

**Application Note**  
**Measurement and Pre Conditioning of**  
**Calyxo PV Modules**  
**Series: CX1, CX3, CX3pro, CX3plus, CX3pro-2**

**Scope**

This document gives a short overview about the key requirement in order to measure Calyxo modules on a standard industrial flasher. It also describes a fast module preconditioning method.

**Content**

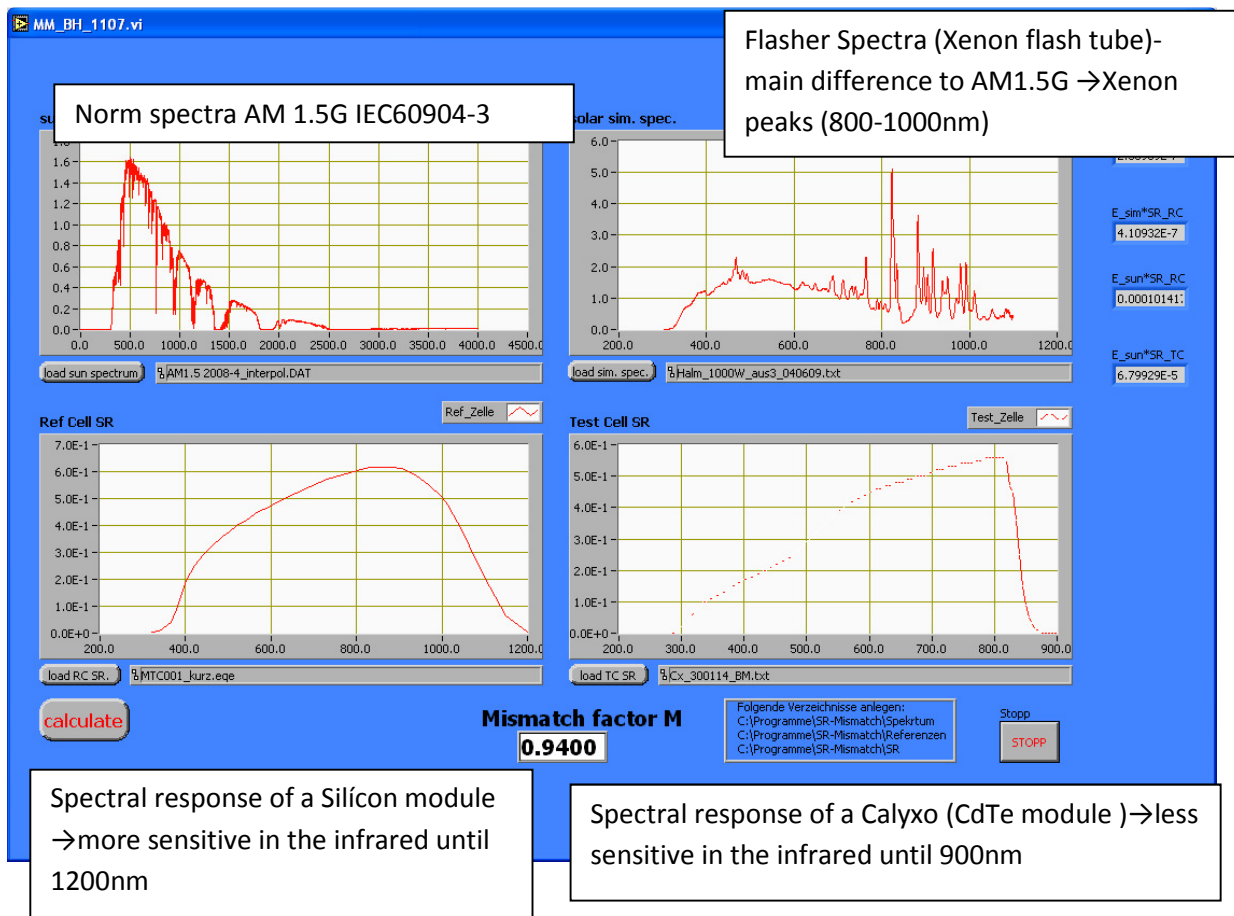
1. Spectral mismatch correction
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**1. Spectral mismatch correction**

Measuring Calyxo modules with an indoor flasher, the test-engineer has to take care of the differences (see also IEC Standard IEC60904 1-10 for measuring IV curves on solar cells & modules)

- a) of AM1.5G spectrum IEC360904-3 to Flasher spectrum (e.g. Spire, Halm) and
- b) the spectral response of the reference module (e.g. Si) and the test module (CdTe).

If the Flasher is calibrated with a silicon module to 1000W/m<sup>2</sup> and a CdTe module is measured against it a spectral correction for the Isc measurement needs to be done. In the next pictures, you can find an example how to proceed.



$$I_{sc} \text{ (corrected)} = I_{sc} \text{ (measured)} / \text{Mismatch factor (IEC 60904-7)}$$

$I_{sc}(\text{corrected}) = I_{sc}(\text{measured})/0.94$

In our example, if  $I_{sc}$  is not corrected, the measurement will yield a result which is minimum 6% relative to low. The correction factor will vary according to the spectrum of the flash used, as can be seen from this example.

## 2. IV Tracker Requirement

Parameter	Symbol	Unit	Minimum	Typical	Maximum
Exposure Time after reaching 1000 W/m <sup>2</sup> before starting IV Tracker	t_exp	[ms]	10	15	50
Time to measure the IV curve	t_m	[ms]	20		100

## 3. Optical Pulse Requirement

Parameter	Symbol	Unit	Minimum	Typical	Maximum
Optical Pulse Length at 1000 W/m <sup>2</sup>	t_pulse	[ms]	t_exp + t_m		300

The IV tracker should start the measurement from Voc over Vmpp towards  $I_{sc}$ . The direction and dynamic set up has an impact on the result of the flasher measurement. The reason for the requirement is the impact of the capacitance of the module on the measurement result.

## 4. Preconditioning of the modules prior IV-curve measurement

In order to compensate the typical reversible dark soak behavior of CdTe modules it is needed to light soak the modules at one sun (1000W/m<sup>2</sup> light intensity) with an open connector for 40 hours at 75°C. If need allow the module an heating up time of up to two hours.

Parameter	Symbol	Unit	Minimum	Typical	Maximum
Light Soak Temperature	T_LS	[°C]	70	75	80
Ligh Soak Time	t_LS	[h]	36	40	44
Time to heat the module	T_heat	[ms]	1,0	1,5	2,0
Current	I_LS	[A]	0	0	0
Light Soak Intensity	P_LS	[W/m <sup>2</sup> ]	800	1000	1050
Homogeneity Temperature	h_T	%rel.	0	2,5	5
Homogeneity Light Field	h_P	%rel.	0	5	10

For the measurement the module has to cool down to 25°C. This will take approximately 2 hours in addition. Re- measure the module within 24 hours' time frame!

It is not recommended to use the so called field preconditioning method of running

modules in MPP over 15 kWhrs/m<sup>2</sup> at an irradiation level between 800 and 1000 W/m<sup>2</sup>.

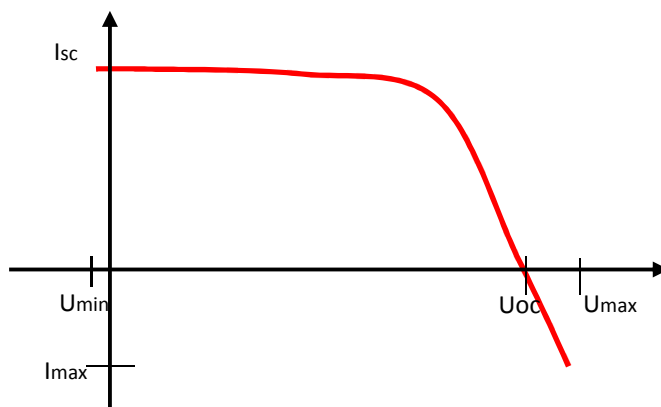
### 5. IV – curve measurement

Measure the IV curve within the limits in the table below. Exceeding the limits might lead to wrong measurement or module damage. The irradiated spectrum should match Class A according to IEC60904-3.

IV-curve measurement has to be done before electroluminescence (Pt. 6.).

#### 5.1 CX3, CX3pro,CX3pro-2,CX3plus

Parameter	Symbol	Unit	Minimum	Typical	Maximum
Voltage	U	[V]	-5		70
Resulting Current	I	[A]	Isc		≈ -0,5A



#### 5.2 CX1

Parameter	Symbol	Unit	Minimum	Typical	Maximum
Voltage	U	[V]	-10		110
Resulting Current	I	[A]	Isc		≈ -0,7A

### 6. Conditions for electroluminescence measurement

Connect PV-module in forward direction to a power supply. Take the electroluminescence picture by using the following parameters:

#### 6.1 CX3, CX3pro, CX3pro-2, CX3plus

Parameter	Symbol	Unit	Condition	Maximum
Current	I	[A]	U=60V, applied for max 80 sec	0,25A
Current	I	[A]	U>60V applied for max 8 sec	0,4A

Note: The electroluminescence measurement will influence the power of the module. Do not measure or flash after luminiscense measurements!

## 6.2 CX1

Parameter	Symbol	Unit	Condition	Maximum
Current	I	[A]	U=90V, applied for max 80 sec	0,3A
Current	I	[A]	U>90V applied for max 8 sec	0,5A

## 7. Conditions for infrared measurement

Connect PV-module in forward direction to a power supply. Take the infrared picture by using the following parameters:

## 7.1 CX3, CX3pro, CX3pro-2, CX3plus

Parameter	Symbol	Unit	Condition	Maximum
Current	I	[A]	U=60V, applied for max 80 sec	0,25A
Current	I	[A]	U>60V applied for max 8 sec	0,4A

## 7.2 CX1

Parameter	Symbol	Unit	Condition	Maximum
Current	I	[A]	U=90V, applied for max 80 sec	0,3A
Current	I	[A]	U>90V applied for max 8 sec	0,5A

History of Changes	
Rev 0.1	Initial Version FB
Rev 0.2	Editorial Changes (2014.06.13) FB
Rev 0.3	Conditions flash, EL, IR added (2015.04.02) MW
Rev 1.0	New attachments by MQ
Rev 2.0	Final Version