

## 1. LFSM-O

### Applicable Regulations:

- RfG Article: 13(2)
- EN50549-1&2 article: 4.6.1
- Netherlands Grid Code Article: 3.13, sub 4

Description	Requirement	Inverter Capability / Setting
Frequency Threshold Setting Range	50.2 Hz – 50.5 Hz	45.00 Hz – 55.00 Hz
Frequency Threshold Default Value	50.2 Hz	50.20 Hz
Droop Setting Range	4% - 12%	0% - 100%
Droop Default Value	5%	5%
Switch off at 0W power output	No	No
P <sub>REF</sub> value	P <sub>OUT</sub> at time of threshold exceeding	P <sub>OUT</sub> at time of threshold exceeding

## 2. Frequency & Voltage range

### Applicable Regulations:

- RfG Article: 13(1)
- EN50549-1&2 article: 4.4
- Netherlands Grid Code Article: 3.13, sub 1

### *Operational capability at various frequencies*

Description	Requirement	Inverter Capability
Power capability for frequency 47.5 Hz – 48.5 Hz	At least 30 minutes	Unlimited
Power capability for frequency 48.5 Hz – 49.0 Hz	At least 30 minutes	Unlimited
Power capability for frequency 49.0 Hz – 51.0 Hz	Unlimited	Unlimited
Power capability for frequency 51.0 Hz – 51.5 Hz	At least 30 minutes	Unlimited

### *Operational capability at various voltages*

Description	Requirement	Inverter Capability
Power capability for voltage 90%U <sub>NOM</sub> – 95%U <sub>NOM</sub>	Continuous Operation Power Derating Allowed	Continuous Operation @ Nominal Power
Power capability for voltage 95%U <sub>NOM</sub> – 110%U <sub>NOM</sub>	Continuous Operation	Continuous Operation @ Maximum Power

### 3. Reactive Power Capability

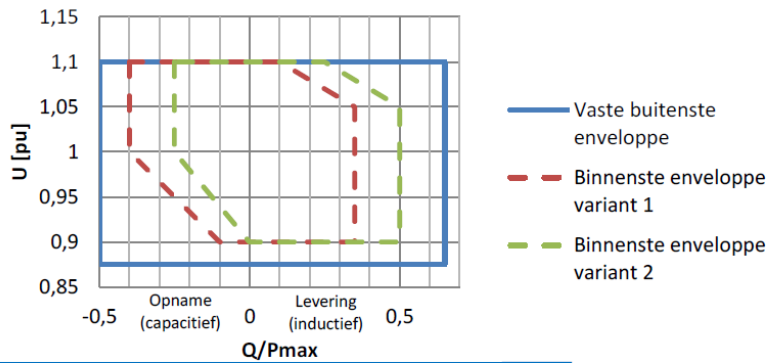
**Applicable Regulations:**

- RfG Article: 21(3)(b/c)
- EN50549-1&2 article: 4.7.2.2
- Netherlands Grid Code Article: 3.19, sub 1-3

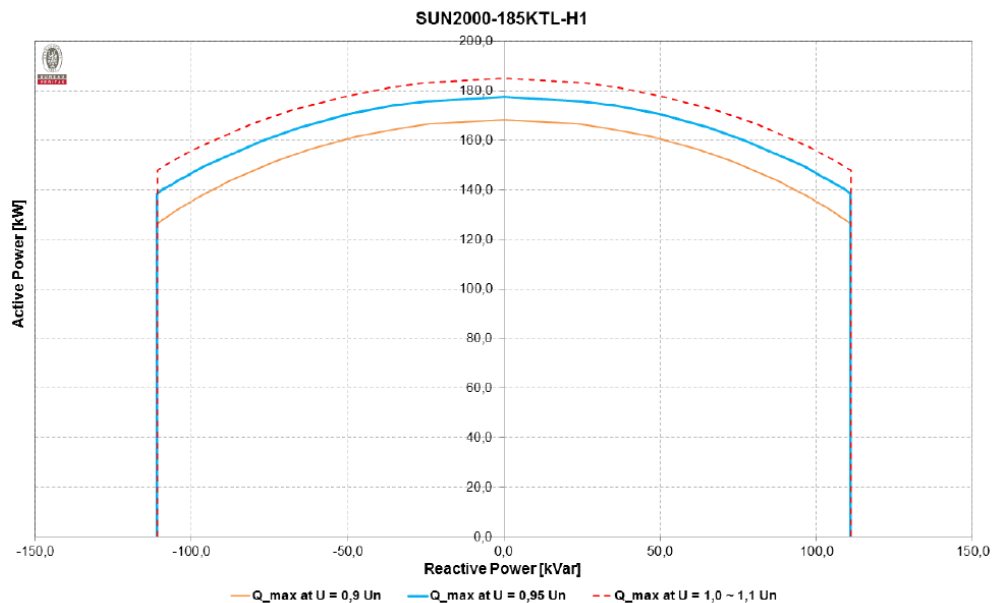
**Note 1:** RfG Article 21(3) is applicable to “Type C” Power Park Modules. Netcode Nederland however, refers to this requirement for “Type B” Power Park Modules.

**Note 2:** The Reactive Power Capability is a requirement for the plant. The EPC must demonstrate conformity up to the connection point and include local impedances such as transformers if applicable.

**Plant Reactive Power capability is required as per the dotted red line in the figure below (Binnenste envelope, variant 1 or 2):**



**Inverter capability:**



## 4. FRT

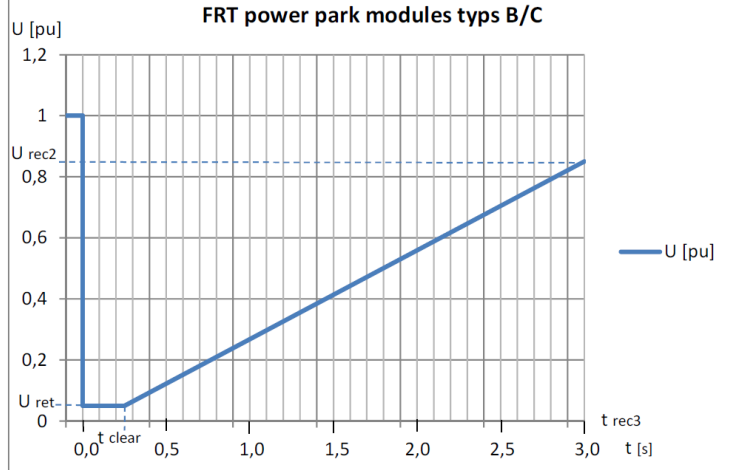
### Applicable Regulations:

- RfG Article: 14(3)(a)
- EN50549-1&2 article: 4.5.3
- Netherlands Grid Code Article: 3.17, sub 3

### Low-Voltage Ride-Through

Description	Requirement	Inverter Setting
$U_{RET}$	0,05 p.u.	0,00 p.u.
$U_{CLEAR}$	0,05 p.u.	0,00 p.u.
$U_{REC1}$	0,05 p.u.	0,00 p.u.
$U_{REC2}$	0,85 p.u.	0,85 p.u.
$t_{CLEAR}$	0,25 sec	0,25 sec
$t_{REC1}$	0,25 sec	0,25 sec
$t_{REC2}$	0,25 sec	0,25 sec
$t_{REC3}$	3,0 sec	3,0 sec

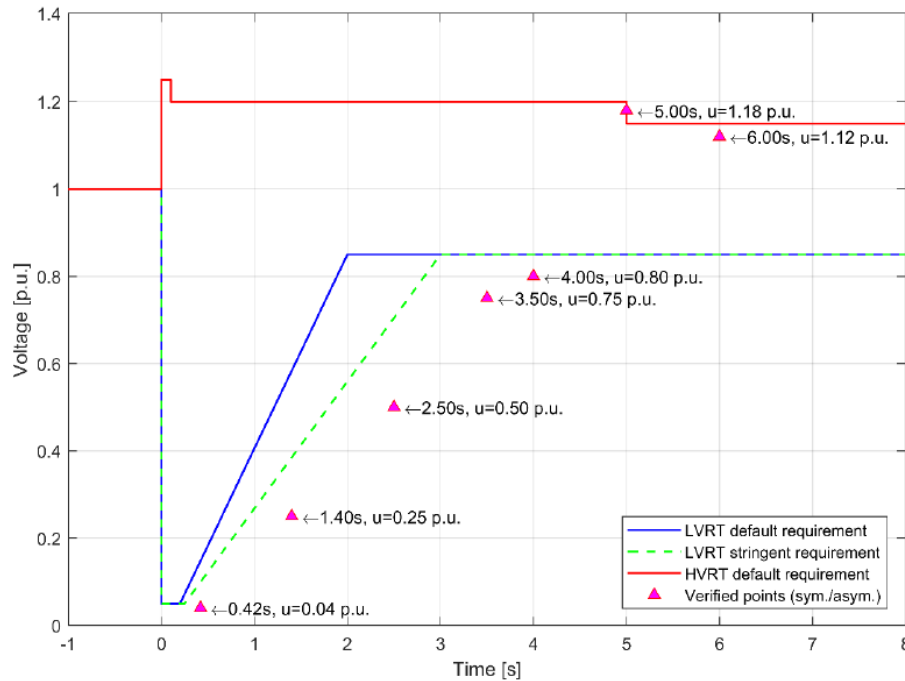
  

Visualisation
 <p>The graph illustrates the Low-Voltage Ride-Through (LVRT) characteristic for power park modules of types B and C. The vertical axis represents voltage <math>U</math> in per unit (pu), ranging from 0 to 1.2. The horizontal axis represents time <math>t</math> in seconds (s), ranging from 0 to 3.0. The voltage starts at 1.0 pu. At <math>t = 0</math>, it drops to a retention level <math>U_{ret} = 0.05</math> pu. It remains at this level until the clearing time <math>t_{clear} = 0.25</math> s. After <math>t_{clear}</math>, the voltage recovers linearly, reaching <math>U_{rec2} = 0.85</math> pu at the end of the ride-through period <math>t_{rec3} = 3.0</math> s.</p>

### Verified Characteristic:

Test Sequence	Verified Test Points (Symmetrical)		Verified Test Points (Asymmetrical)	
	Drop Depth [p.u. $U_n$ ]	Fault Duration [ms]	Drop Depth [p.u. $U_n$ ]	Fault Duration [ms]
1	< 0,05	$\geq 318$	< 0,05	$\geq 406$
2	0,20 – 0,30	$\geq 1156$	0,20 – 0,30	$\geq 1332$
3	0,45 – 0,60	$\geq 2162$	0,45 – 0,60	$\geq 2444$
4	0,70 – 0,80	$\geq 2833$	0,70 – 0,80	$\geq 3000$
5	0,85 – 0,90	$\geq 60000$	N/A	N/A

Verified U-t-characteristic (view 3)



## 5. Automatic Restart after Voltage Loss

### Applicable Regulations:

- RfG Article: 14(4)(a)
- EN50549-1&2 article: 4.10.2
- Netherlands Grid Code Article: 3.12

**After a major grid fault, when the voltage returns within 60 minutes the inverter must automatically restart:**

Description	Requirement	Inverter Setting
Grid Voltage	0,90 p.u. < U < 1,10 p.u.	0,90 p.u. < U < 1,10 p.u.
Grid Frequency	49,9 Hz < f < 50.1 Hz	49,9 Hz < f < 50.1 Hz
Validity of U & f	> 60 sec	> 60 sec
Max. Power Gradient	20% of P <sub>NOM</sub> per minute	10% of P <sub>NOM</sub> per minute

## 6. Power Recovery after Transient Grid Faults

### Applicable Regulations:

- RfG Article: 20(3)
- EN50549-1&2 article: 4.5.3.3
- Netherlands Grid Code Article: 3.19, sub 7

Description	Requirement	Inverter Capability
Power Recovery Threshold	$U > 90\% U_{NOM}$	$U > 90\% U_{NOM}$
Power Recovery Within	0,5 – 10 seconds	Immediately
Restored Power	$> 90\%$ of $P_{OUT}$ before the fault	Full recovery
Accuracy of Restored Power	$< 10\%$ of $P_{OUT}$ before the fault	$< 1\%$ of $P_{OUT}$ before the fault

## 7. Voltage Support during Transient Grid Faults

### Applicable Regulations:

- RfG Article: 20(2)(b,c)
- EN50549-1&2 article: 4.7.4.2.1
- Netherlands Grid Code Article: 3.19, sub 4, 6

Description	Requirement	Inverter Capability / Setting
K-factor Setting Range	$2 \leq k \leq 10$	$2 \leq k \leq 10$
K-Factor Setting Accuracy	0,01 p.u.	0,1
K-Factor Default Value	$k = 2$	$k = 2$

## 8. Harmonics

### Applicable Regulations:

- RfG Article: none
- EN50549-1&2 article: 4.8
- Netherlands Grid Code Article: 2.15

### Odd Harmonics [% $I_n$ ]:

3	5	7	9	11	13	15	17	19	21	23	25	27	29
0,18	0,18	0,37	0,04	0,10	0,16	0,09	0,11	0,26	0,12	0,11	0,29	0,09	0,11

### Even Harmonics [% $I_n$ ]:

2	4	6	8	10	12	14	16	18	20	22	24	26	28
0,21	0,14	0,06	0,08	0,07	0,06	0,09	0,13	0,08	0,14	0,12	0,08	0,12	0,08