	Warehouse sampling	88
E.5	Reporting	89
Annex F (normative)	Visual screening	91
F.1	Background	91
F.2	Test outcomes	91
F.3	Related tests	91
F.4	Procedure	91
F.4.1	Properties, features, and information	91
F.4.2	Specifications	96
F.4.3	Functionality and internal inspection	99
F.5	Reporting	102
Annex G (normative)	Sample preparation	106
G.1	Background	106
G.2	Test outcomes	106
G.3	Related tests	106
G.4	Procedure	106
G.4.1	General	106
G.4.2	Equipment requirements	106
G.4.3	Test prerequisites	107
G.4.4	Procedure.....	107
G.4.5	Calculations.....	110
G.5	Reporting	110
Annex H (normative)	Power supply setup procedure	111
H.1	Background	111
H.2	Test outcomes	111
H.3	Related tests	111
H.4	Equipment requirements	111
H.5	Setup procedure for photometric measurements and lumen maintenance tests	112
H.5.1	Test setup	112
H.5.2	DC voltage and current levels	113
H.5.3	Stabilization period	114
H.5.4	4-wire power supply measurements	114
H.5.5	Filtering electronic noise	115
H.5.6	Troubleshooting.....	115
H.6	Reporting	117
Annex I (normative)	Light output test	118
I.1	Background	118
I.2	Test outcomes	118

I.3	Related tests	118
I.4	Luminous flux measurement techniques.....	119
I.4.1	General	119
I.4.2	Calculation for lighting appliances tested according to IEC TS 62257-12-1.....	119
I.4.3	Luminous flux measurements with an integrating sphere or goniophotometer.....	120
I.4.4	Luminous flux measurements using the multi-plane method.....	120
I.5	Correlated colour temperature (CCT) measurement	123
I.6	Colour rendering index (CRI) measurement	123
I.7	Reporting	123
Annex J (normative)	Lumen maintenance test.....	124
J.1	Background	124
J.2	Test outcomes	124
J.3	Related tests	125
J.4	Procedure	125
J.4.1	General	125
J.4.2	Equipment requirements	126
J.4.3	Test prerequisites	127
J.4.4	Test methods.....	127
J.5	Calculations	128
J.6	Alternate method for testing lumen maintenance using IESNA LM-80-08	128
J.6.1	Background	128
J.6.2	Equipment requirements	129
J.6.3	Test prerequisites	129
J.6.4	Procedure.....	129
J.6.5	DUT preparation and LED thermocouple attachment guidelines.....	130
J.6.6	Calculations.....	130
J.7	Reporting	130
Annex K (normative)	Battery test	133
K.1	Background	133
K.2	Test outcomes	133
K.3	Related tests	133
K.4	Procedure.....	133
K.4.1	General	133
K.4.2	Lead-acid battery test	134
K.4.3	Nickel-metal hydride battery test.....	137
K.4.4	Lithium-ion battery test	138
K.4.5	Lithium iron phosphate battery test.....	139
K.5	Reporting	140
Annex L (informative)	Battery testing recommended practices	141
L.1	Background	141
L.2	Deep discharge protection specifications by battery type	141
L.3	Overcharge protection specifications by battery type	142
Annex M (normative)	Full-battery run time test.....	143
M.1	Background	143
M.2	Test outcomes	143

M.3	Related tests	144
M.4	Equipment requirements	144
M.5	Test prerequisites	145
M.6	Apparatus	145
M.7	Procedure	146
M.8	Calculations	149
M.9	Reporting	151
Annex N (normative)	Full discharge preparation	153
N.1	Background	153
N.2	Test outcomes	153
N.3	Related tests	153
N.4	Procedure	153
N.4.1	General	153
N.4.2	Equipment requirements	153
N.4.3	Test prerequisites	153
N.4.4	Procedure	154
N.4.5	Calculations	155
N.5	Reporting	155
Annex O (normative)	Grid charge test	156
O.1	Background	156
O.2	Test outcomes	156
O.3	Related tests	156
O.4	Procedure	156
O.4.1	General	156
O.4.2	Equipment requirements	156
O.4.3	Test prerequisites	157
O.4.4	Apparatus	157
O.4.5	Procedure	157
O.4.6	Calculations	157
O.5	Reporting	158
Annex P (normative)	Electromechanical charge test	159
P.1	Background	159
P.2	Test outcomes	159
P.3	Related tests	159
P.4	Procedure	159
P.4.1	General	159
P.4.2	Equipment requirements	159
P.4.3	Test prerequisites	160
P.4.4	Apparatus	160
P.4.5	Procedure	160
P.4.6	Calculations	160
P.4.7	Modifications for atypical products	160
P.5	Reporting	161
Annex Q (normative)	Photovoltaic module I-V characteristics test	162
Q.1	Background	162
Q.2	Test outcomes	162
Q.3	Related tests	163
Q.4	Procedure	163

Q.4.1	Substitution of IEC 61215-2 test results	163
Q.4.2	Test programme using a solar simulator	164
Q.4.3	Outdoor photovoltaic module I-V characteristics test.....	166
Q.5	Reporting	171
Annex R (normative)	Solar charge test.....	172
R.1	Background	172
R.2	Test outcomes	172
R.3	Related tests	172
R.4	Procedure	173
R.4.1	General	173
R.4.2	Test method using a resistor network	173
R.4.3	Test method using a solar array simulator (SAS)	180
R.4.4	Calculations.....	181
R.4.5	Alternative method to measure battery-charging circuit efficiency	189
R.5	Reporting	190
Annex S (normative)	Charge controller behaviour test	193
S.1	Background	193
S.2	Test outcomes	193
S.3	Related tests	194
S.4	Procedure	194
S.4.1	Active deep discharge protection test	194
S.4.2	Active overcharge protection test.....	196
S.4.3	Passive deep discharge protection test.....	200
S.4.4	Passive overcharge protection test	202
S.4.5	Standby loss measurement.....	204
S.5	Reporting	205
Annex T (normative)	Light distribution test	207
T.1	Background	207
T.2	Test outcomes	207
T.3	Related tests	208
T.4	Substitution of results from IEC TS 62257-12-1.....	208
T.5	Approved test methods	208
T.5.1	General	208
T.5.2	Goniophotometer	211
T.5.3	Multi-plane method	211
T.5.4	Illuminance on a plane method	215
T.5.5	Turntable method	218
T.5.6	Illuminance on a desktop method.....	220
T.6	Reporting	221
Annex U (normative)	Physical and water ingress protection test	226
U.1	Background	226
U.2	Test outcomes	226
U.3	Related tests	227
U.4	Procedure	227
U.4.1	General	227
U.4.2	IP testing at a laboratory that has been accredited to test according to IEC 60529	227
U.4.3	Simplified IP inspection for ingress of solid foreign objects	228

U.4.4	Simplified IP preliminary inspection for ingress of water with harmful effects	229
U.5	Reporting	232
Annex V (normative)	Level of water protection	233
V.1	Background	233
V.2	Test outcomes	233
V.3	Related tests	234
V.4	Laboratory requirements	234
V.5	Procedure	234
V.5.1	General	234
V.5.2	Level of water protection for enclosure only	235
V.5.3	Level of water protection from technical aspects	235
V.5.4	Overall level of water protection	238
V.6	Reporting	239
Annex W (normative)	Mechanical durability test	241
W.1	Background	241
W.2	Test outcomes	241
W.3	Related tests	242
W.4	Procedures	242
W.4.1	Drop test	242
W.4.2	Switch and connector test	244
W.4.3	Gooseneck and moving part test	245
W.4.4	Strain relief test	246
W.5	Reporting	248
Annex X (informative)	Reserved	250
Annex Y (informative)	Photometer box for relative luminous flux measurements	251
Y.1	Background	251
Y.2	Plans	252
Y.3	Instructions for construction	255
Annex Z (informative)	Reserved	256
Annex AA (informative)	Reserved	257
Annex BB (normative)	Battery durability test	258
BB.1	Background	258
BB.2	Test outcomes	258
BB.3	Related tests	258
BB.4	Procedure	258
BB.4.1	Durability storage test for valve-regulated lead-acid batteries	258
BB.4.2	Durability storage test for flooded lead-acid batteries	259
BB.4.3	Durability storage test for nickel-metal hydride batteries	260
BB.4.4	Durability storage test for lithium-ion batteries	261
BB.4.5	Durability storage test for lithium iron phosphate batteries	262
BB.5	Reporting	263
Annex CC (normative)	Equipment requirements	264
CC.1	Overview	264
CC.2	Requirements and recommendations for equipment and materials	264
CC.3	Guidelines for electrical power measurements	275
CC.3.1	Background	275
CC.3.2	Overview of DC power measurement	275

CC.3.3	Power measurement accuracy recommendations.....	277
CC.3.4	Additional guidelines and corrective measures	278
Annex DD (normative)	Protection tests	279
DD.1	Background	279
DD.2	Test outcomes	279
DD.3	Related tests	280
DD.4	Procedure	280
DD.4.1	Miswiring protection test	280
DD.4.2	Output overload protection test	283
DD.4.3	PV overvoltage protection test	286
DD.5	Reporting	290
Annex EE (normative)	Assessment of DC ports	294
EE.1	Background	294
EE.2	Test outcomes	294
EE.3	Related tests	295
EE.4	Procedure	295
EE.4.1	Preparation.....	295
EE.4.2	Measurement of steady-state port characteristics	296
EE.4.3	Dynamic measurement	306
EE.4.4	Summary calculations	310
EE.4.5	Pass/fail tests for functionality and truth in advertising.....	310
EE.5	Reporting	314
Annex FF (normative)	Appliance tests	316
FF.1	Background	316
FF.2	Appliance testing requirements	316
FF.3	Test outcomes	318
FF.4	Related tests	319
FF.5	Setup and determination of appliance operating voltage	319
FF.5.1	General	319
FF.5.2	Procedure using the power control unit.....	320
FF.5.3	Procedure using a power supply	321
FF.6	Power consumption test.....	322
FF.6.1	General	322
FF.6.2	General equipment requirements	322
FF.6.3	Procedure for appliances that have been previously tested according to a recognized test method.....	322
FF.6.4	Test procedure for LED or CFL lighting appliances without an internal battery	324
FF.6.5	Test procedure for television sets without internal batteries	325
FF.6.6	Test procedure for radios without internal batteries.....	326
FF.6.7	Test procedure for fans, motor-driven appliances, and other appliances without internal batteries.....	327
FF.6.8	Test procedure for appliances with an internal battery	328
FF.7	Charging efficiency test	330
FF.7.1	General	330
FF.7.2	Equipment requirements	330
FF.7.3	Test prerequisites	330
FF.7.4	Procedure.....	330
FF.7.5	Calculations.....	331

FF.8	Appliance operating voltage range test	331
FF.8.1	General	331
FF.8.2	Equipment requirements	332
FF.8.3	Test prerequisites	332
FF.8.4	Simultaneous testing for multiple products and applicability of previous test results	332
FF.8.5	Procedure for appliances without batteries that have been tested according to a recognized test method	333
FF.8.6	Procedure for appliances without an internal battery	335
FF.8.7	Procedure for appliances with internal batteries	336
FF.9	Appliance full-battery run time test with deep discharge protection measurement	337
FF.9.1	General	337
FF.9.2	Equipment requirements	337
FF.9.3	Test prerequisites	337
FF.9.4	Apparatus	337
FF.9.5	Procedure	338
FF.9.6	Calculations	340
FF.10	Reporting	341
Annex GG (normative)	Energy service calculations	343
GG.1	Background	343
GG.2	Test outcomes	344
GG.3	Related tests	345
GG.4	Procedure	346
GG.4.1	Full-battery run time energy service calculations	346
GG.4.2	Solar run time energy service calculations	360
GG.4.3	Grid or electromechanical run time energy service calculations	377
GG.4.4	Solar charging time calculation	377
GG.5	Reporting	378
Annex HH (normative)	Generic appliances	380
HH.1	Background	380
HH.2	Test outcomes	380
HH.3	Related tests	380
HH.4	Equipment requirements	380
HH.5	Procedures	381
HH.5.1	Constructing generic appliances	381
HH.5.2	Appliance reference values	383
HH.6	Reporting	383
Bibliography	384
Figure 1	– Fixed indoor components and PV module – Example	26
Figure 2	– Fixed outdoor components with an indoor light point – Example	27
Figure 3	– Portable separate components – Example	27
Figure 4	– Portable integrated components – Example	28
Figure 5	– Division of a product into subsystems – Illustrative example	29
Figure 6	– Recommended sequence of testing for QTM for products without ports	65
Figure 7	– Recommended sequence of testing for QTM for products with ports	66
Figure G.1	– Connections with secondary set of wires to avoid battery disconnection	110

Figure H.1 – Power supply setup for powering a power control unit.....	112
Figure H.2 – Power supply setup for directly powering an appliance	112
Figure H.3 – 4-wire test configuration with input filter capacitors	115
Figure I.1 – Conceptual schematic of the light output test setup, including the 11 × 11 grid, Cartesian coordinate axes for rotation reference, and the DUT	121
Figure J.1 – Example lumen maintenance plot	132
Figure M.1 – Interior view of photometer box with suspended light.....	146
Figure M.2 – Plot of example results for a product with lighting appliances	150
Figure Q.1 – PV module I-V curve testing rack.....	167
Figure R.1 – Schematic of the power supply and DUT connection for the solar charge test.	175
Figure R.2 – Example "true" and simulated I-V curves plotted with the deviation ratio.....	179
Figure R.3 – Example plots of current vs. time for four different DUT batteries	183
Figure R.4 – Example time series plot of the solar charging cycle showing the maximum power available from the PV simulator, actual power supplied by the PV simulator, and power delivered to the batteries	191
Figure R.5 – Example time series plot of the solar charging cycle showing the instantaneous battery-charging circuit efficiency and solar operation efficiency	192
Figure S.1 – Schematic of the DC power supply-DUT connection using a series protection resistor.....	197
Figure T.1 – Horizontal plane for determining FWHM angle and radial illuminance distribution, for an omnidirectional light point	209
Figure T.2 – Horizontal plane for determining FWHM angle and radial illuminance distribution, for a directed light point	210
Figure T.3 – Radial illuminance distributions in the horizontal plane for two example products, showing the calculation of the horizontal FWHM angle	214
Figure T.4 – Radial illuminance distribution in the vertical plane for an example omnidirectional ambient light with vertical FWHM = 108°	215
Figure T.5 – Schematic of a task light suspended above an illuminance meter.....	216
Figure T.6 – Schematic of turntable setup, with the DUT shown.....	219
Figure T.7 – Side view of desktop light measuring setup.....	221
Figure T.8 – Example plot of usable area as a function of minimum illuminance.....	223
Figure T.9 – Example of resulting surface plot of light distribution from the brightest "face" of the multi-plane method or illuminance on a plane method	224
Figure T.10 – Example of a polar plot of the radial illuminance distribution	225
Figure U.1 – Side view of the apparatus for testing an external solar module for protection against water ingress	231
Figure W.1 – Three-dimensional Cartesian coordinate system for drop test reference.....	243
Figure W.2 – Cable strain angle (γ) schematics for a PV module junction box (left) and a separate light point (right)	247
Figure Y.1 – Interior view of a completed photometer box	251
Figure Y.2 – Exterior view of completed photometer box.....	252
Figure Y.3 – Photometer box dimensions	253
Figure Y.4 – Photometer box assembly pieces and list of materials	254
Figure EE.1 – Schematic of the example DUT with DC port and USB port and variable resistors connected for the measurement of steady-state port characteristics	299
Figure EE.2 – Example of the plots of port characteristics	305

Figure EE.3 – Schematic of the DUT with DC port and USB port and variable resistors connected for the dynamic measurement	307
Figure EE.4 – Illustration of stepped current waveform for procedure 2.....	309
Figure EE.5 – Example time series plot of voltage and current showing a step increase in current and the resulting voltage undershoot.....	309
Figure EE.6 – Example time series plot of voltage and current showing a step decrease in current and the resulting voltage overshoot.....	310
Figure EE.7 – Illustration of functionality assessment	312
Figure EE.8 – Typical configuration of USB port data lines	314
Figure EE.9 – Pin configuration of type A receptacle.....	314
Figure FF.1 – Illustration of calculation of minimum and maximum values of port voltage for the appliance operating voltage range test	334
Figure GG.1 – Conceptual energy flow diagram for energy service estimates	344
Table 1 – Applications of product specifications	44
Table 2 – Qualification as separate PV module	45
Table 3 – Truth-in-advertising tolerance	46
Table 4 – Safety and durability standards	47
Table 5 – End user support standards.....	48
Table 6 – End user support requirements.....	49
Table 7 – Truth-in-advertising criteria for quality standards	51
Table 8 – Remarks on common truth-in-advertising aspects.....	52
Table 9 – Safety and durability criteria for quality standards	53
Table 10 – Recommended level of water protection by product category.....	55
Table 11 – End user support criteria for quality standards.....	55
Table 12 – Criteria for warranty standards	55
Table 13 – Applications of QTM results.....	56
Table 14 – QTM testing requirements	59
Table 15 – Applications of MCM results	69
Table 16 – Applications of ISM results	71
Table 17 – Applications of AVM results	73
Table 18 – Applications of PAYG method results	76
Table 19 – PAYG testing requirements	78
Table D.1 – Manufacturer self-reported information outcomes	82
Table E.1 – Product sampling outcomes	87
Table F.1 – Visual screening test outcomes	91
Table G.1 – Recommended minimum conductor sizes for copper wire	107
Table H.1 – Power supply setup test outcome.....	111
Table H.2 – Standard operating voltage for several common battery types	113
Table H.3 – Voltage and current reporting requirements	117
Table I.1 – Light output test outcomes	118
Table J.1 – Lumen maintenance test outcomes.....	125
Table J.2 – Measurement schedule for full screening test	126
Table J.3 – Measurement schedule for initial screening test	126

Table K.1 – Battery test outcomes	133
Table K.2 – Recommended battery testing parameters	134
Table L.1 – Recommended battery deep discharge protection voltage specifications	142
Table L.2 – Recommended battery overcharge protection voltage and temperature specifications	142
Table M.1 – Full-battery run time test outcomes	144
Table O.1 – Grid charge test outcomes	156
Table P.1 – Mechanical charge test outcomes	159
Table Q.1 – Photovoltaic module I-V characteristics test outcomes	162
Table R.1 – Solar charge test outcomes	172
Table R.2 – Simulated solar day power supply settings	179
Table S.1 – Charge controller behaviour test outcomes	194
Table T.1 – Light distribution test outcomes	207
Table T.2 – Summary of testing options for characterizing lamp distributions	208
Table T.3 – Table of example illuminance measurements on the brightest "face" of the 1 m ² grid and usable area as a function of minimum illuminance	223
Table U.1 – Water exposure and physical ingress protection test outcomes	226
Table V.1 – Water exposure and physical ingress protection test outcomes	234
Table V.2 – Enclosure-only level of water protection requirements	235
Table V.3 – Adjusted level of water protection for products with additional technical water protection	236
Table V.4 – Example detailed assessment supporting technical level of water protection	238
Table V.5 – Overall level of water protection requirements	238
Table W.1 – Mechanical durability test outcomes	241
Table BB.1 – Battery durability test outcomes	258
Table CC.1 – Symbols used in test method column of Table CC.2	264
Table CC.2 – Specifications for all required test equipment	265
Table DD.1 – Protection test outcomes	279
Table DD.2 – Allowable port voltage limit by nominal voltage	287
Table DD.3 – Example table of miswiring protection test results	292
Table DD.4 – Example table of PV overvoltage test results	293
Table EE.1 – DC ports assessment outcomes	294
Table EE.2 – Current pairs for dynamic test	308
Table EE.3 – Recommended voltage and current ranges for port functionality assessment	311
Table FF.1 – Appliance testing requirements	317
Table FF.2 – Appliance test outcomes	318
Table FF.3 – Example table of appliance operating voltage, measured voltage, measured current, and calculated power	342
Table GG.1 – Energy service calculations outcomes	345
Table GG.2 – Examples of advertised combinations involving mobile devices	348
Table GG.3 – Required inputs to estimate the full-battery run time(s)	350
Table GG.4 – Example usage profile	352
Table GG.5 – Required inputs to estimate the solar run time	361

Table GG.6 – Representative case for appliance usage when solar charging	362
Table HH.1 – Power consumption chart for generic appliances	381
Table HH.2 – Energy capacity of generic appliances with internal batteries	383

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RECOMMENDATIONS FOR RENEWABLE ENERGY
AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –****Part 9-5: Integrated systems –
Laboratory evaluation of stand-alone
renewable energy products for rural electrification**

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-9-5, which is a Technical Specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This fourth edition cancels and replaces the third edition issued in 2016. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Replaced the term "stand-alone lighting kits" with "stand-alone renewable energy products" throughout the document (including the title) to reflect that the revised document is applicable to a broader range of products with a more diverse set of capabilities.
- b) Removed the distinction between Class A, Class B, and Class C procedures.
- c) Added an option for the AVM method in which the AVM-VE test can be conducted with a sample size of 6 and the follow-up test can be conducted with a sample size of 2.
- d) Provided guidance on how to accept test results from other approved test methods.
- e) Added test methods for flooded lead-acid batteries.
- f) Significantly revised the protection tests, assessment of DC ports, appliance tests, and energy service calculations based on field experience.
- g) Revised the voltage operating points at which testing is carried out to better reflect actual operation and to simplify the procedures for testing products without lights.
- h) Revised the energy service calculations to include the effect of multiple simultaneously connected loads on the port voltage and battery-to-port efficiency and to accommodate products with grid or electromechanical charging.
- i) Removed the restriction that all connections shall be "plug-and-play."
- j) Added discussion of measurement error and accuracy for DC power measurements.

This part of IEC 62257 is to be used in conjunction with IEC 62257 (all parts).

The text of this Technical Specification is based on the following documents:

Enquiry draft	Reports on voting
82/1346/DTS	82/1385A/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

IEC 62257 (all parts) provides support and strategies for institutions involved in rural electrification projects. It documents technical approaches for designing, building, testing, and maintaining off-grid renewable energy and hybrid systems with AC nominal voltage below 500 V, DC nominal voltage below 750 V and nominal power below 100 kVA.

These documents are recommendations to support buyers who want to connect with good quality options in the market:

- to choose the right system for the right place,
- to design the system, and
- to operate and maintain the system.

These documents are focused only on technical aspects of rural off-grid electrification concentrating on, but not specific to, developing countries. They are not considered as all inclusive to rural electrification. The documents do not describe a range of factors that can determine project or product success: environmental, social, economic, service capabilities, and others. Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems, and costs. The main objectives are to support the capabilities of households and communities that use small renewable energy and hybrid off-grid systems and inform organizations and institutions in the off-grid power market.

The purpose of this document is to specify laboratory test methods for evaluating the quality assurance of stand-alone renewable energy products. This document is specifically related to renewable energy products that are packaged and made available to end-use consumers at the point of purchase as single, stand-alone products that do not require additional system components to function.

The term "stand-alone renewable energy product" is used in this document to describe this class of products. Other equivalent terms, including "off-grid solar" or "rechargeable," are often used by manufacturers, distributors, and other stakeholders to describe these products. Many of these systems meet the definition of type T₂I (individual electrification systems with energy storage) in IEC TS 62257-2.

The intended users of this document are:

- Market support programmes that support the off-grid lighting market with financing, consumer education, awareness, and other services;
- Manufacturers and distributors that need to verify the quality and performance of products;
- Bulk procurement programmes that facilitate or place large orders of products; and,
- Trade regulators such as government policymakers and officials who craft and implement trade and tax policy.

This document establishes the framework for creating a product specification, the basis for evaluating quality for a particular context. Product specifications include minimum requirements for quality standards and warranty requirements. Products are compared to specifications based on test results and other information about the product. The product specification framework is flexible and can accommodate the goals of diverse organizations and institutions. The tests and inspections are designed to be widely applicable across different markets, countries, and regions.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-5: Integrated systems – Laboratory evaluation of stand-alone renewable energy products for rural electrification

1 Scope

This part of IEC 62257, which is a Technical Specification, applies to stand-alone renewable energy products having the following characteristics:

- All components required to provide basic energy services are sold/installed as a kit or integrated into a single component, including at a minimum:
 - A battery/batteries or other energy storage device(s)
 - Power generating device, such as a solar panel, capable of charging the battery/batteries or other energy storage device(s)
 - Cables, switches, wiring, connectors and protective devices sufficient to connect the power generating device, power control unit(s) and energy storage device(s)
 - Loads (optional), such as lighting, load adapter cables (e.g., for mobile devices), and appliances (television, radio, fan, etc.).
- The PV module maximum power point voltage and the working voltage of any other components in the kit do not exceed 35 V. Exceptions are made for AC-to-DC converters that meet appropriate safety standards.

NOTE This voltage limit corresponds to the definition of decisive voltage classification A (DVC-A) for wet locations in Table 6 of IEC 62109-1:2010.

- The peak power rating of the PV module or other power generating device is less than or equal to 350 W.
- No design expertise is required to choose appropriate system components.

This document was written primarily for off-grid renewable energy products with batteries and solar modules with DC system voltages not exceeding 35 V and peak power ratings not exceeding 350 W. The tests contained herein are capable in many cases of adequately assessing systems at higher voltages and/or power ratings. In situations where the specifying organization agrees to apply these tests to products with higher voltages and power ratings, the test laboratory is responsible for ensuring that adequate safety measures are employed to protect technicians and test equipment. The specifying organization is also responsible for defining the consumer safety requirements of these products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60891:2009, *Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-V characteristics*

IEC 60904-1:2006, *Photovoltaic devices – Part 1: Measurement of photovoltaic current-voltage characteristics*

IEC 61056-1:2012, *General purpose lead-acid batteries (valve-regulated types) – Part 1: General requirements, functional characteristics – Methods of test*

IEC 61215 (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61427-1:2013, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1: Photovoltaic off-grid application*

IEC 61951-2:2017, *Secondary cells and batteries containing alkaline or other non acid electrolytes – Secondary sealed cells and batteries for portable applications – Part 2: Nickel-metal hydride*

IEC 61960-3:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications – Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them*

IEC 62087-2:2015, *Audio, video, and related equipment – Determination of power consumption – Part 2: Signals and media*

IEC 62087-3:2015, *Audio, video, and related equipment – Determination of power consumption – Part 3: Television sets*

IEC 62087-6:2015, *Audio, video, and related equipment – Determination of power consumption – Part 6: Audio equipment*

IEC TS 62257-12-1:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems*

IEC 62509:2010, *Battery charge controllers for photovoltaic systems – Performance and functioning*

CIE 15:2004, *Colorimetry*

CIE 084, *The measurement of luminous flux*

CIE 13.3, *Method of measuring and specifying colour rendering properties of light sources*

CIE 127, *Measurement of LEDs*

CIE 177, *Colour rendering of white LED light sources*

IESNA LM-78-07, *IESNA approved method for total luminous flux measurement of lamps using an integrating sphere photometer*

IESNA LM-79-08, *IES approval method for electrical and photometric measurements of solid state lighting products*

IESNA LM-80-08, *Approved method: measuring lumen maintenance of LED light sources*