



TECHNICAL REPORT

SHORT CIRCUIT CURRENT IN FREESUN HEMK INVERTERS

July 2018

SUBJECT	SHORT CIRCUIT CURRENT IN FREESUN HEMK INVERTERS			
REVIEW	D			
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INDEX

1. AIM	3
2. CURRENT VALUES	3
3. TECHNICAL CHARACTERISTICS	4
4. GRAPHS	8
5. ANNEX – PARAMETERS ACCORDING TO IEC 60909-0:2016	16

1. AIM

The scope of this report is to communicate the maximum inverter output fault current (peak and RMS) and short circuit current duration according to the section 47.3 of the UL 1741 in a Freesun HEMKU inverter configured for FRAME 1 and FRAME 2.

The results contained in this document have been extracted from the **MET/CERE Report No.: 20040-1**. Test have been performed a total of four times so the short occurs in different portions of the line cycle.

2. CURRENT VALUES

Inverters FRAME 2: (FS3450K, FS3670K, FS3300K, FS3510K, FS3225K, FS3430K, FS3150K, FS3350K, FS3075K, FS3270K, FS3000K, FS3190K)

#	Phases	A _{PK}	A _{RMS}	Peak/Total Duration (ms)	Data
1	L1-L2	9570,5	3490,1	2,2/27,4	Figure 1
2	L1-L2	-7134,9	3334,7	2,6/30,6	Figure 2
3	L1-L2	6900,3	3494,2	3,0/32,8	Figure 3
4	L1-L2	-10413,7	3675,6	2,2/22,6	Figure 4
1	L1-L2-L3	-10772,1	3700,5	1,8/25,8	Figure 5
2	L1-L2-L3	10568,9	3490,5	1,6/27,0	Figure 6
3	L1-L2-L3	-10713,6	3643,7	2,0/25,6	Figure 7
4	L1-L2-L3	11745,6	3742,6	2,0/27,6	Figure 8

Inverters FRAME 1: (FS2300K, FS2445K, FS2200K, FS2340K, FS2150K, FS2285K, FS2100K, FS2235K, FS2050K, FS2180K, FS2000K, FS2125K)

#	Phases	A _{PK}	A _{RMS}	Peak/Total Duration (ms)	Data
1	L1-L2	6396,8	2438,5	2,8/28,0	Figure 9
2	L1-L2	9210,2	3509,9	6,2/34,0	Figure 10
3	L1-L2	-8789,8	2803,6	2,8/32,4	Figure 11
4	L1-L2	10382,2	2820,7	2,4/26,2	Figure 12
1	L1-L2-L3	11082,4	3124,9	1,8/28,2	Figure 13
2	L1-L2-L3	-10338,5	3056,7	4,6/29,8	Figure 14
3	L1-L2-L3	9969,2	2981,9	2,0/24,0	Figure 15
4	L1-L2-L3	10087,1	2877,3	2,6/26,4	Figure 16

3. TECHNICAL CHARACTERISTICS

TECHNICAL CHARACTERISTICS

HEMK 600V

		FRAME 1	FRAME 2
REFERENCE		FS2000K	FS3000K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2000	3000
	AC Output Power(kVA/kW) @25°C ¹⁾	2200	3300
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ²⁾	600V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power (VDC)	849V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS

HEMK 600V

		FRAME 1	FRAME 2
REFERENCE		FS2125K	FS3190K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2125	3190
	AC Output Power(kVA/kW) @40°C ¹⁾	2200	3300
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ²⁾	600V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power (VDC)	849V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS

HEMK 615V

		FRAME 1	FRAME 2
REFERENCE		FS2050K	FS3075K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2050	3075
	AC Output Power(kVA/kW) @25°C ¹⁾	2255	3380
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ²⁾	615V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power (VDC)	870V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 615V**

		FRAME 1	FRAME 2
REFERENCE		FS2180K	FS3270K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁴⁾	2180	3270
	AC Output Power(kVA/kW) @40°C ¹⁴⁾	2255	3380
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ¹⁴⁾	615V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ¹⁴⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	870V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ¹⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 630V**

		FRAME 1	FRAME 2
REFERENCE		FS2100K	FS3150K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁴⁾	2100	3150
	AC Output Power(kVA/kW) @25°C ¹⁴⁾	2310	3465
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ¹⁴⁾	630V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ¹⁴⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	891V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ¹⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 630V**

		FRAME 1	FRAME 2
REFERENCE		FS2235K	FS3350K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁴⁾	2235	3350
	AC Output Power(kVA/kW) @40°C ¹⁴⁾	2310	3465
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ¹⁴⁾	630V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ¹⁴⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	891V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ¹⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 645V**

		FRAME 1	FRAME 2
REFERENCE		FS2150K	FS3225K
OUTPUT	AC Output Power(kVA/kW) @50°C ^[1]	2150	3225
	AC Output Power(kVA/kW) @25°C ^[1]	2365	3550
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ^[2]	645V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ^[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
	MPPT @full power (VDC)	913V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ^[4]	Up to 36	
INPUT	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 645V**

		FRAME 1	FRAME 2
REFERENCE		FS2285K	FS3430K
OUTPUT	AC Output Power(kVA/kW) @50°C ^[1]	2285	3430
	AC Output Power(kVA/kW) @40°C ^[1]	2365	3550
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ^[2]	645V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ^[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
	MPPT @full power (VDC)	913V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ^[4]	Up to 36	
INPUT	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 660V**

		FRAME 1	FRAME 2
REFERENCE		FS2200K	FS3300K
OUTPUT	AC Output Power(kVA/kW) @50°C ^[1]	2200	3300
	AC Output Power(kVA/kW) @25°C ^[1]	2420	3630
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ^[2]	660V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ^[3]	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
	MPPT @full power (VDC)	934V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ^[4]	Up to 36	
INPUT	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

TECHNICAL CHARACTERISTICS**HEMK 660V**

		FRAME 1	FRAME 2
REFERENCE		FS2340K	FS3510K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2340	3510
	AC Output Power(kVA/kW) @40°C ¹⁾	2420	3630
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ²⁾	660V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	934V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

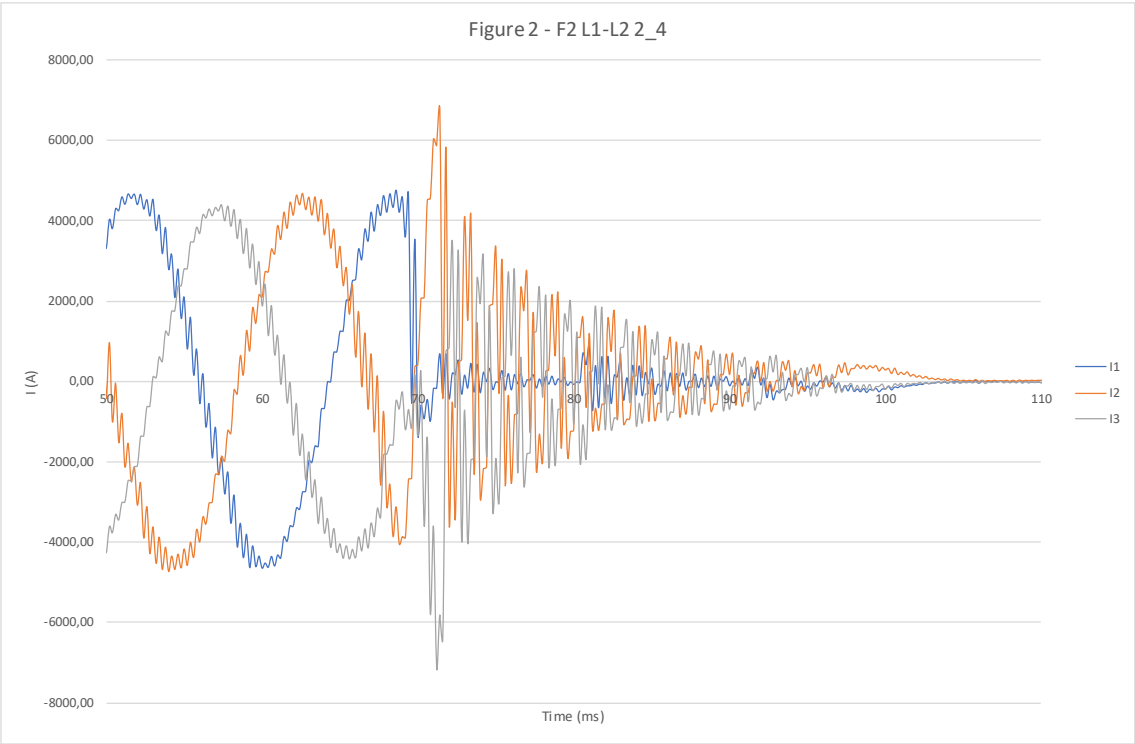
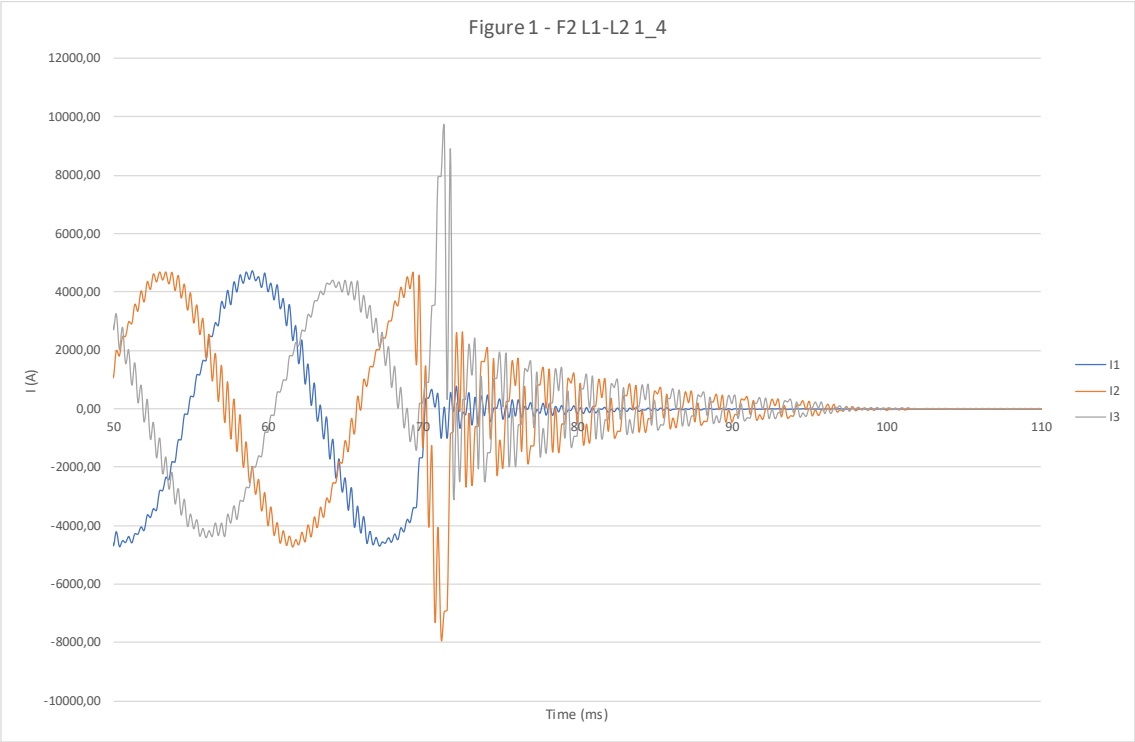
TECHNICAL CHARACTERISTICS**HEMK 690V**

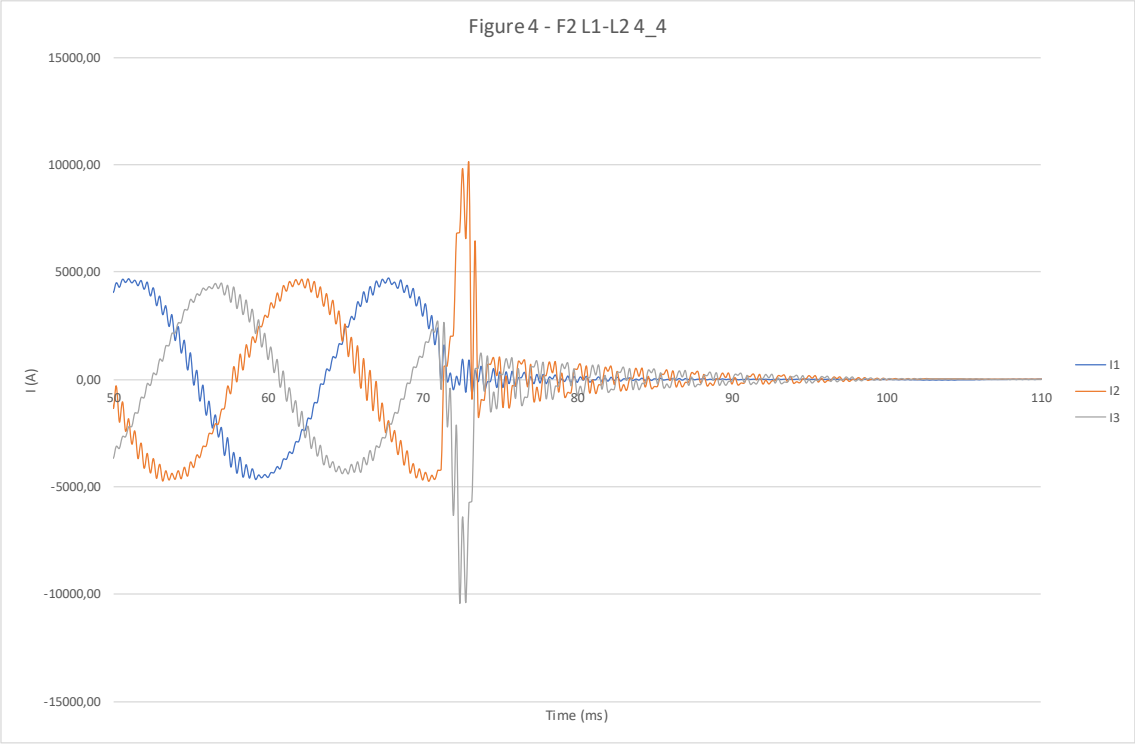
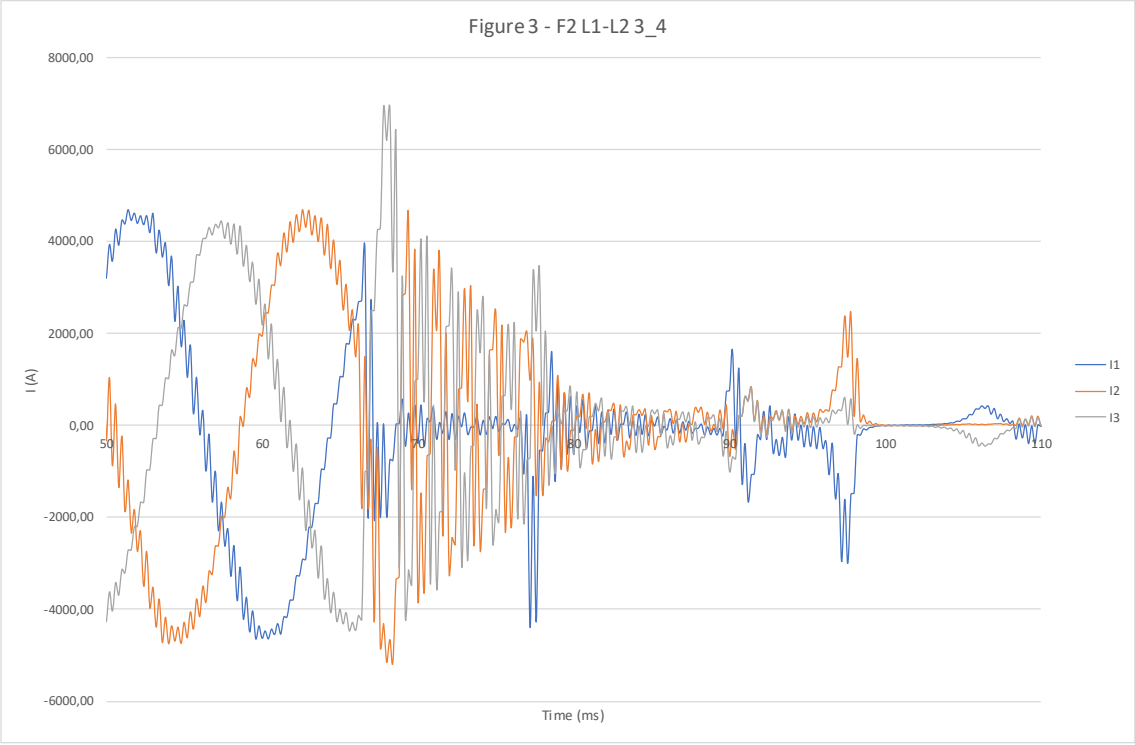
		FRAME 1	FRAME 2
REFERENCE		FS2300K	FS3450K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2300	3450
	AC Output Power(kVA/kW) @25°C ¹⁾	2530	3800
	Max. AC Output Current (A) @25°C	2120	3175
	Operating Grid Voltage(VAC) ²⁾	690V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	976V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

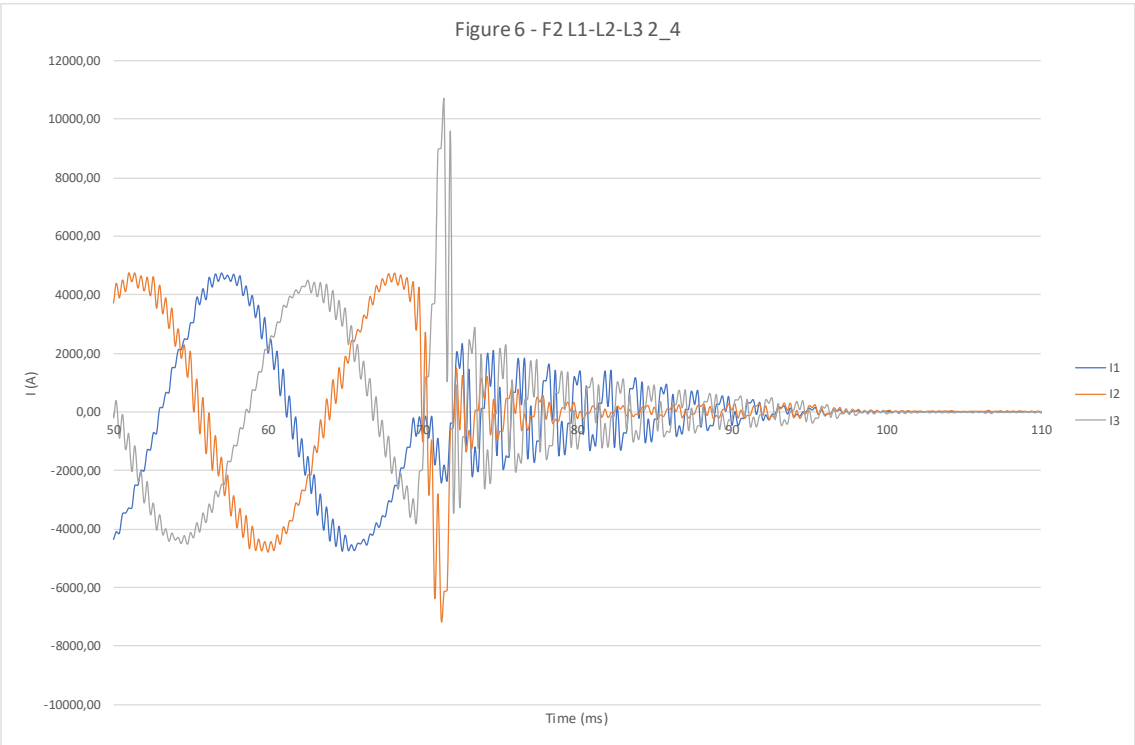
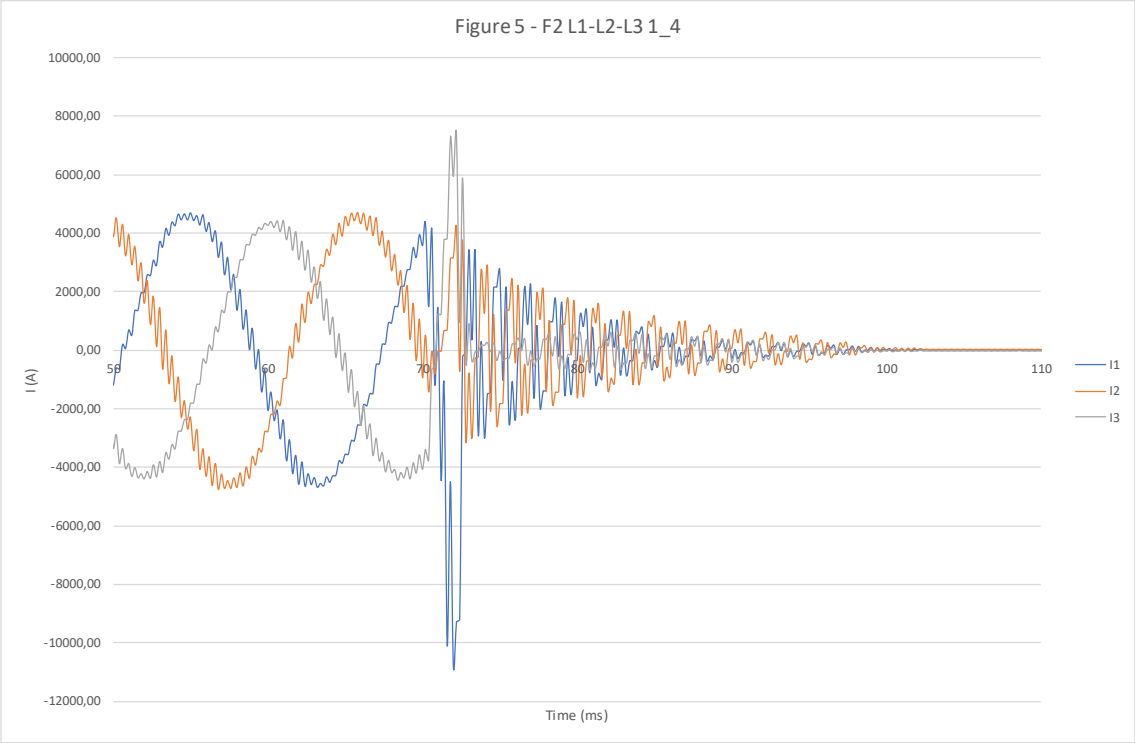
TECHNICAL CHARACTERISTICS**HEMK 690V**

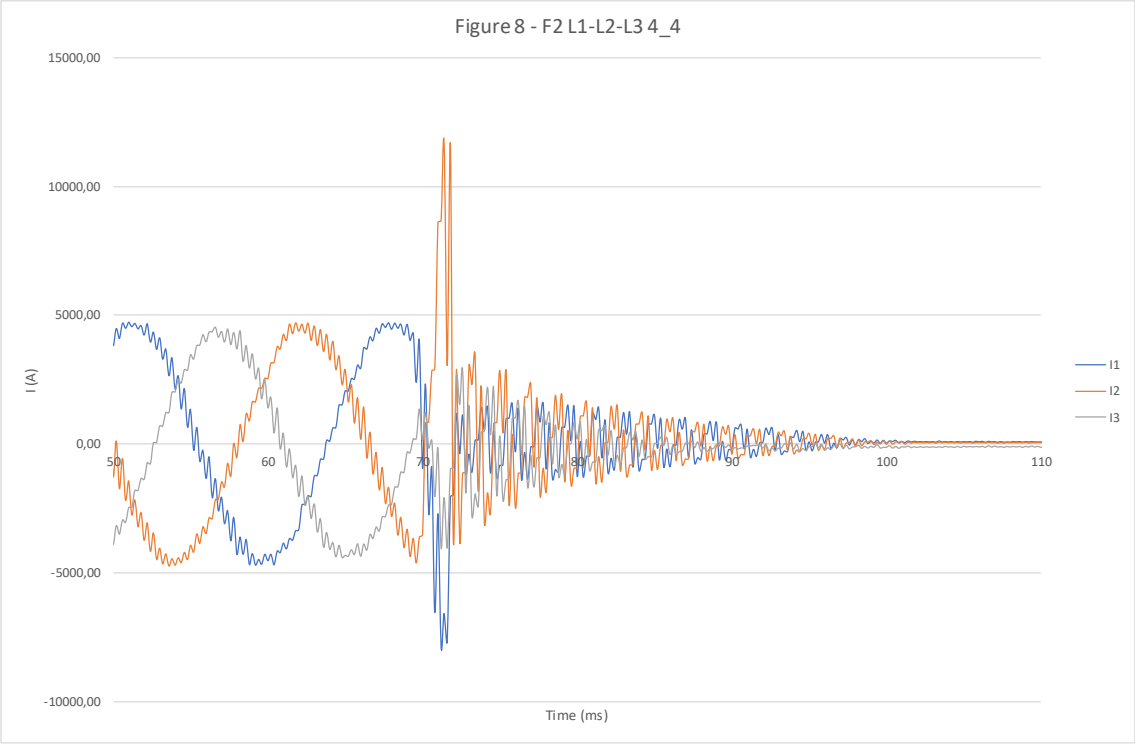
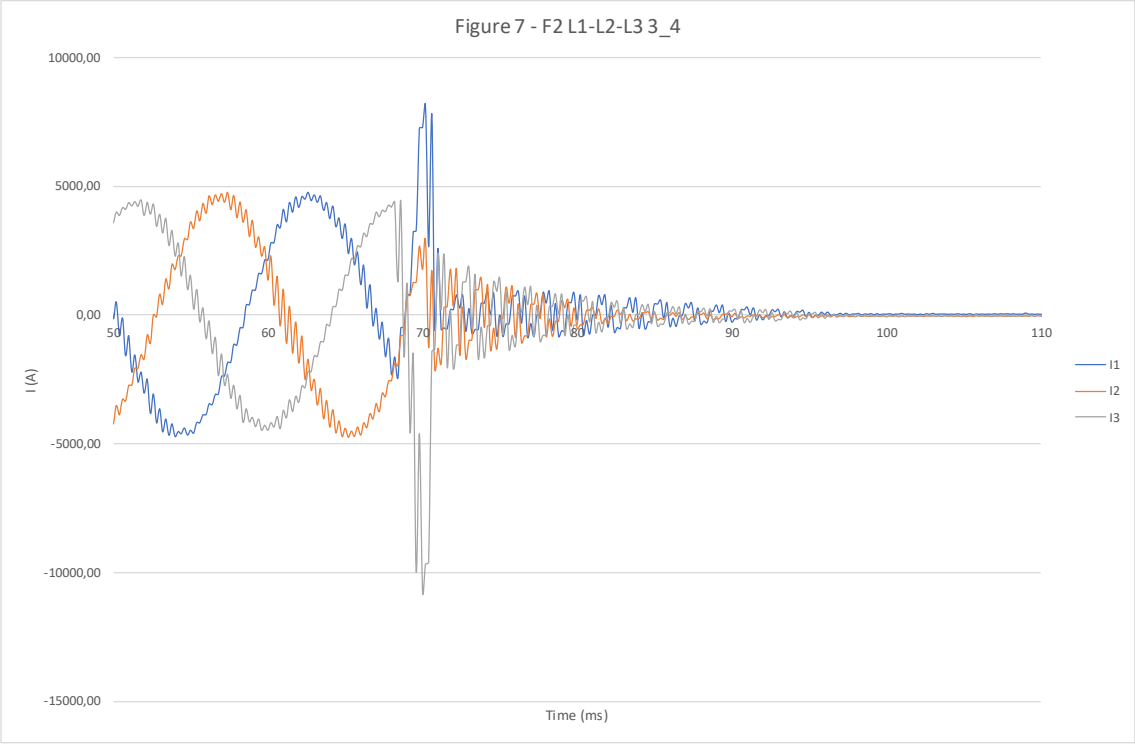
		FRAME 1	FRAME 2
REFERENCE		FS2445K	FS3670K
OUTPUT	AC Output Power(kVA/kW) @50°C ¹⁾	2445	3670
	AC Output Power(kVA/kW) @40°C ¹⁾	2530	3800
	Max. AC Output Current (A) @40°C	2117	3175
	Operating Grid Voltage(VAC) ²⁾	690V ±10%	
	Operating Grid Frequency(Hz)	50Hz/60Hz	
	Current Harmonic Distortion (THDi)	< 3% per IEEE519	
	Power Factor (cosine phi) ³⁾	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPT @full power (VDC)	976V-1310V	
	Maximum DC voltage	1500V	
	Number of inputs ⁴⁾	Up to 36	
	Number of MPPTs	Up to 4	Up to 6
	Max. DC continuous current (A)	2645	3970
	Max. DC short circuit current (A)	4000	6000

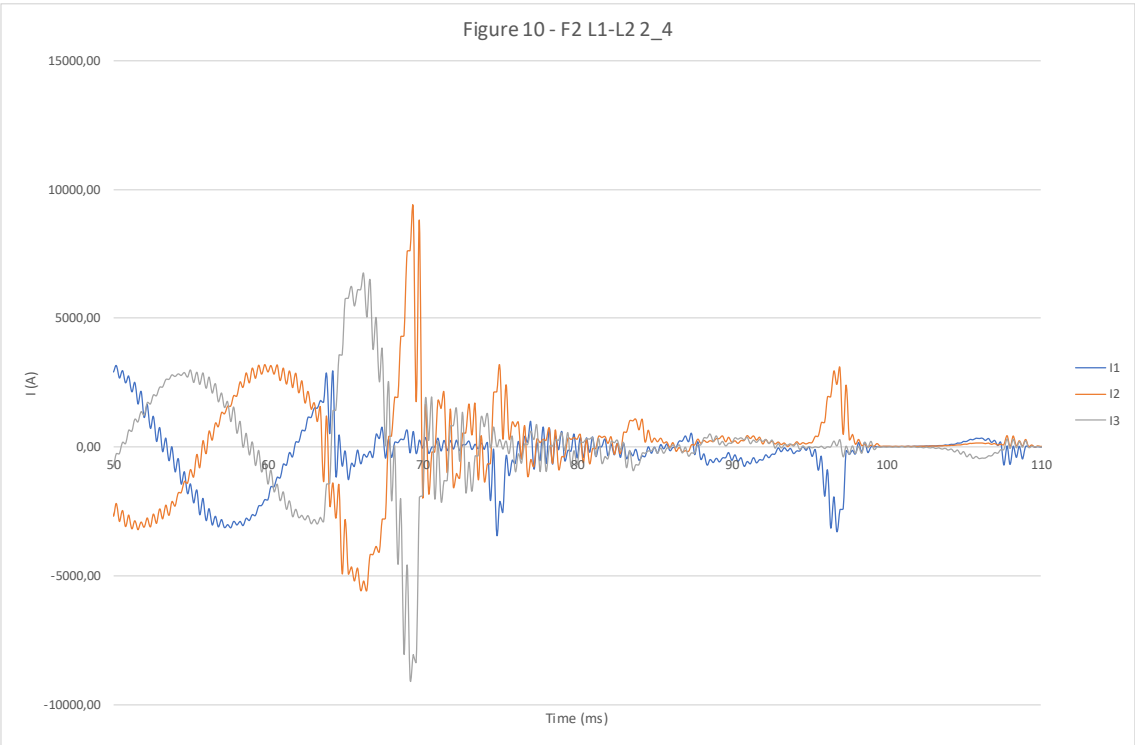
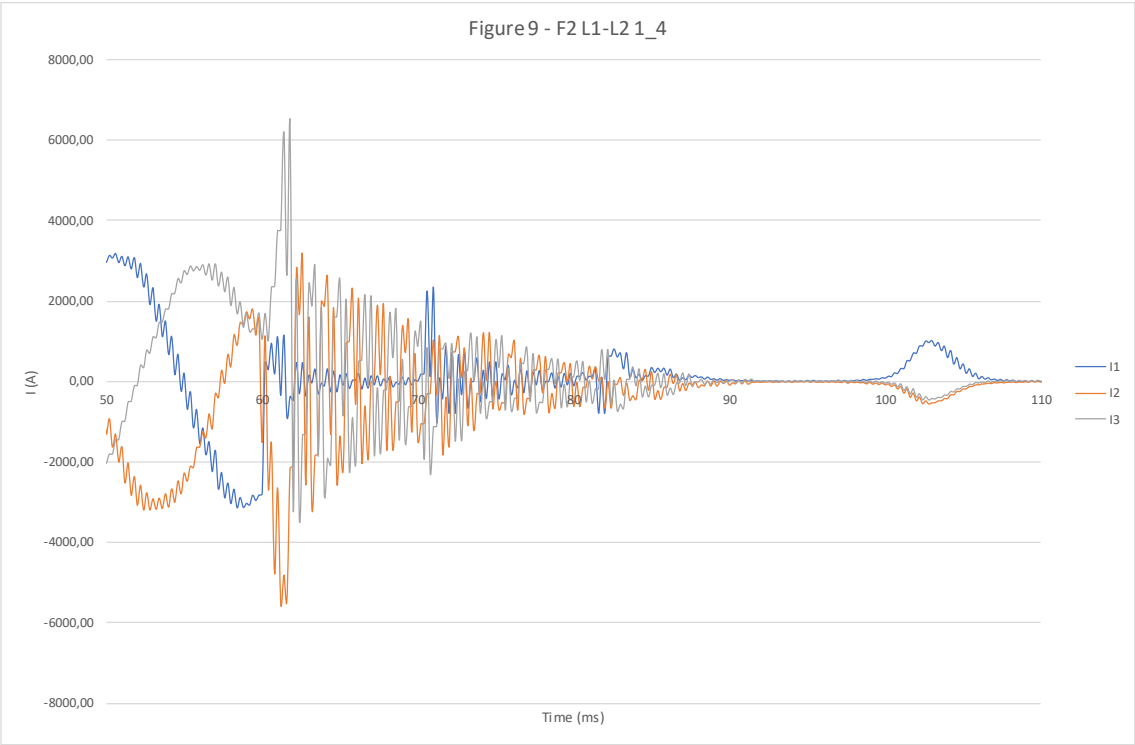
4. GRAPHS

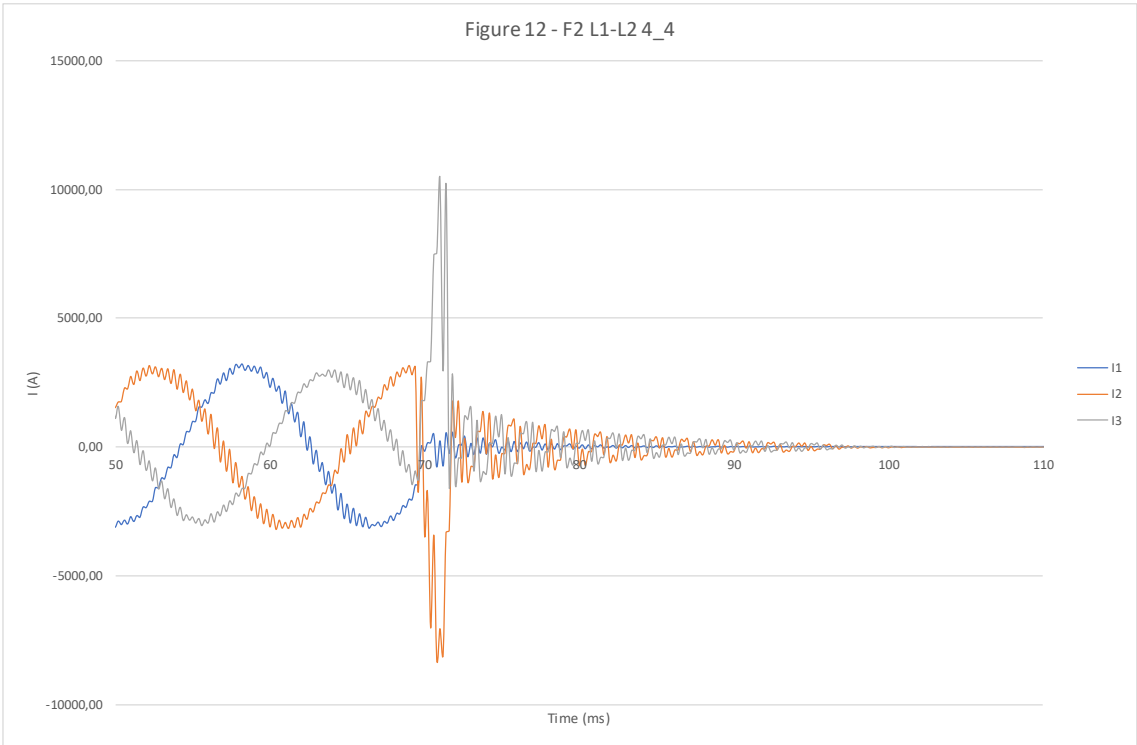
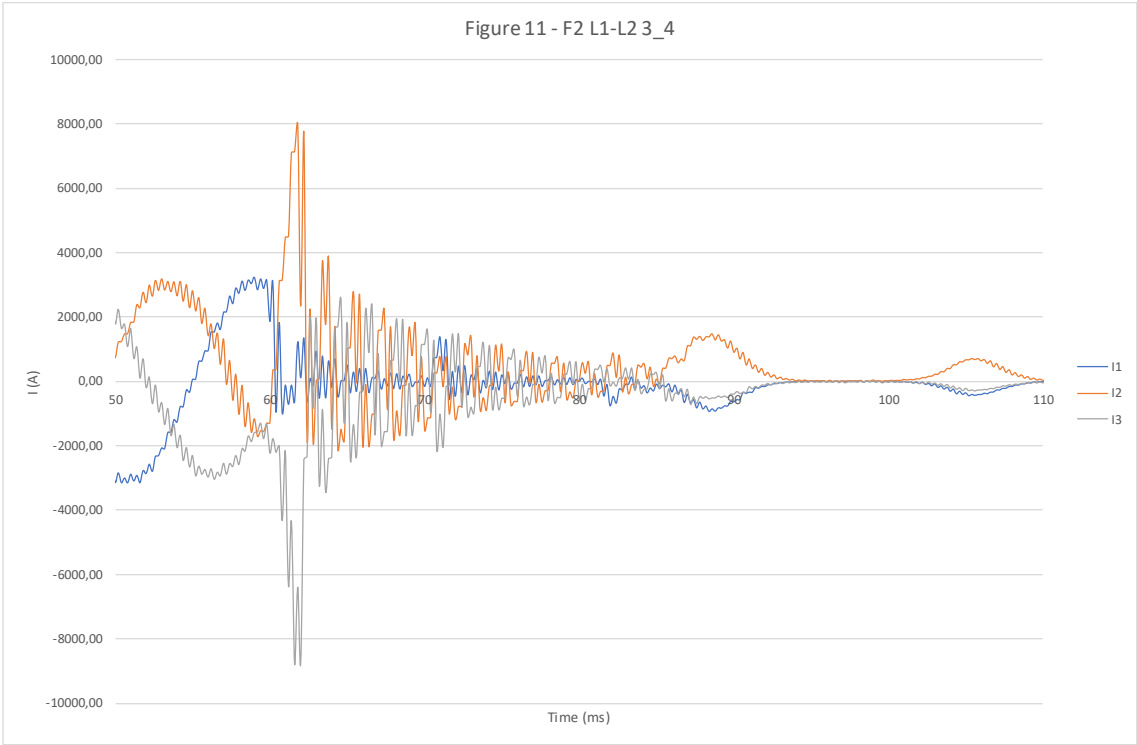


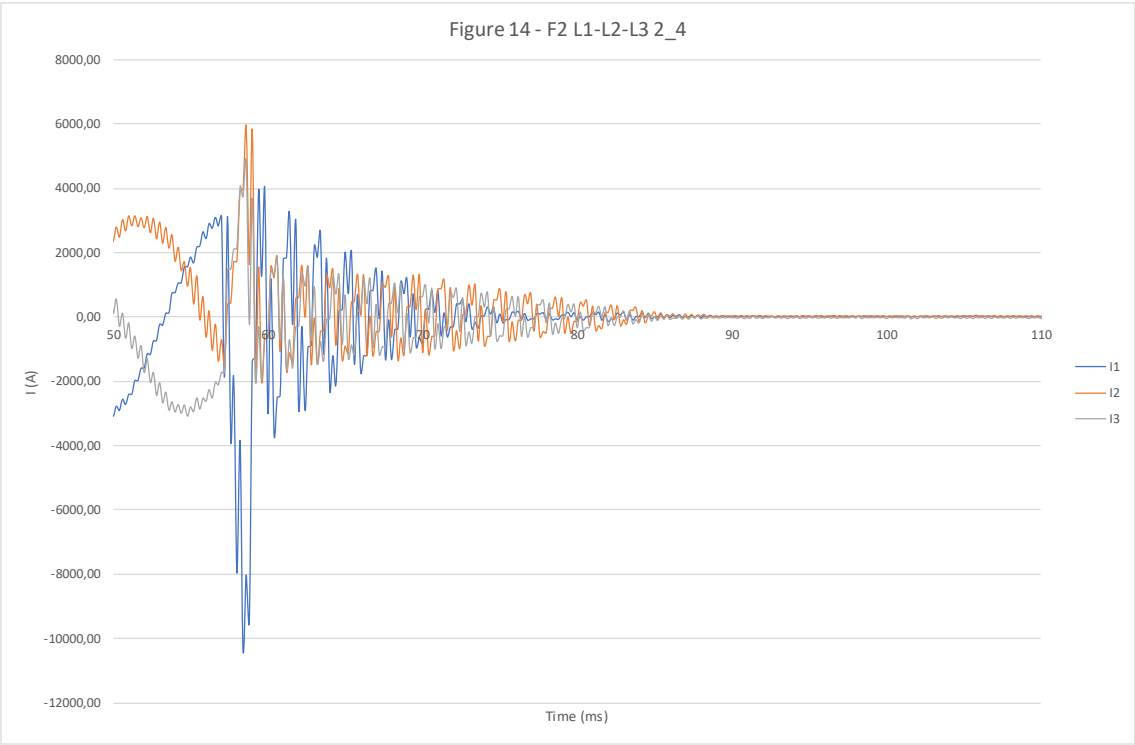
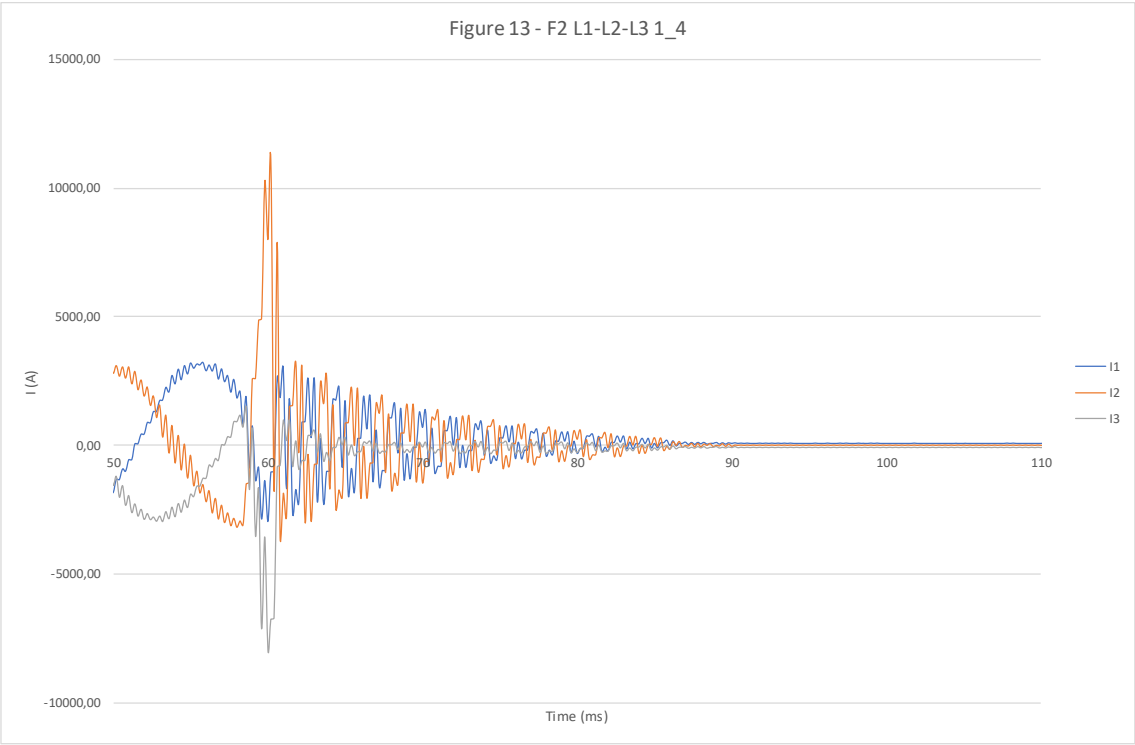


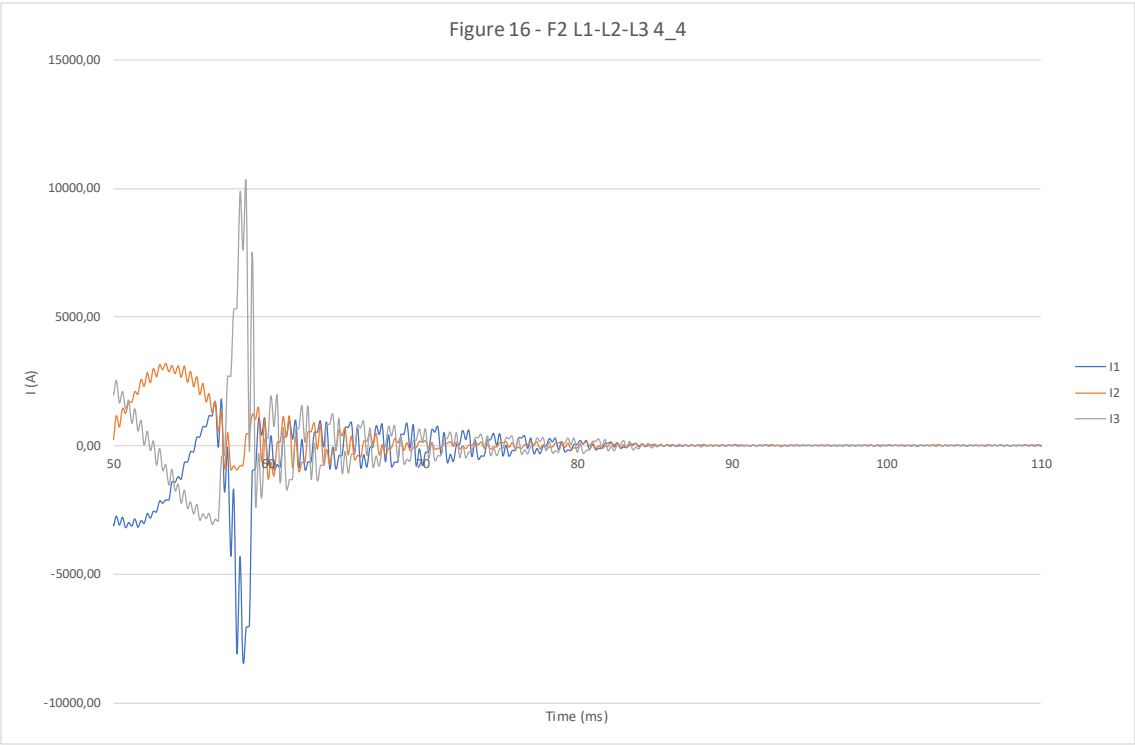
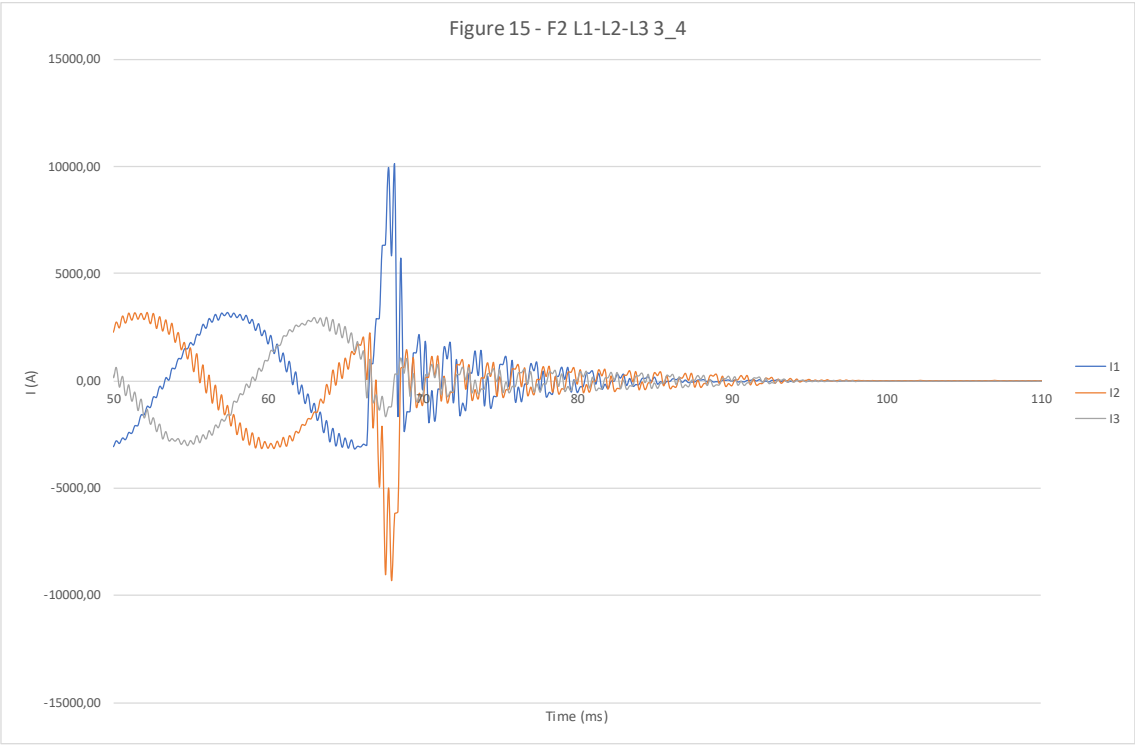












5. ANNEX – PARAMETERS ACCORDING TO IEC 60909-0:2016

This annex describes the calculation of the values of the parameters I_p and I_k'' defined in the standard IEC 60909-0. These calculations are based on the same measurements that have been showed before in the report.

According to the IEC 60909-0 I_p and I_k'' are defined as follow:

I_p - Maximum current (first peak of the fault current)
 I_k'' - Initial symmetrical short-circuit current

Based on that definition we assume that I_p is the maximum peak value obtain in symmetrical short circuit (A_{PK}) and I_k'' can be obtain according to the standard using the equation:

$$I_p = 2\sqrt{2} I_k''$$

Thus, the values of the parameters defined in the IEC 60909-0 in a Freesun HEMKU inverter configured for Frame2 and Frame 1 for symmetrical short circuit are as follow:

#	FRAME	Phases	I_p (A)	I_k'' (A)
1	F2	L1-L2-L3	10772,1	3808,5
2	F2	L1-L2-L3	10568,9	3736,7
3	F2	L1-L2-L3	10713,6	3787,8
4	F2	L1-L2-L3	11745,6	4152,7
1	F1	L1-L2-L3	11082,4	3918,2
2	F1	L1-L2-L3	10338,5	3655,2
3	F1	L1-L2-L3	9969,2	3524,6
4	F1	L1-L2-L3	10087,1	3566,3