Research Center for Photovoltaics

複合加速試験に許容される試験費用推定

Acceptable volume of investment for “Combined Stress Testing”

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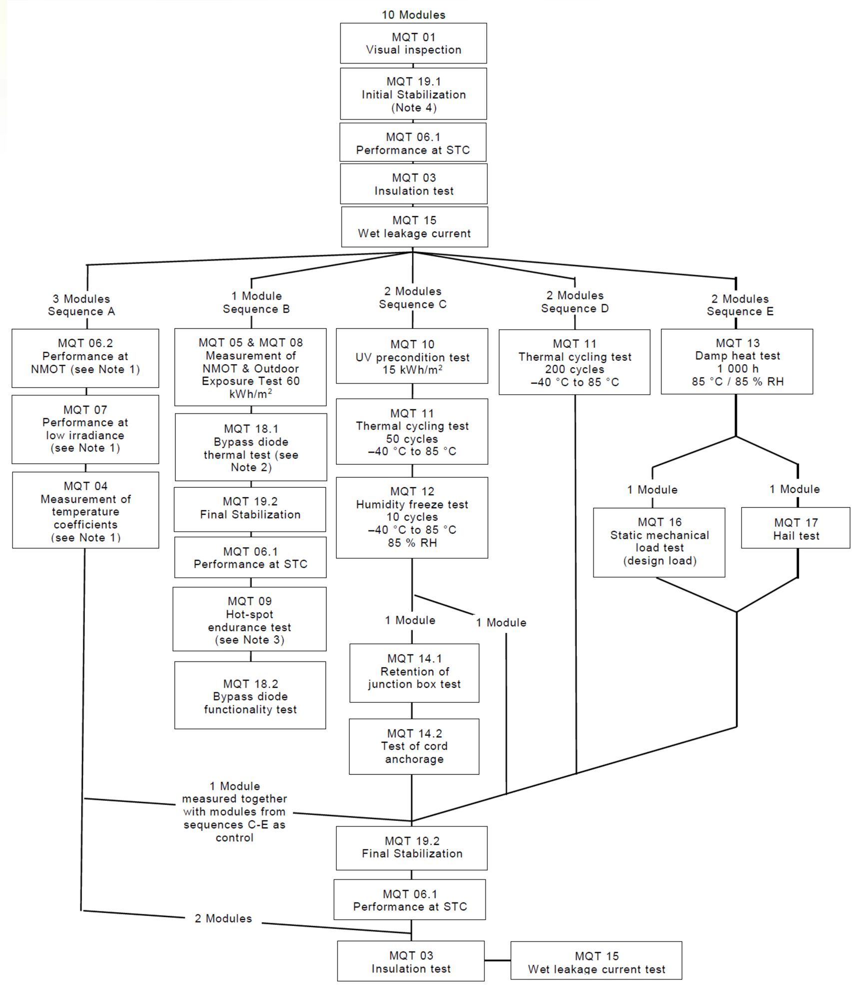
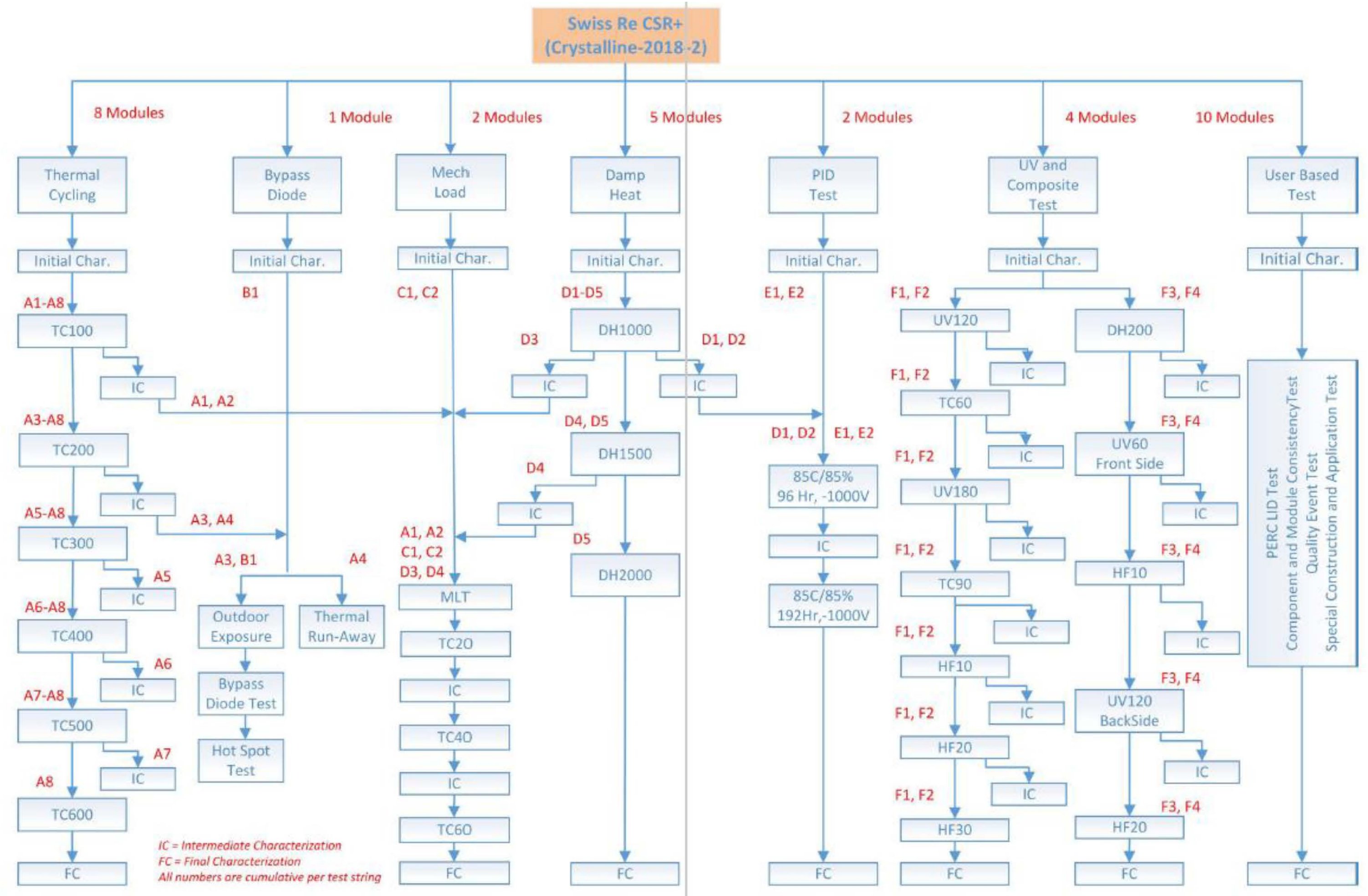
Summary

The combined stress tests, in which some kinds of stressors simultaneously applied to the testing PV modules, have several advantages to contribute the risk avoidance on long-term operation of PV modules in fields (find the failure modes which are a-priori unknown in new module designs, reduction of potential risk, acceleration of the time to market of a product, and so on). Through the analyses for the cost-of-ownerships in the conventional qualification test and the proposed extended stress tests for PV modules, we predict that of a combined stress test, to clarify the acceptable level of investment for this novel test system. In this study, we demonstrate that, if we could develop the test equipment with a comparable cost to those required in these extended stress tests, the combined stress test would be accepted by all stake-holders in PV industry sector. Furthermore, it is suggested that the market penetration of this combined stress test would be facilitated by the equipment-improvement for the multi-module testing.

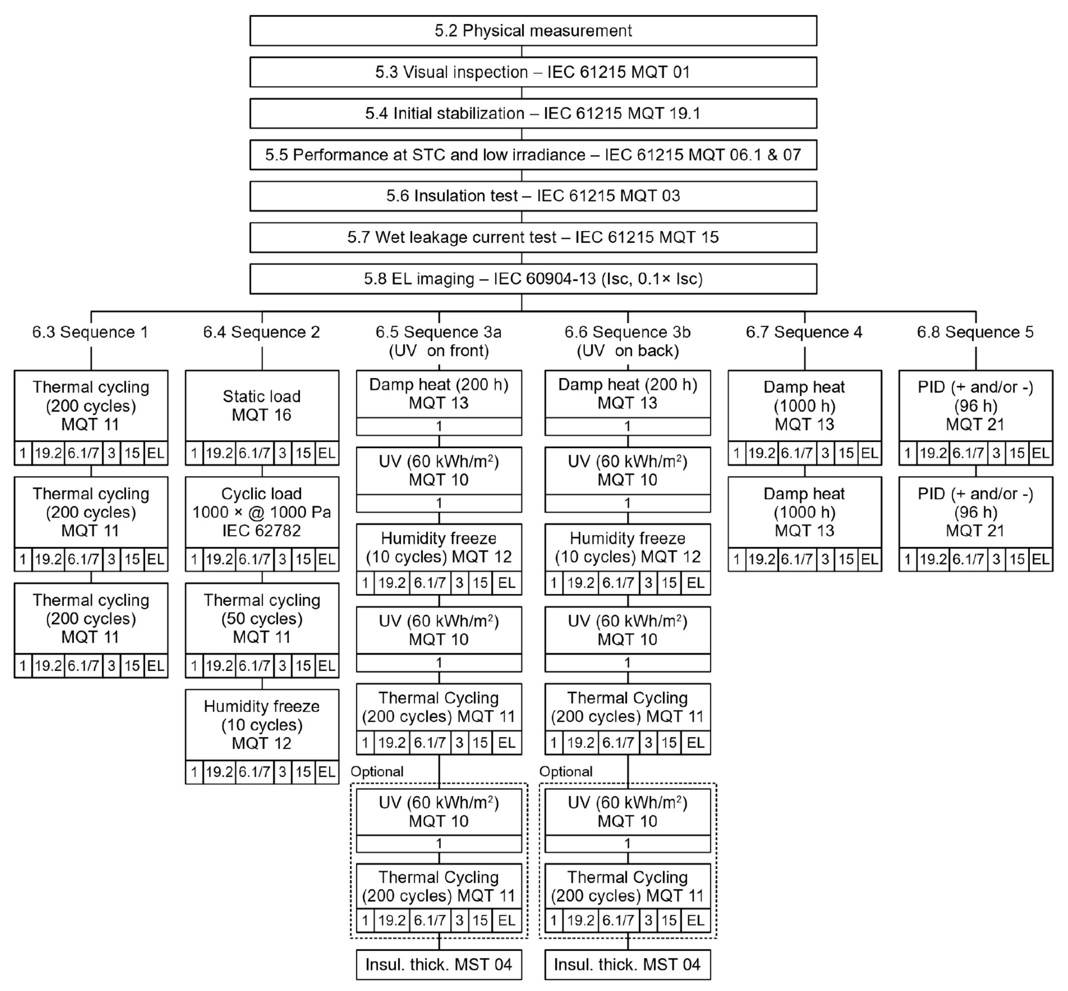
Conventional Qualification Test & Proposed Extended Stress Tests



IEC 61215-1-1: 2016 [1]



CSR+: 2018 [2]



IEC TS 63209 draft [3]

Approach & Results

The cost-of-ownerships of the existing test system (IEC 61215-1-1) and 2 proposed protocol (CSR+ and IEC TS 63209 draft) were calculated, in reference to the total cost-of-ownership guide on PV cell manufacturing [4]–[6] (**Tables I, II, III**).

Table I: Spread sheet to be input the price and the depreciation period of equipment required in IEC 61215-1-1

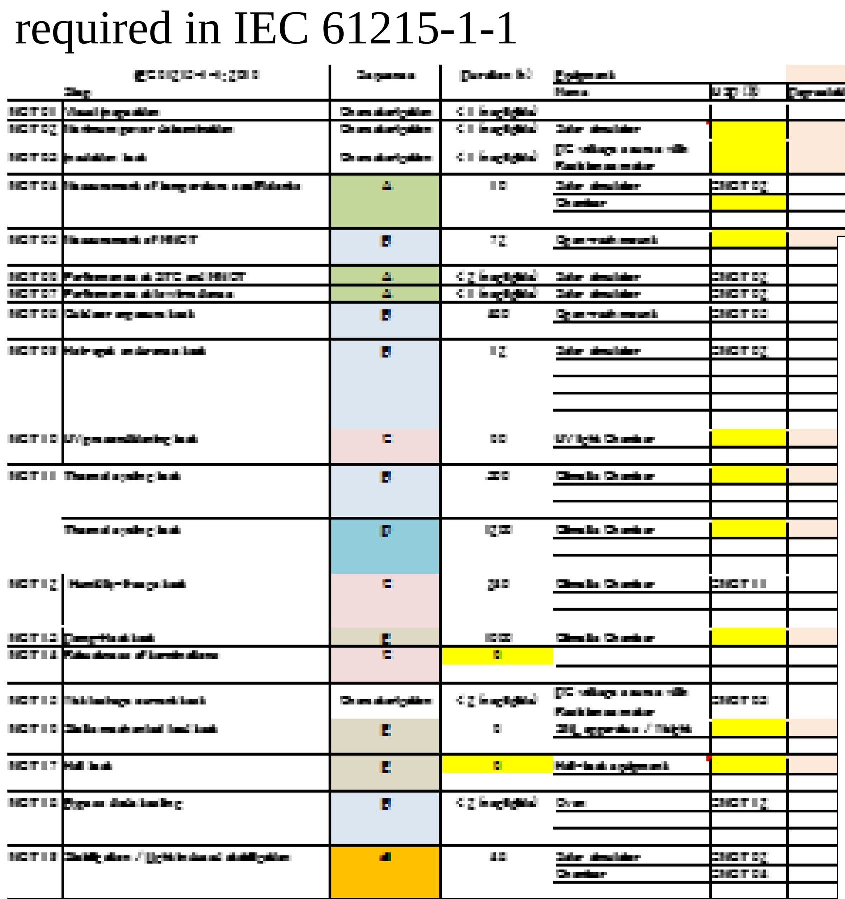


Table II: Annual cumulative tests calculation

In Case of IEC 61215-1-1

Unit Tact: 1,300 h TC 200 (6 h x 200 cycles)
+ Stabilization
+ Inspection + else

Productive Time: 8,396 h
Operation Time - Standby Time - else

Annual Turnover: 6.45 = 8,396/1,300 --- (a)

Chamber Capacity: 10 modules/chamber --- (b)
Required Module: 2 --- (c)
in IEC 61215-1-1 Seq. C, D, and E
Max Parellel Test: 5 = (b)/(c)
Safety Factor: 0.95
Practical Parallel Test: 4 (during Unit Tact) --- (d)
Ann. Cumulative Tests: 25.8 = (a) x (d) --- (e)

Unit Modules/Test: 10 --- (f)
(IEC 61215-1-1 Sample Size)
Annual Throughput: 258 = (e) x (f)

Table III: Annual cumulative tests in 3 test-protocols*

Test Protocol	61215-1-1	CSR+	63209 draft
Unit Tact (h)	1,300	3,700	3,700
Ann. Turnover	6.45	2.33	2.33
Parallel Tests	4	1	1
Ann. Cumulative Tests (Tests/Year)	25.8	2.33	2.33
Unit Modules/Test	10	32	50**
Ann. Throughput (Modules/Year)	258	74.6	116.5

* The optional tests (e.g., the user-based tests defined in CSR+) are not included.

** Since the major objective of IEC TS 63209 draft is the risk-data collection on the testing PV modules, we assumed that the confidence in the test results would be emphasized by a large sample size (e.g., 10 modules/sequence).

Acceptable volume of investment (AVI) for the increasing in confidence on reliability = ca. 10-times of the unit cost in the conventional qualification test

Table IV: Assumed add-on process costs by cost element

		61215-1-1				CSR+				63209 draft			
1	Depreciation	319	k$/y	26.9	%	0.83	-fold	23.5	%	0.80	-fold	22.5	%
2	Floor space	444	k$/y	52.4	%	1.00	-fold	54.9	%	1.00	-fold	55.4	%
3	Materials/Consumables	41	k$/y			1.00	-fold			1.00	-fold		
4	Utilities	54	k$/y			1.00	-fold			1.00	-fold		
5	Waste Disposal	81	k$/y			1.00	-fold			1.00	-fold		
6	Labor	245	k$/y	20.7	%	1.00	-fold	21.7	%	1.00	-fold	21.7	%
7	Cost of Yield Loss	0	k$/y			0				0			
8	Cost of Ownership	1,183	k$/y			1,130	k$/y			1,120	k$/y		
9	Ann. Cumulative Tests	25.8	tests/y			2.33	tests/y			2.33	test/y		
10	Unit Cost (Cost / Test)	46	k$/test			485	k$/test			480	k$/test		

References

[1] Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules. IEC 61215-1-1: 2016, 2016.
[2] J. Li and E. Hsi, Solar Panel Code of Practice International guideline on the risk management and sustainability of solar panel warranty insurance. Swiss Reinsurance, 2018.
[3] Extended-stress testing of photovoltaic modules for risk analysis. IEC TS 63209 draft.
[4] D. W. Jimenez, “Cost of ownership and overall equipment efficiency: a photovoltaics perspective,” Photovoltaics International, pp. 16–22, 2009.
[5] Guide to Calculate Cost of Ownership (COO) Metrics for Semiconductor Manufacturing Equipment. SEMI E35-0618, 2017.
[6] SEMI and VDMA, “Calculate cost of ownership,” 2014. [Online]. Available: http://www.itrpv.net/.cm4all/iproc.php/SEMI_CoO_Template_20140218.xlsx?cdp=a.