SVEUČILIŠTE U ZAGREBU
FAKULTET
ELEKTROTEHNIKE
I RAČUNARSTVA

Predmet: **SNIMANJE PARAMETARA KVALITETE OPSKRBE ELEKTRIČNOM ENERGIJOM**

Objekt: **PBZ - Radnička c. 42-46, Zagreb**

Period: **22.02 - 27.02.2009.**

Voditelj: **Prof.dr.sc. Tomislav Tomiša**

V

Zagreb, ožujak 2009.

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SADRŽAJ

1. OPĆENITO

Općim uvjetima za opskrbu električnom energijom (NN 14 / 08.02.2006.) definiran je pojam "*kvaliteta opskrbe električnom energijom"* koji objedinjuje tri pokazatelja: *kvalitetu napona, pouzdanost napajanja* i *kvalitetu usluga* korisnicima mreže na mjestu preuzimanja odnosno predaje električne energije:

kvaliteta napona = stalnost fizikalnih značajki napona u odnosu na normirane vrijednosti (efektivna vrijednost, frekvencija, valni oblik, simetričnost faznih vrijednosti napona i dr.)

pouzdanost napajanja = sposobnost mreže da osigura stalnost napajanja električnom energijom u određenom vremenskom razdoblju, iskazana pokazateljima broja i trajanja prekida napajanja

kvaliteta usluga = razina pružanja usluga koje je operator prijenosne mreže ili operator distribucijske mreže ili opskrbljivač dužan osigurati korisnicima mreže

smetnja = događaj ili pojava koja može uzrokovati odstupanja kvalitete napona veća od dopuštenih,

Operator prijenosnog sustava i operator distribucijskog sustava dužni su osigurati standardnu razinu kvalitete opskrbe električnom energijom na obračunskom mjernom mjestu korisnika mreže, sukladno odredbama Općih uvjeta za opskrbu električnom energijom, mrežnih pravila elektroenergetskog sustava i uvjetima koje odobri Agencija prilikom donošenja planova razvoja i izgradnje prijenosne i distribucijske mreže.

Ugovor o korištenju mreže tarifnog kupca zaključuju operator prijenosnog sustava ili operator distribucijskog sustava i tarifni kupac. Ugovor sadrži razinu kvalitete opskrbe električnom energijom;

Standardna razina kvalitete opskrbe električnom energijom iskazuje se pokazateljima kvalitete napona, pokazateljima pouzdanosti napajanja električnom energijom i ostalim pokazateljima kvalitete opskrbe električnom energijom propisanih ovim Općim uvjetima za opskrbu električnom energijom.

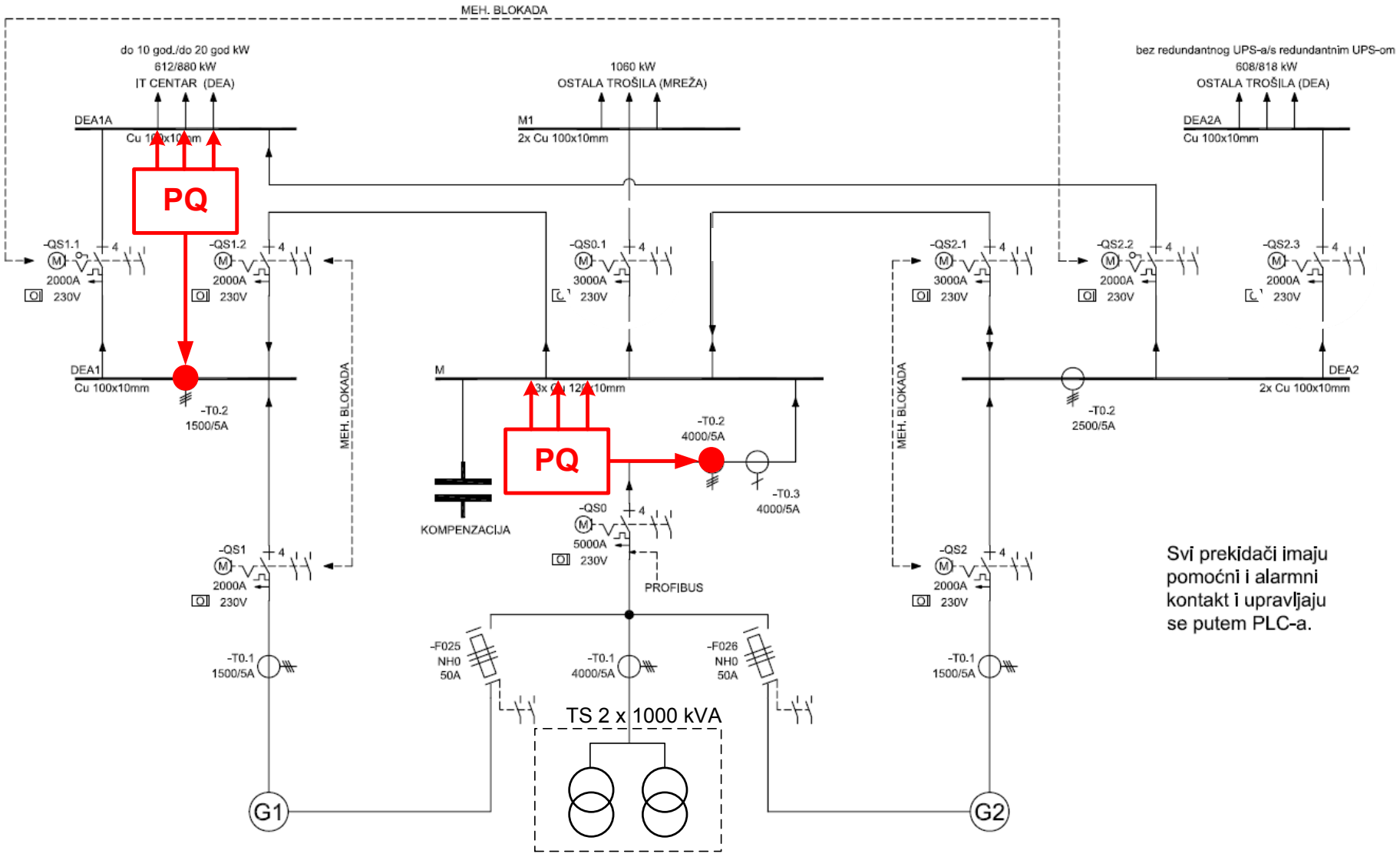
S obzirom da je tijekom dosadašnje eksploatacije elektroenergetskog sustava napajanja objekta PBZ- radnička c. 42.46 u nekoliko navrata došlo do pregaranja određenih elemenata nadzorne opreme (kontrolnici napona) što je imalo za posljedicu ispad napajanja IT centra, provedeno je snimanje parametara kvalitete napona mreže na mjestu preuzimanja električne energije da se utvrdi da li je uzrok pregaranja navedenih elemenata loša kvaliteta ugrađene opreme ili smetnje iz napojne mreže.

Standardne vrijednosti pojedinih parametara kvalitete napona sukladno europskoj normi EN 50160 prikazane u su Tablici 1.

Mjesta priključka mjerne opreme prikazana su na Slici 1.

Tablica 1

Značajke napona	**Granične vrijednosti**	**Mjerni i vrijednosni parametri**			
	niski napon srednji napon	Osnovna veličina	Interval usrednjavanja	Promatrano razdoblje	Granice
Frekvencija u EES-u	49.5 do 50.5 Hz 47 do 52 Hz	Prosječna vrijednost	10 s	1 tjedan	95% 100%
Spore promjene napona	230 V±10% Un±10% Un +10%/-15%	Efektivna vrijednost	10 min	1 tjedan	95% 100%
Brze promjene napona	5% 4% max 10% 6%	Efektivna vrijednost	10 ms	1 dan	100%
Flikeri Dugotrajni flikeri	Pst Plt < 1	Algoritam flikera	10 min 2 h	1tjedan	95%
Padovi napona ≤ 1 min	ispod 85% Un 10 do 1000 godišnje	Efektivna vrijednost	10 ms	1 godina	100%
Kratki prekidi opskrbe ≤ 3 min	ispod 1% Un 10 do 100 godišnje	Efektivna vrijednost	10 ms	1 godina	100%
Dulji prekidi opskrbe > 3 min	ispod 1% Un 10 do 50 godišnje	Efektivna vrijednost	10 ms	1 godina	100%
Povremeni prenaponi mrežne frekvencije (vodič/zemlja)	< 1.5 kV 1.7 do 2.0 Un	Efektivna vrijednost	10 ms	-	100%
Naponska nesimetrija	< 2%	Efektivna vrijednost	10min	1 tjedan	95%
Viši harmonici	THD ≤ 8% (tablica do 40. harmonika)	Efektivna vrijednost	10 min	1 tjedan	95%
Signalni napon	do 500 Hz: < 9% 1-10 kHz: < 5%	Efektivna vrijednost	3 s	1 dan	99%



Slika 1. Jednopolna shema elektroenergetskog postrojenja PBZ - mjesta priključka mjernih garnitura za snimanje PQ

2. PODEŠENJA INSTRUMENATA

Dranetz-BMI Power Xplorer Configuration

Firmware	Power Xplorer (c) 1998-2003 Dranetz-BMI Apr 26 2005 @ 16:43:22 Ver.: V 1.11, Build: 0, DB ver.: 0
Serial Number	PX50ZA040
Site/Filename	RR NN-ups
Measured from	20.02.2009 13:44:16
Measured to	27.02.2009 11:08:32
File ending	OK
Synchronization	Standard A
Configuration	4 WIRE / 3 PROBE (WYE)
Monitoring type	EN50160
Nominal voltage	230.0 V
Nominal current	434.0 A
Nominal frequency	50.0 Hz
Use inverse sequence	No
Using currents	Yes
Characterizer mode	IEC 61000-4-30

Current probes

Chan A	TR2510, 0A-10A RMS (Scale=6.67)
Chan B	TR2510, 0A-10A RMS (Scale=6.67)
Chan C	TR2510, 0A-10A RMS (Scale=6.67)
Chan D	TR2510, 0A-10A RMS (Scale=6.67)

Voltage scale factors

Chan A	1.000
Chan B	1.000
Chan C	1.000
Chan D	1.000

Current scale factors

Chan A	300.000
Chan B	300.000
Chan C	300.000
Chan D	1.000

Trigger Response Setups

Summary Pre-trigger cycles	0 cycles
Summary Post-trigger cycles IN-TO-OUT	0 cycles
Summary Post-trigger cycles OUT-TO-IN	0 cycles
Waveform Pre-trigger cycles	1 cycles
Waveform Post-trigger cycles	2 cycles

Trigger-	**Saved waveforms**										
channel	**Va**	**Vb**	**Vc**	**Vd**	**Ia**	**Ib**	**Ic**	**Id**	**AB**	**BC**	**CA**
Volts A	Va	Vb	Vc	-	Ia	Ib	Ic	-	-	-	-
Volts B	Va	Vb	Vc	-	Ia	Ib	Ic	-	-	-	-
Volts C	Va	Vb	Vc	-	Ia	Ib	Ic	-	-	-	-
Volts D	-	-	-	Vd	-	-	-	-	-	-	-
Amps A	-	-	-	-	Ia	-	-	-	-	-	-
Amps B	-	-	-	-	-	Ib	-	-	-	-	-
Amps C	-	-	-	-	-	-	Ic	-	-	-	-

Amps D	-	-	-	-	-	-	-	Id	-	-	-
Volts A-B	-	-	-	-	-	-	-	-	-	-	-
Volts B-C	-	-	-	-	-	-	-	-	-	-	-
Volts C-A	-	-	-	-	-	-	-	-	-	-	-

Timed waveform savings: NOT active
After recording: STOP

Limit Setups

Voltages	**A**	**B**	**C**	**D**	**A-B**	**B-C**	**C-A**
RMS High:	253.0	253.0	253.0	0.0	0.0	0.0	0.0
RMS Low:	207.0	207.0	207.0	0.0	0.0	0.0	0.0
RMS Very Low:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crest:	391.0	391.0	391.0	0.0	0.0	0.0	0.0
Wave:	16.1	16.1	16.1	0.0	0.0	0.0	0.0
DC:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEG:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WAVE Window Mag:	23.0	23.0	23.0	0.0	0.0	0.0	0.0
WAVE Window Dur:	10.0	10.0	10.0	0.0	0.0	0.0	0.0
HF:	230.0	230.0	230.0	0.0	0.0	0.0	0.0

Currents	**A**	**B**	**C**	**D**
RMS High:	0.0	0.0	0.0	0.0
RMS Low:	0.0	0.0	0.0	0.0
RMS Very Low:	0.0	0.0	0.0	0.0
Crest:	0.0	0.0	0.0	0.0
Wave:	0.0	0.0	0.0	0.0
DC:	0.0	0.0	0.0	0.0
(null):	0.0	0.0	0.0	0.0
WAVE Window Mag:	0.0	0.0	0.0	0.0
WAVE Window Dur:	0.0	0.0	0.0	0.0
HF:	0.0	0.0	0.0	0.0

Periodic Journal Intervals

Voltage	10.0 minutes	
Current	10.0 minutes	
Power	10.0 minutes	
Harmonics	10.0 minutes	
Demand	5.0 minutes, Subintervals/Intervals:	3
Energy	10.0 minutes	
Inst. flicker	10.0 minutes	
Short term flicker	10.0 minutes	
Long term flicker	120.0 minutes	
EN50160 compliance	10.0 minutes	

Journal Limits

Voltage	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
RMS_PhAN	264.0	242.0	198.0	176.0	-	-	-
RMS_PhBN	264.0	242.0	198.0	176.0	-	-	-
RMS_PhCN	264.0	242.0	198.0	176.0	-	-	-
CycRMS_PhAN	264.0	242.0	198.0	176.0	-	-	-
CycRMS_PhBN	264.0	242.0	198.0	176.0	-	-	-
CycRMS_PhCN	264.0	242.0	198.0	176.0	-	-	-
NegUnbalTotal	-	2.0	-	-	-	-	-
FreqHz	-	50.5	49.5	-	-	-	-

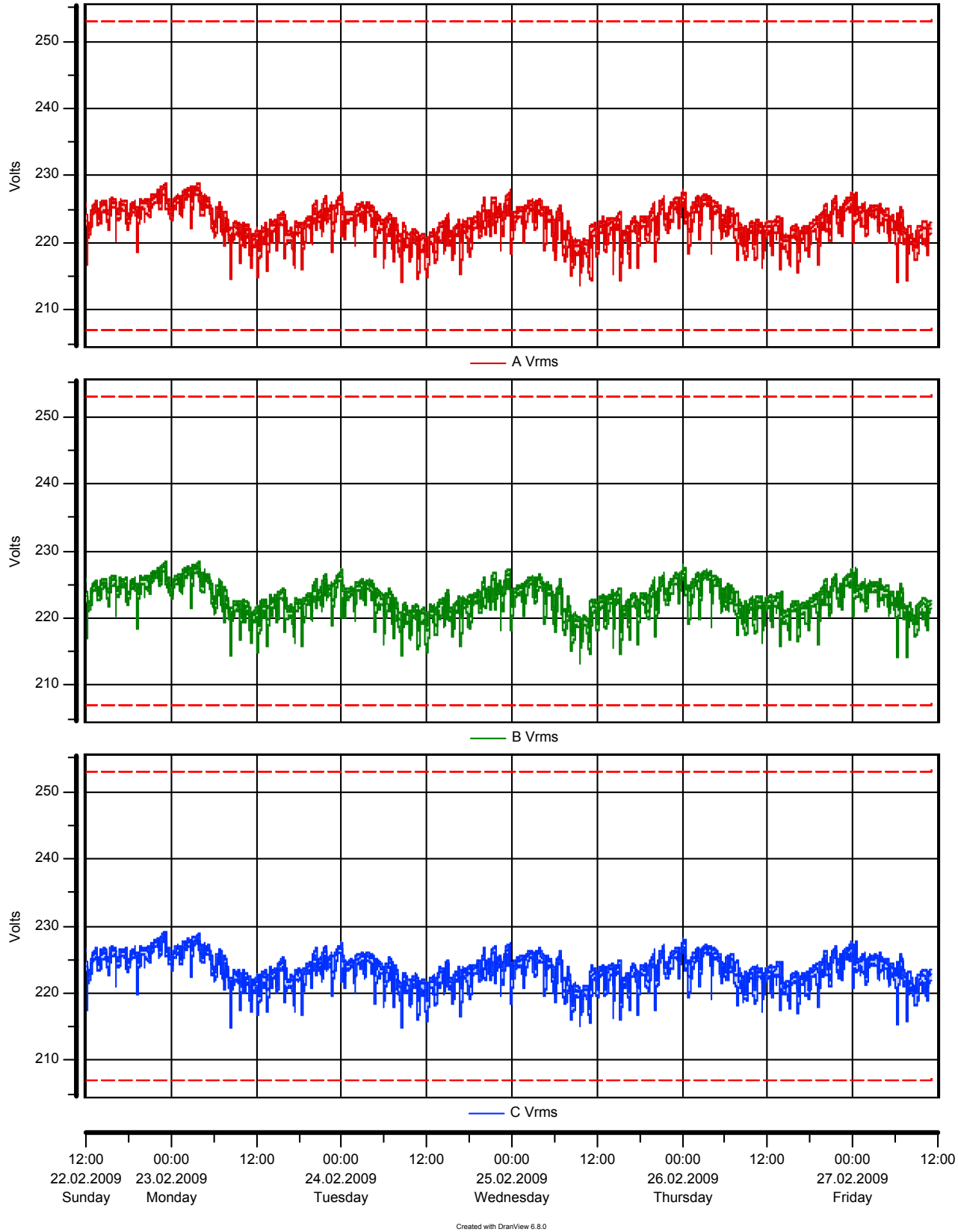
Harmonics	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
VoltageFundNormTHD_PhA	8.0	5.0	-	-	-	-	-
VoltageFundNormTHD_PhB	8.0	5.0	-	-	-	-	-
VoltageFundNormTHD_PhC	8.0	5.0	-	-	-	-	-
CurrentFundNormTHD_PhA	13.04	11.95	-	-	-	-	-
CurrentFundNormTHD_PhB	14.31	13.12	-	-	-	-	-
CurrentFundNormTHD_PhC	13.31	12.2	-	-	-	-	-

Short term flicker	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
Pst_PhA	-	1.0	-	-	-	-	-
Pst_PhB	-	1.0	-	-	-	-	-
Pst_PhC	-	1.0	-	-	-	-	-

3. VREMENSKI DIJAGRAMI

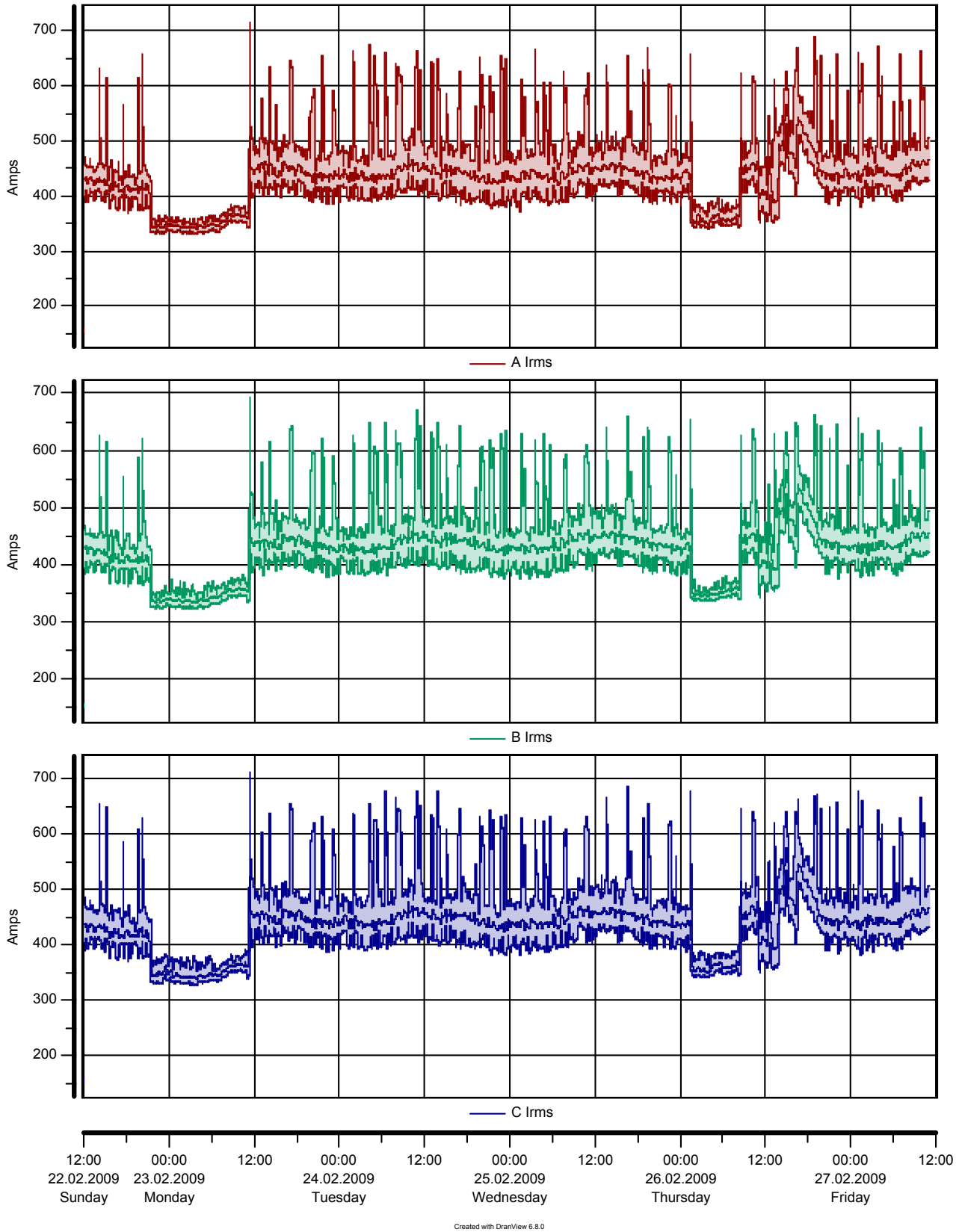
3.1. VOLTAGE TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



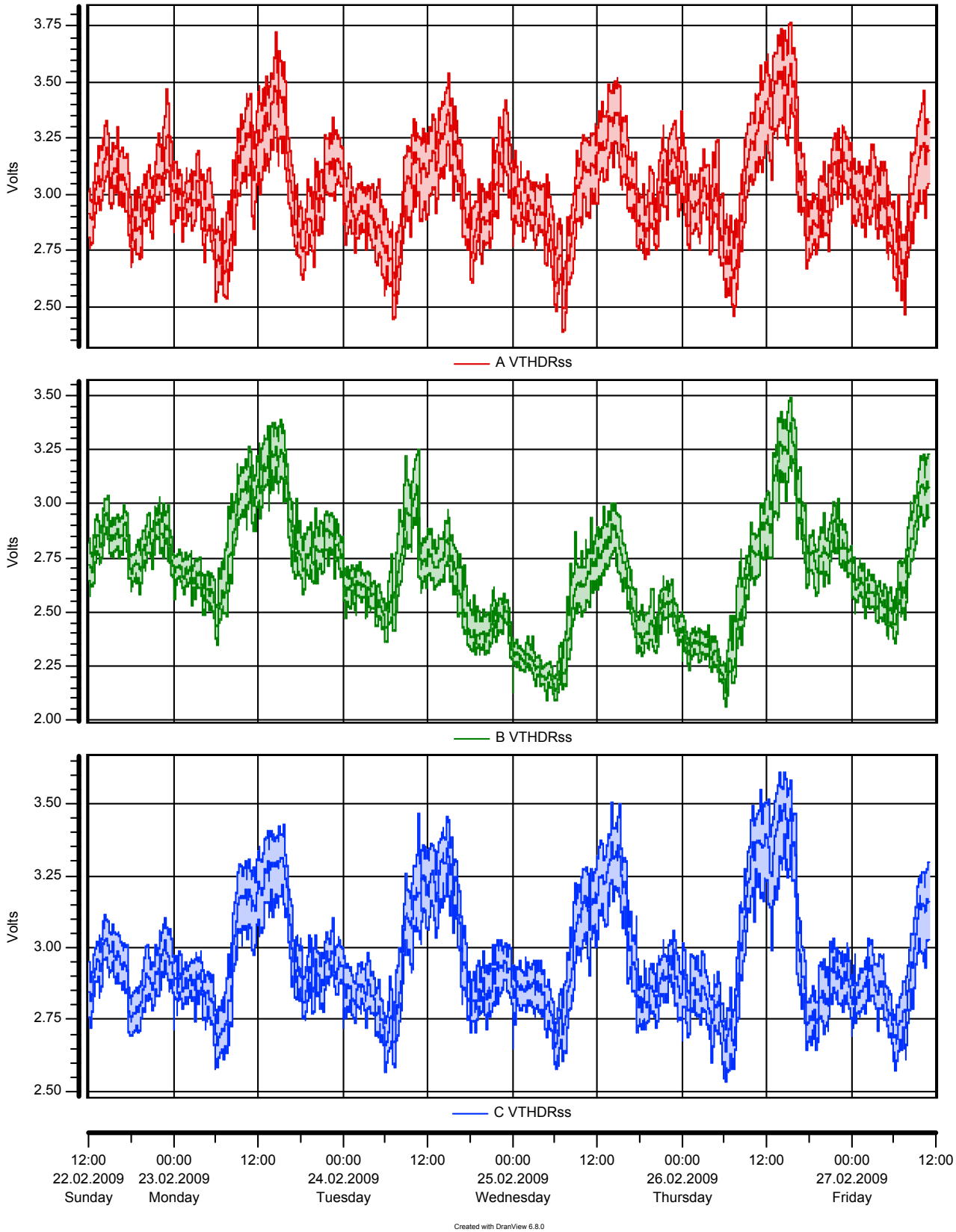
3.2. CURRENT TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



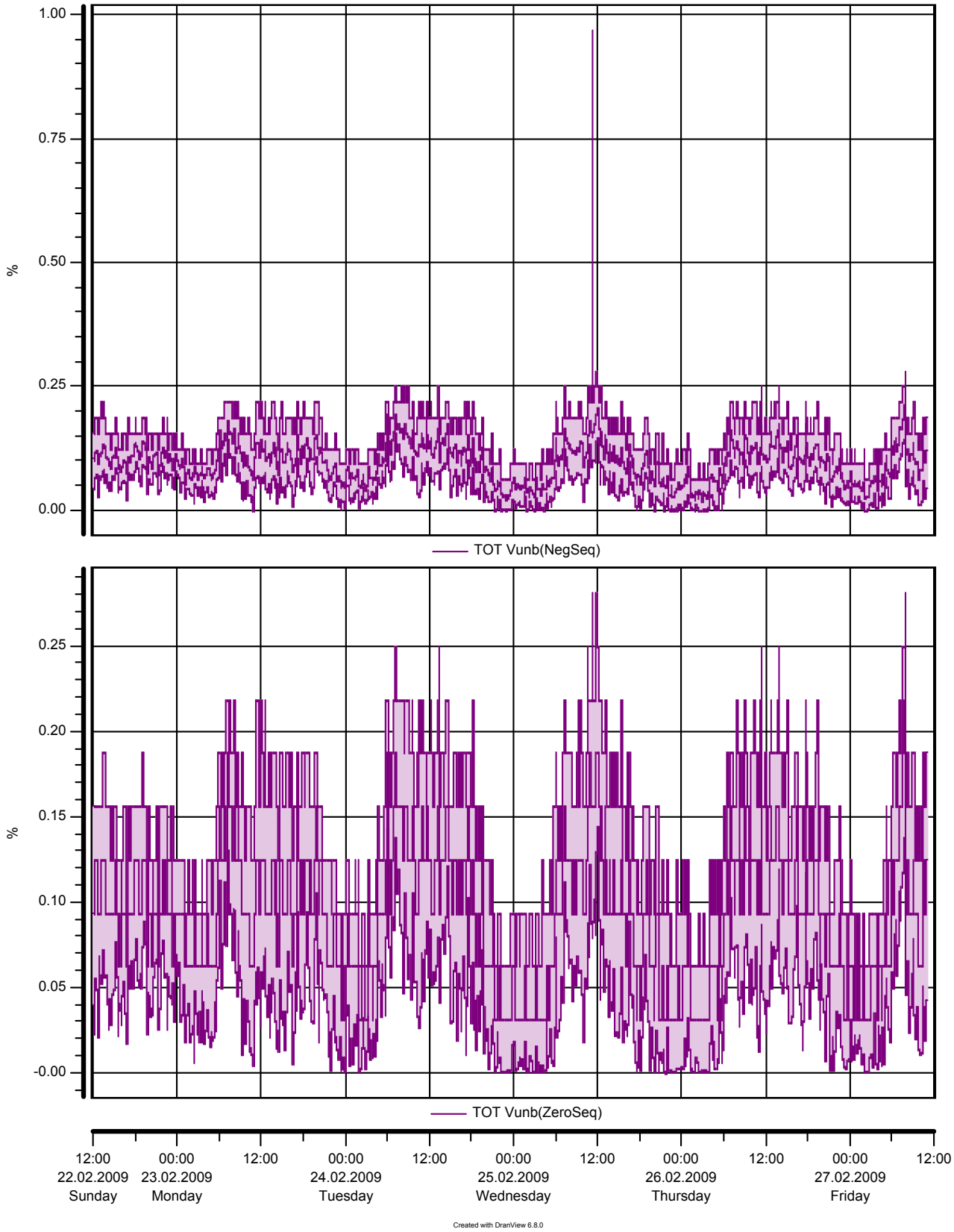
3.3. VTHD TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



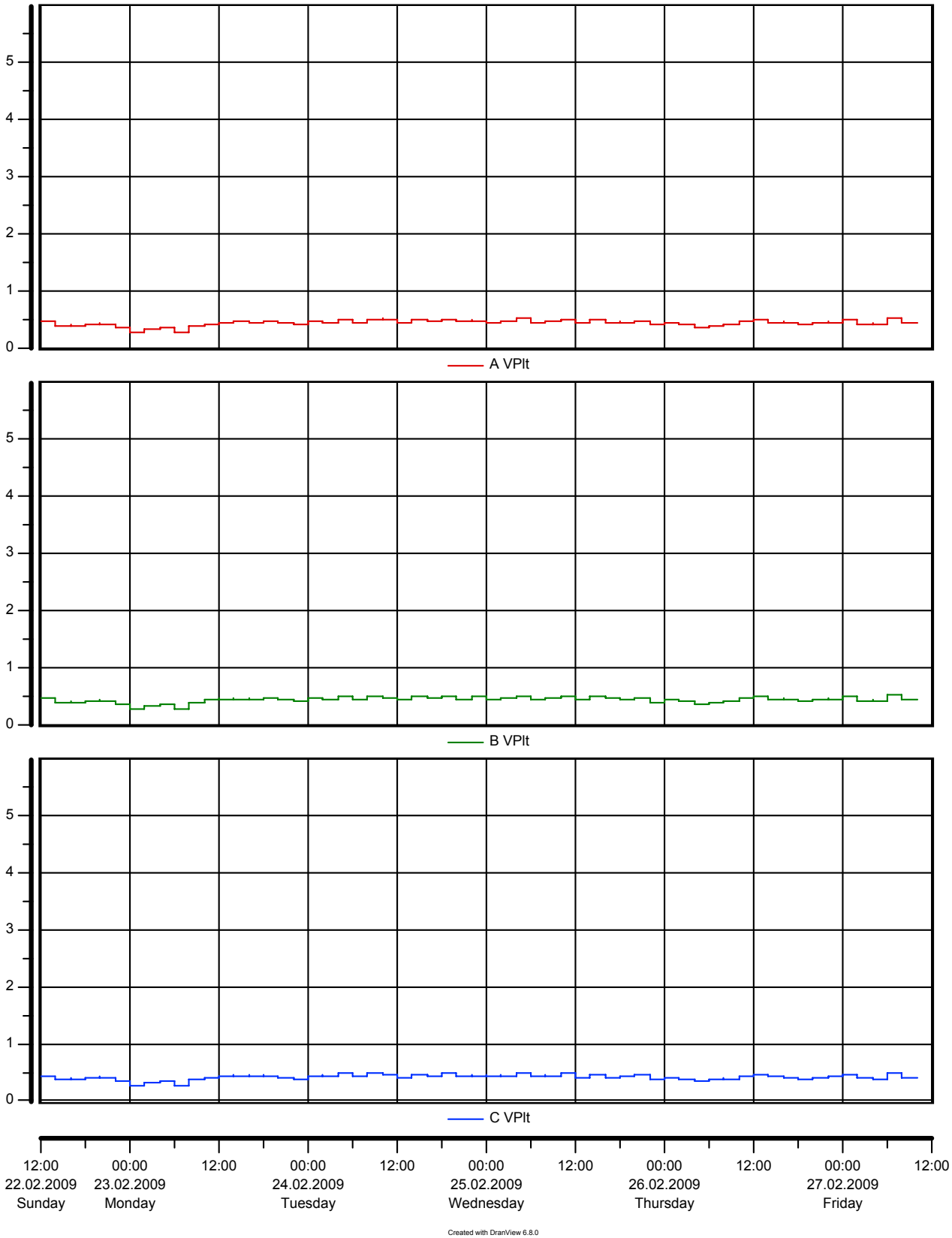
3.4. VOLTAGE UNBALANCE TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



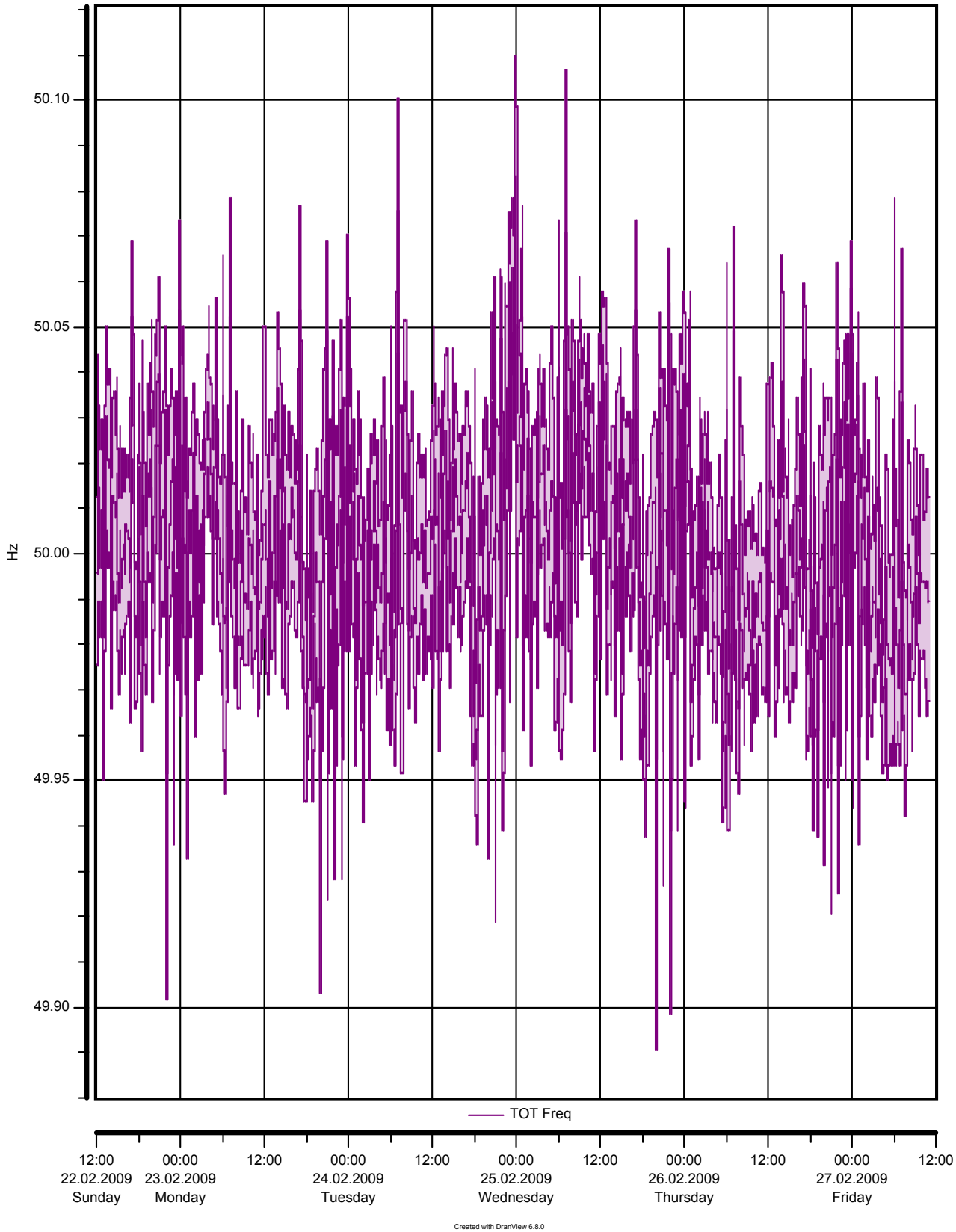
3.5. FLICKER (PLT) TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



3.6. VOLTAGE FREQUENCY TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

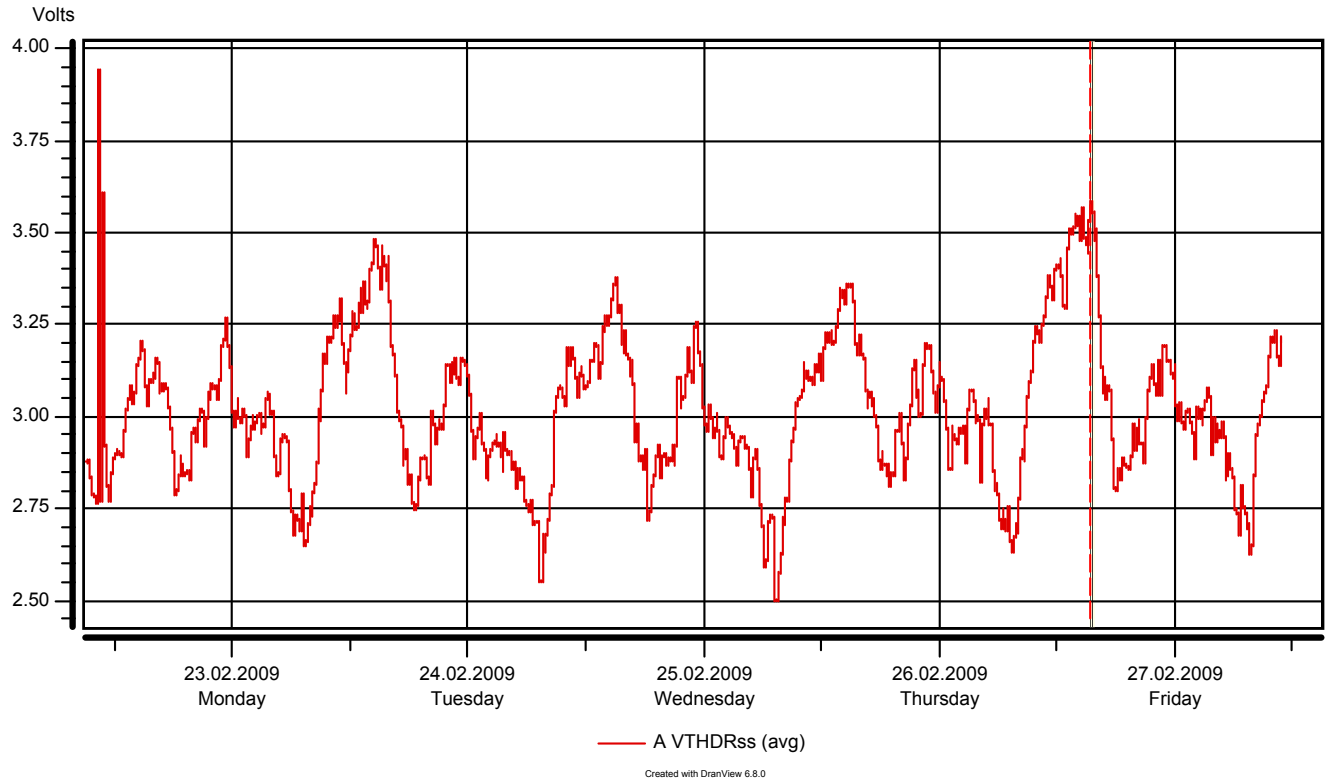


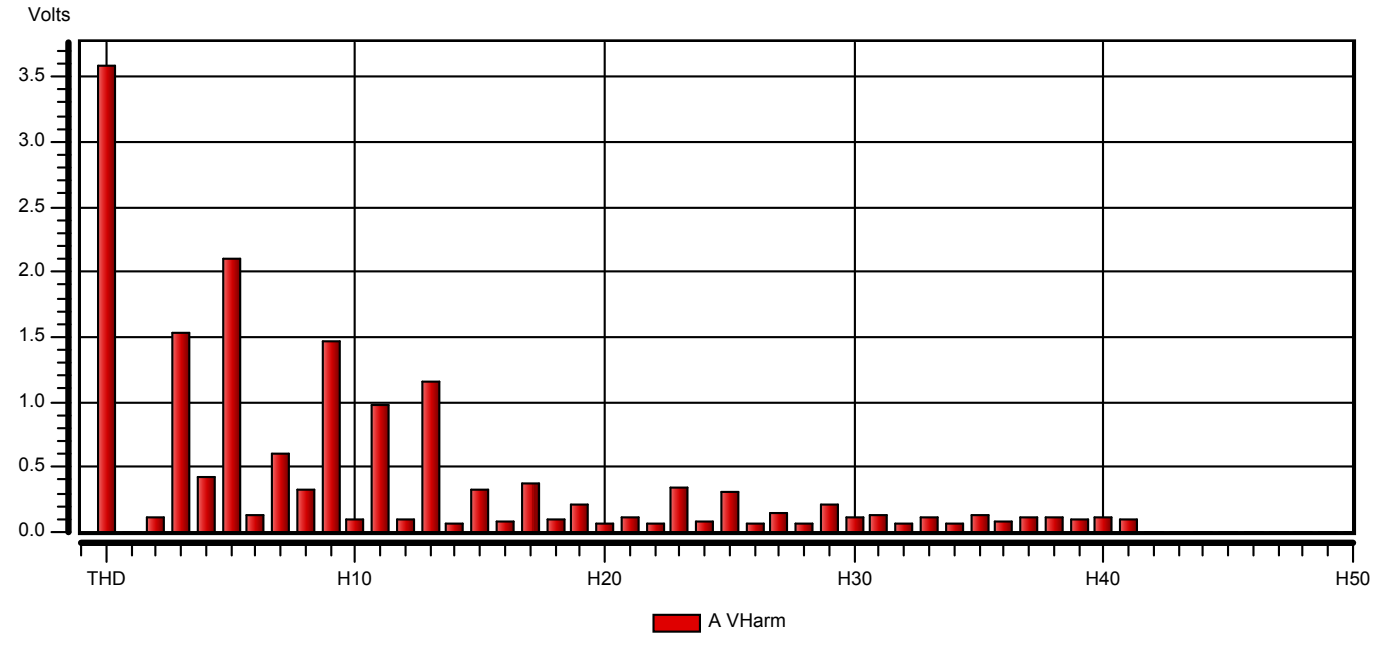
3.7. HARMONIC TIMEPLOTS

3.7.1. PHASE A – VOLTAGE HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

VOLTAGE





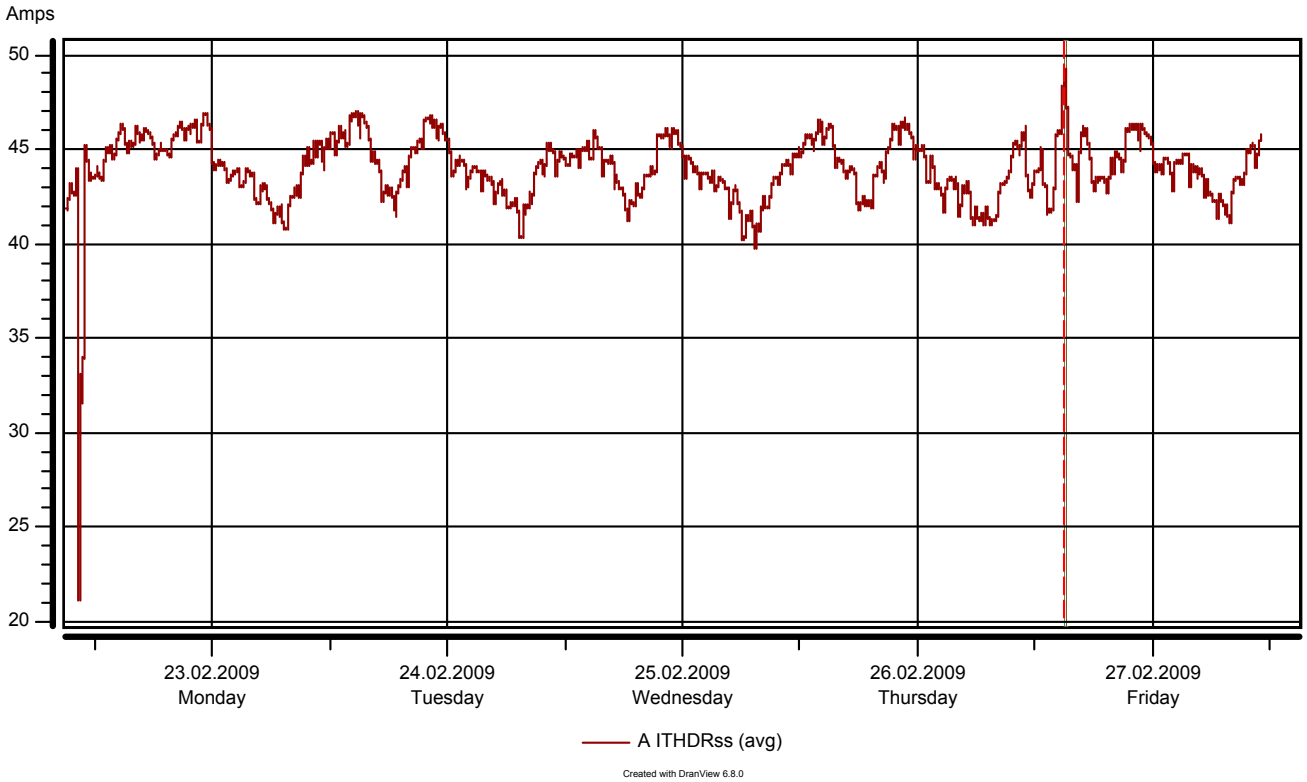
Total RMS:	221.78 V
DC Level:	0.14 V
Fundamental(H1) RMS:	220.57 V
Total Harmonic Distortion THD:	3.56 V (Even: 0.65 V, Odd: 3.50 V)

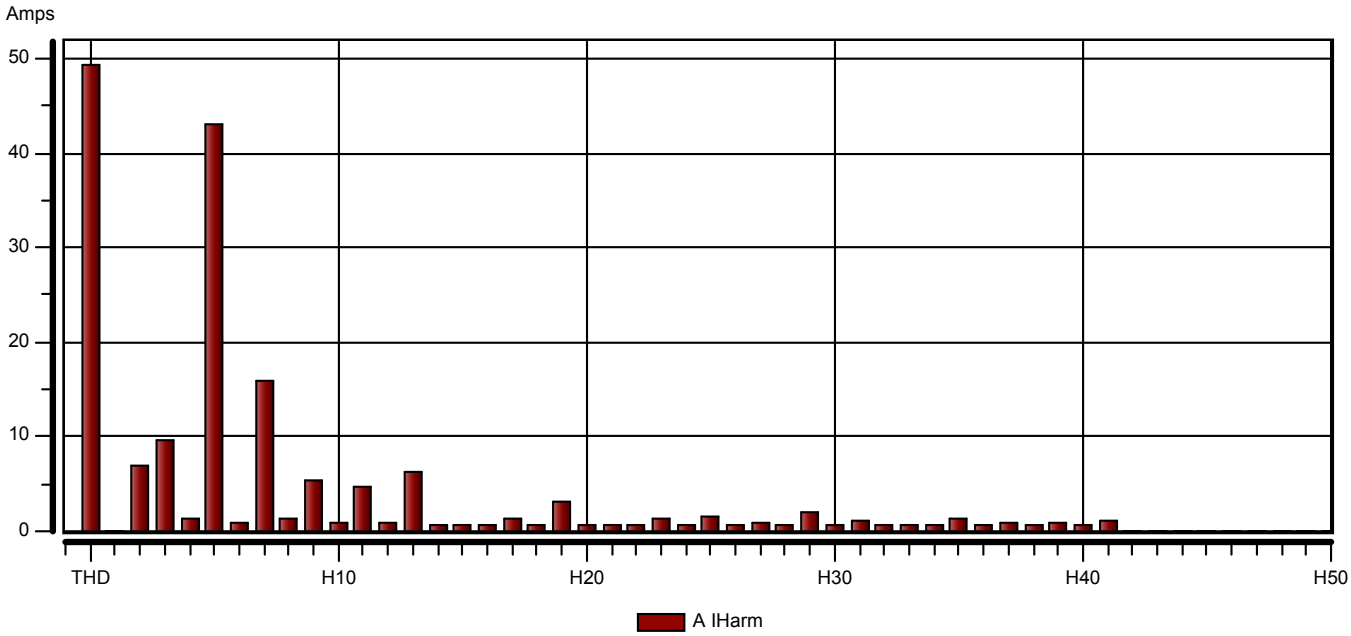
Created with DranView 6.8.0

3.7.2. PHASE A – CURRENT HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

CURRENT





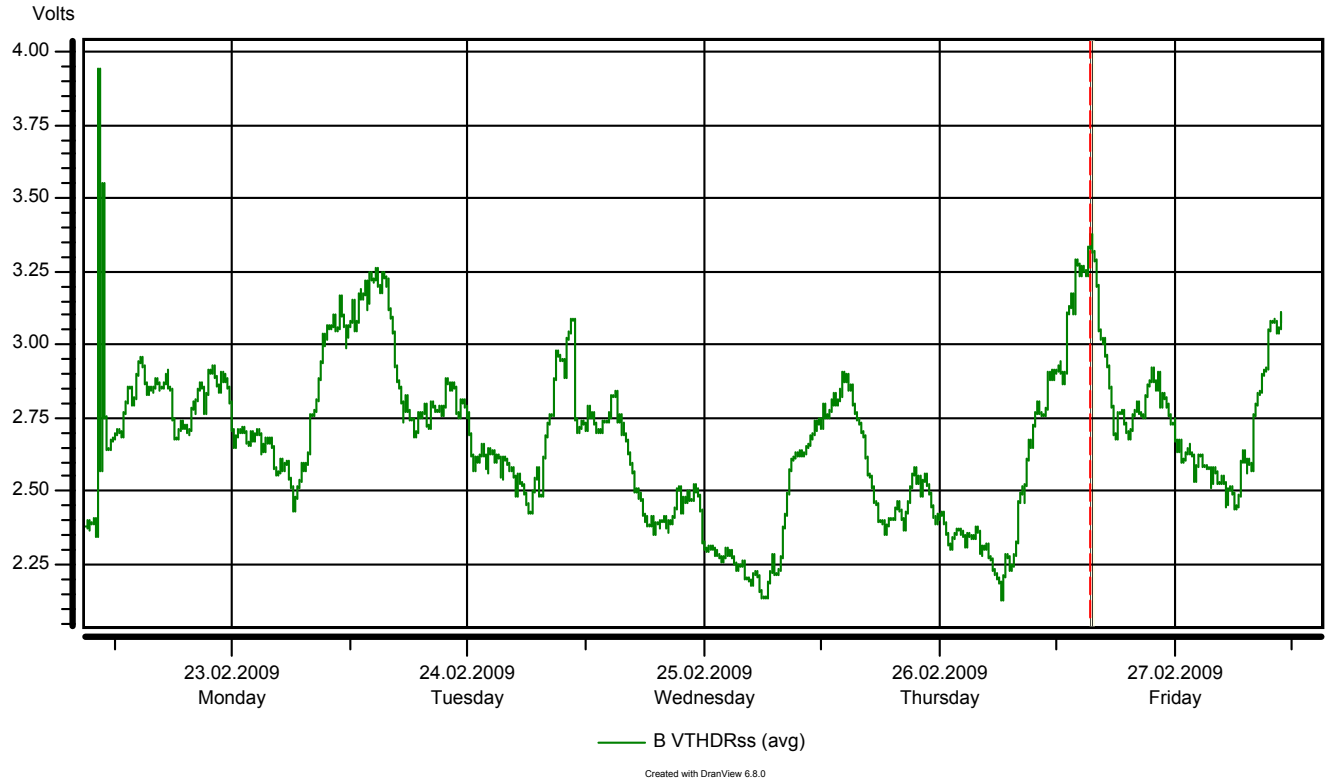
Total RMS:	567.24 A
DC Level:	1.14 A
Fundamental(H1) RMS:	551.11 A
Total Harmonic Distortion THD:	48.88 A (Even: 7.75 A, Odd: 48.26 A)

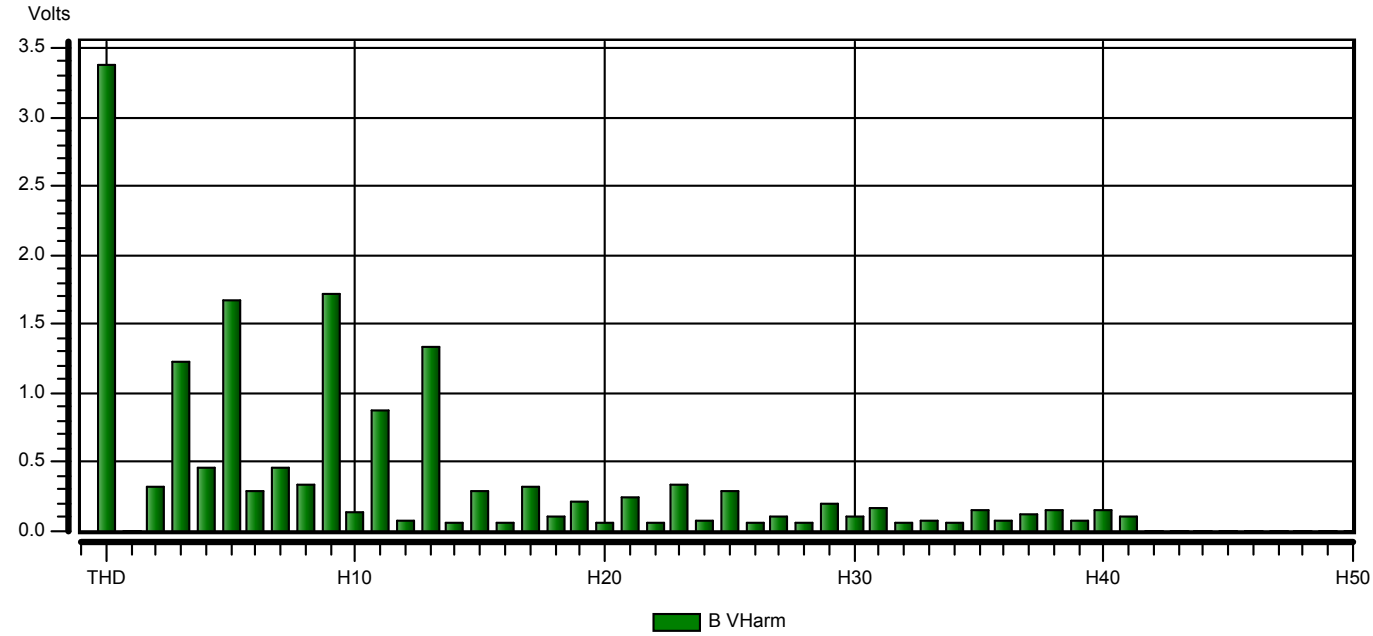
Created with DranView 6.8.0

3.7.3. PHASE B – VOLTAGE HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

VOLTAGE





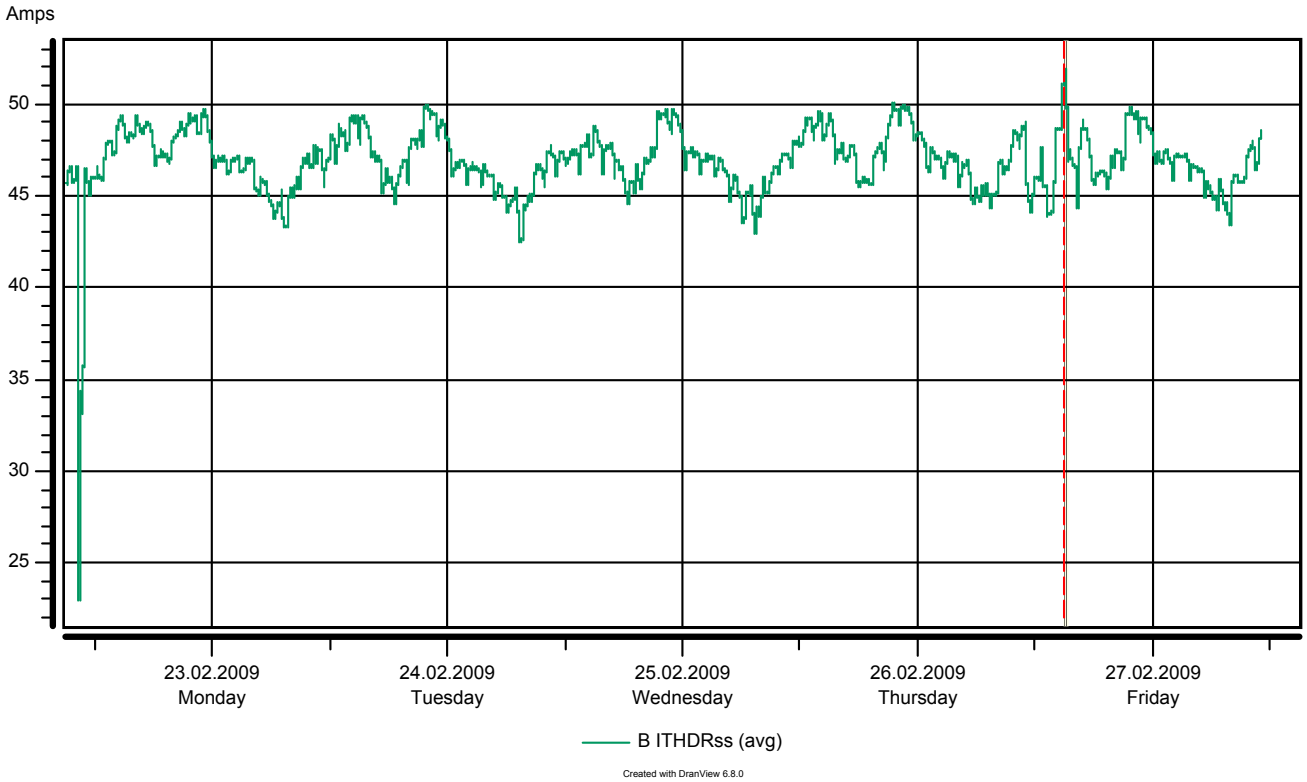
Total RMS:	221.59 V
DC Level:	0.17 V
Fundamental(H1) RMS:	220.49 V
Total Harmonic Distortion THD:	3.36 V (Even: 0.80 V, Odd: 3.26 V)

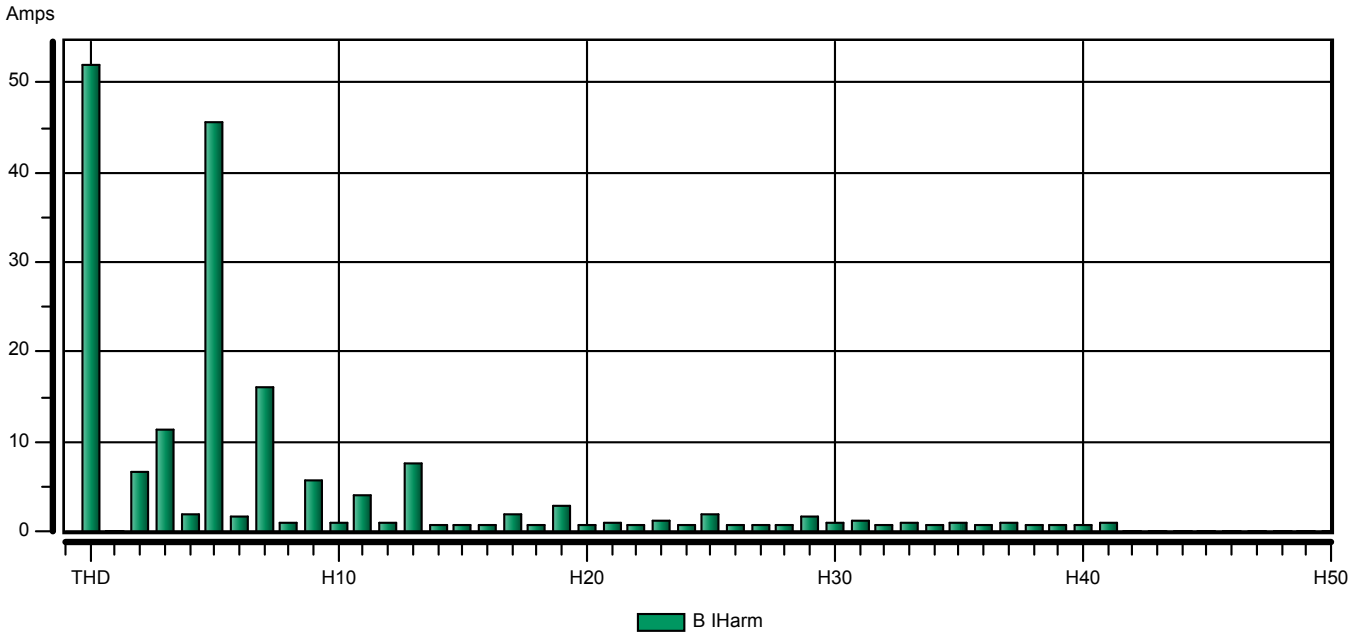
Created with DranView 6.8.0

3.7.4. PHASE B – CURRENT HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

CURRENT





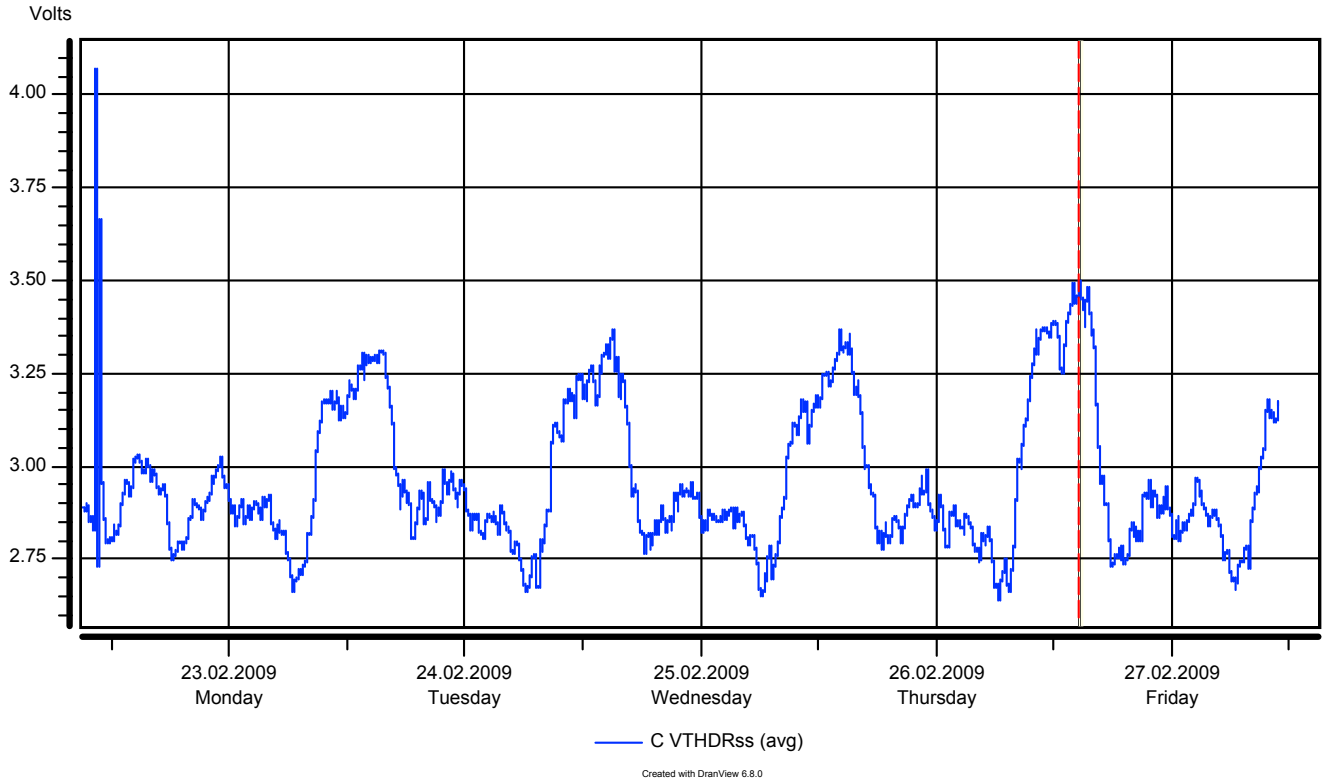
Total RMS:	564.78 A
DC Level:	1.04 A
Fundamental(H1) RMS:	548.57 A
Total Harmonic Distortion THD:	51.59 A (Even: 7.84 A, Odd: 50.99 A)

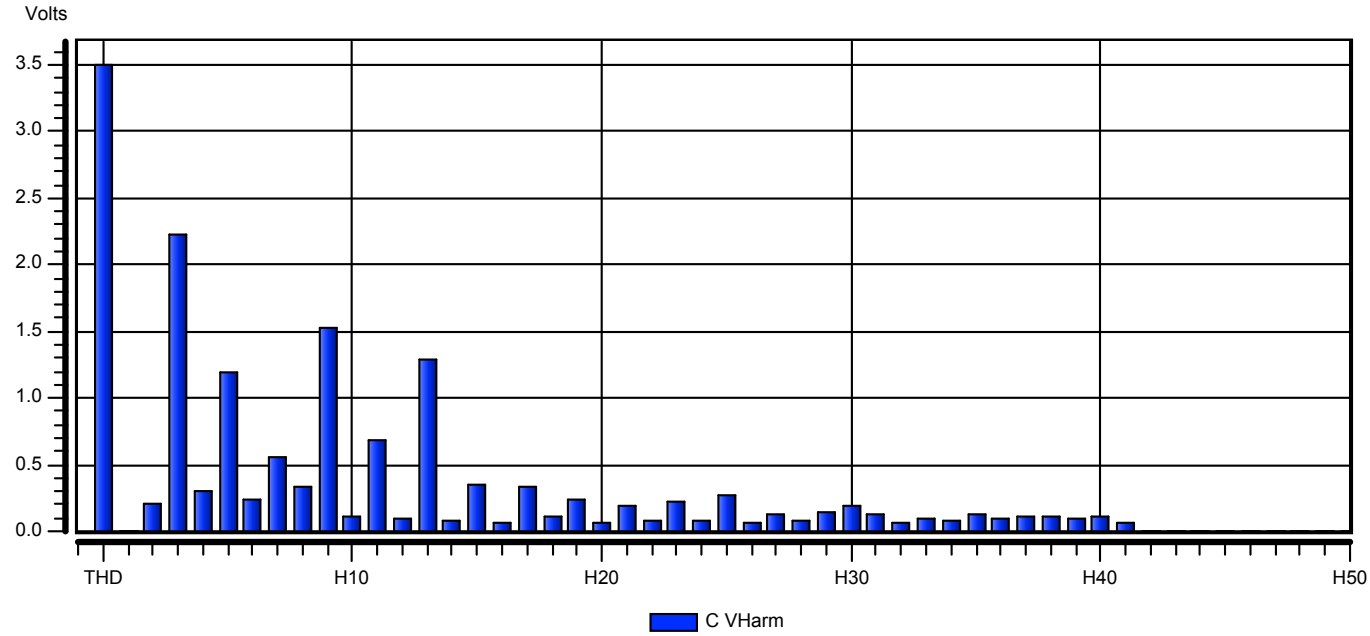
Created with DranView 6.8.0

3.7.5. PHASE C – VOLTAGE HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

VOLTAGE





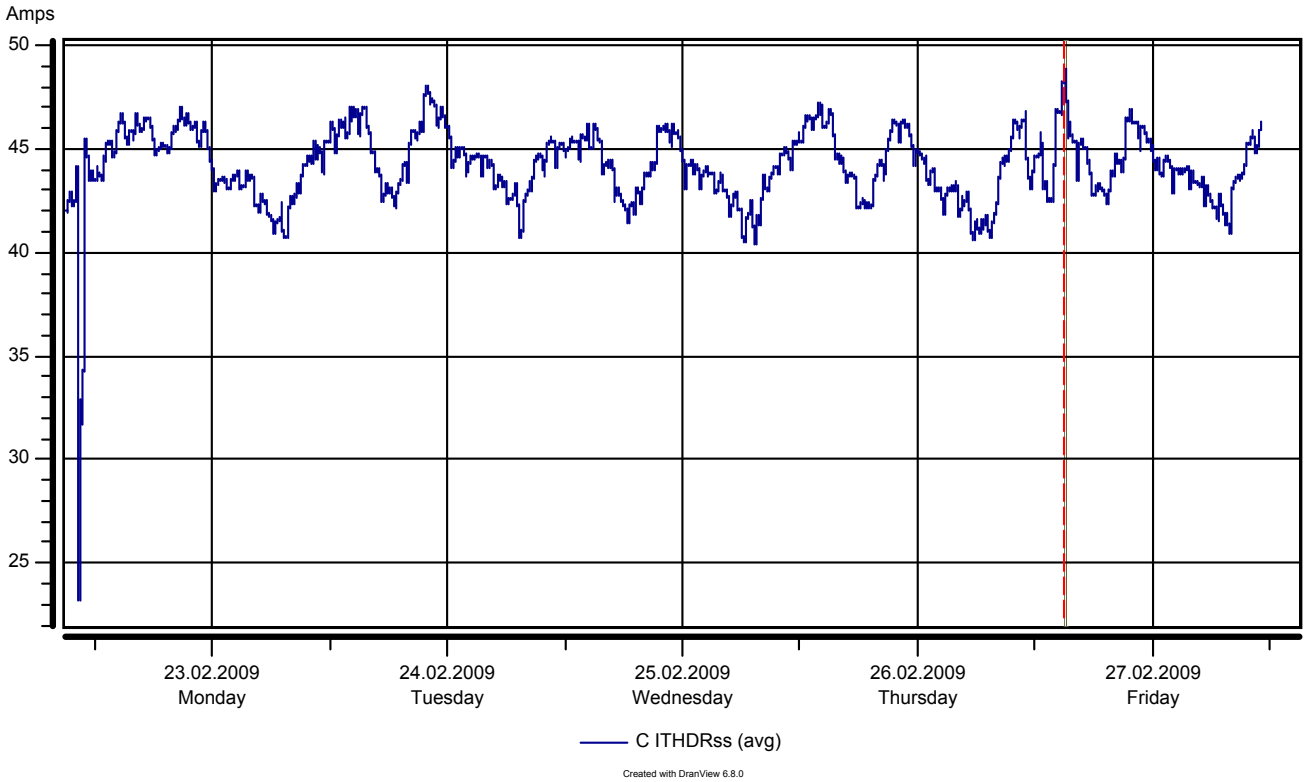
Total RMS:	221.32 V
DC Level:	0.10 V
Fundamental(H1) RMS:	221.21 V
Total Harmonic Distortion THD:	3.49 V (Even: 0.67 V, Odd: 3.42 V)

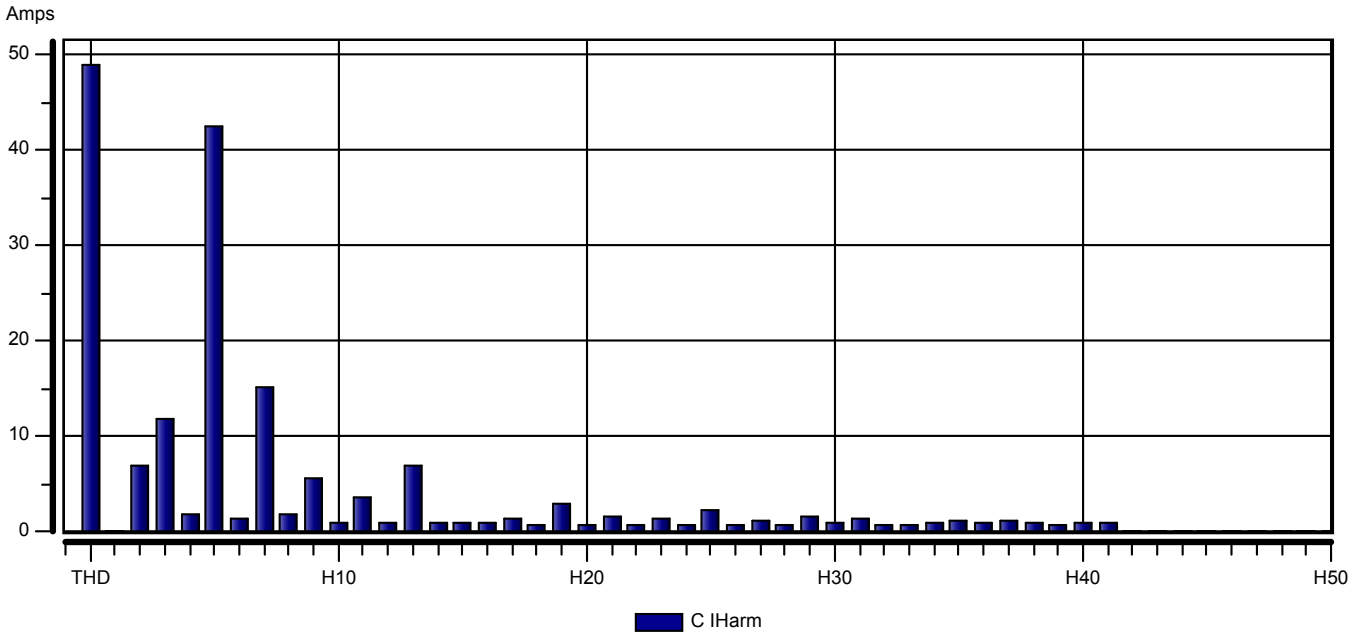
Created with DranView 6.8.0

3.7.6. PHASE C – CURRENT HARMONIC TIMEPLOT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

CURRENT



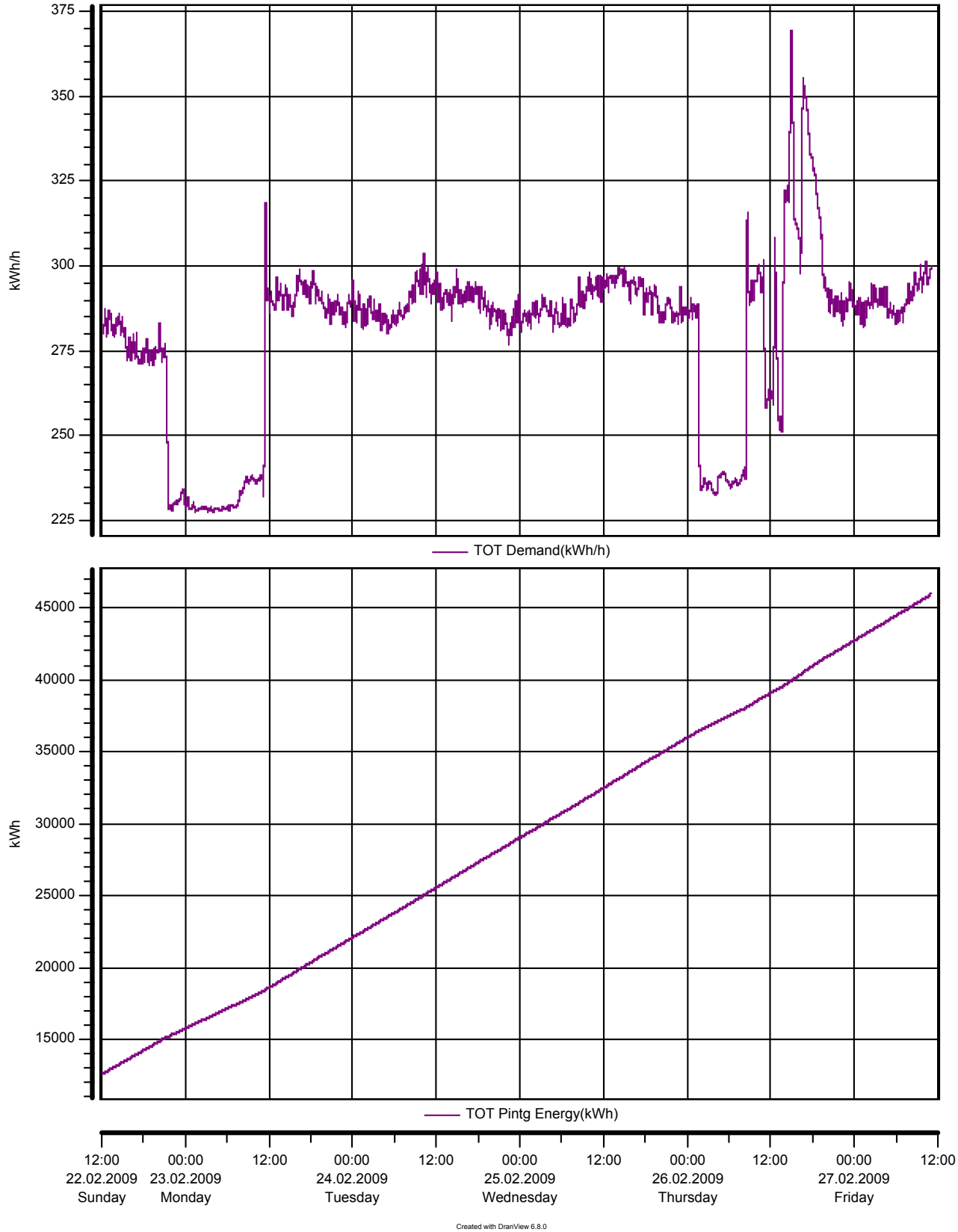


Total RMS:	573.89 A
DC Level:	1.01 A
Fundamental(H1) RMS:	557.46 A
Total Harmonic Distortion THD:	48.62 A (Even: 8.18 A, Odd: 47.92 A)

Created with DranView 6.8.0

3.8. DEMAND AND ENERGY TIMEPLOTS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0



3.9. WORST CASE SUMMARY

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

Of 0 total VOLTAGE SAGS

CRITERIA	PHASE	CATEGORY	DATA	DATE/TIME

Of 0 total VOLTAGE SWELLS

CRITERIA	PHASE	CATEGORY	DATA	DATE/TIME

Of 0 total VOLTAGE INTERRUPTIONS

CRITERIA	PHASE	CATEGORY	DATA	DATE/TIME

Of 0 total VOLTAGE TRANSIENTS

CRITERIA	PHASE	DATA	DATE/TIME

3.10. WORST CASE SUMMARY WAVEFORMS

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

Lowest Magnitude Voltage Sag:No event

NO WAVEFORM AVAILABLE

Highest Magnitude Voltage Swell:No event

NO WAVEFORM AVAILABLE

Longest Duration Voltage Sag:No event

NO WAVEFORM AVAILABLE

Longest Duration Voltage Swell:No event

NO WAVEFORM AVAILABLE

Most Energy Missing Voltage Sag:No event

Most Energy Added Voltage Swell:No event

NO WAVEFORM AVAILABLE

NO WAVEFORM AVAILABLE

Longest Duration Voltage Interruption:No event

Largest Magnitude Voltage Transients:No event

NO WAVEFORM AVAILABLE

NO WAVEFORM AVAILABLE

3.11. MIN/MAX/AVG SUMMARY REPORT

Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

VOLTAGE

	Channel A	**Channel B**
Min Volts	213.97 on 25.02.2009 09:40:00	213.41 on 25.02.2009 09:40:00
Max Volts	229.00 on 22.02.2009 23:20:00	228.49 on 22.02.2009 23:20:00
Median Volts	223.07	223.01
Average Volts	223.11	222.98
	Channel C	**Channel A-B**
Min Volts	215.08 on 24.02.2009 08:30:00	369.6 on 25.02.2009 09:40:00
Max Volts	229.14 on 22.02.2009 23:20:00	395.5 on 23.02.2009 03:50:00
Median Volts	223.61	385.9
Average Volts	223.61	385.8
	Channel B-C	**Channel C-A**
Min Volts	371.9 on 25.02.2009 09:40:00	371.7 on 25.02.2009 09:40:00
Max Volts	396.1 on 22.02.2009 23:20:00	397.4 on 22.02.2009 23:20:00
Median Volts	386.8	387.1
Average Volts	386.8	387.2

CURRENT

	Channel A	**Channel B**
Min Amps	332.7 on 23.02.2009 04:00:00	323.4 on 23.02.2009 04:00:00
Max Amps	716.3 on 23.02.2009 11:30:00	693.7 on 23.02.2009 11:30:00
Median Amps	437.2	430.9
Average Amps	426.7	421.4
	Channel C	
Min Amps	328.1 on 23.02.2009 04:00:00	
Max Amps	712.1 on 23.02.2009 11:30:00	
Median Amps	440.1	
Average Amps	430.4	

3.12. EN50160 COMPLIANCE REPORT

Site: RR NN-ups, Week #1 (22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0)

Nominal Voltage (Un) = 230 V

Power Frequency

Range	Threshold	Compliance	
50 Hz +1%/-1%	99.5%	100.0%	PASSED
50 Hz +4%/-6%	100.0%	100.0%	PASSED

Supply Voltage Variations

		Compliance:			
Range	Threshold	CHA	CHB	CHC	
230 V +10%/-10%	95.0%	100.0%	100.0%	100.0%	PASSED
230 V +10%/-15%	100.0%	100.0%	100.0%	100.0%	PASSED

Rapid Voltage Changes

Not available

Flicker

		Compliance:			
Range	Threshold	CHA	CHB	CHC	
<1	95.0%	100.0%	100.0%	100.0%	PASSED

Supply Voltage Unbalance

Range	Threshold	Compliance	
0-2%	95.0%	100.0%	PASSED

Harmonics

All shown figures are 95% values

	Limit(% of Un)	A	B	C	Status
THD	<8.00%	1.52%	1.42%	1.50%	PASSED
H02	<2.00%	0.07%	0.17%	0.11%	PASSED
H03	<5.00%	0.70%	0.62%	0.95%	PASSED
H04	<1.00%	0.17%	0.21%	0.17%	PASSED
H05	<6.00%	0.91%	0.69%	0.52%	PASSED
H06	<0.50%	0.04%	0.16%	0.10%	PASSED
H07	<5.00%	0.34%	0.29%	0.38%	PASSED
H08	<0.50%	0.14%	0.16%	0.18%	PASSED
H09	<1.50%	0.65%	0.73%	0.67%	PASSED
H10	<0.50%	0.05%	0.07%	0.07%	PASSED
H11	<3.50%	0.41%	0.33%	0.35%	PASSED
H12	<0.50%	0.04%	0.04%	0.04%	PASSED
H13	<3.00%	0.50%	0.57%	0.61%	PASSED
H14	<0.50%	0.03%	0.04%	0.04%	PASSED
H15	<0.50%	0.21%	0.18%	0.16%	PASSED
H16	<0.50%	0.04%	0.03%	0.03%	PASSED
H17	<2.00%	0.16%	0.09%	0.14%	PASSED
H18	<0.50%	0.04%	0.05%	0.04%	PASSED
H19	<1.50%	0.09%	0.12%	0.09%	PASSED
H20	<0.50%	0.03%	0.03%	0.04%	PASSED
H21	<0.50%	0.05%	0.11%	0.10%	PASSED
H22	<0.50%	0.04%	0.03%	0.03%	PASSED
H23	<1.50%	0.16%	0.15%	0.11%	PASSED
H24	<0.50%	0.03%	0.04%	0.03%	PASSED
H25	<1.50%	0.13%	0.12%	0.12%	PASSED

Supply Voltage Mains Signalling

75Hz - 100kHz Unavailable from this instrument.

3.13. EN50160 COMPLIANCE REPORT - ADDITIONAL INFORMATION

Site: RR NN-ups, Week #1 (22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0)

Supply Voltage Dips, Interruptions and Overvoltages

(EN50160 does not specify limits for this category, these are informative figures)

Magnitude	10-100 msec	0.1-0.5 Sec.	0.5-1 Sec.	1-3 Sec.	3-20 Sec.	20-60 Sec.	1-3 Min	>3 Min
Dips:								
0% - 10%	-	-	-	-	-	-	-	-
10% - 15%	-	-	-	-	-	-	-	-
15% - 30%	-	-	-	-	-	-	-	-
30% - 60%	-	-	-	-	-	-	-	-
60% - 99%	-	-	-	-	-	-	-	-
Interruptions:								
99% - 100%	-	-	-	-	-	-	-	-
Swells:								
0% - 110%	-	-	-	-	-	-	-	-
110% - 120%	-	-	-	-	-	-	-	-
120% - 140%	-	-	-	-	-	-	-	-
140% - 160%	-	-	-	-	-	-	-	-
160% - 200%	-	-	-	-	-	-	-	-
200% -	-	-	-	-	-	-	-	-

Transient Overvoltages

(EN50160 does not specify limits for this category, these are informative figures)

Magnitude	Counts
0% - 110%	-
110% - 120%	-
120% - 140%	-
140% - 160%	-
160% - 200%	-
200% -	-

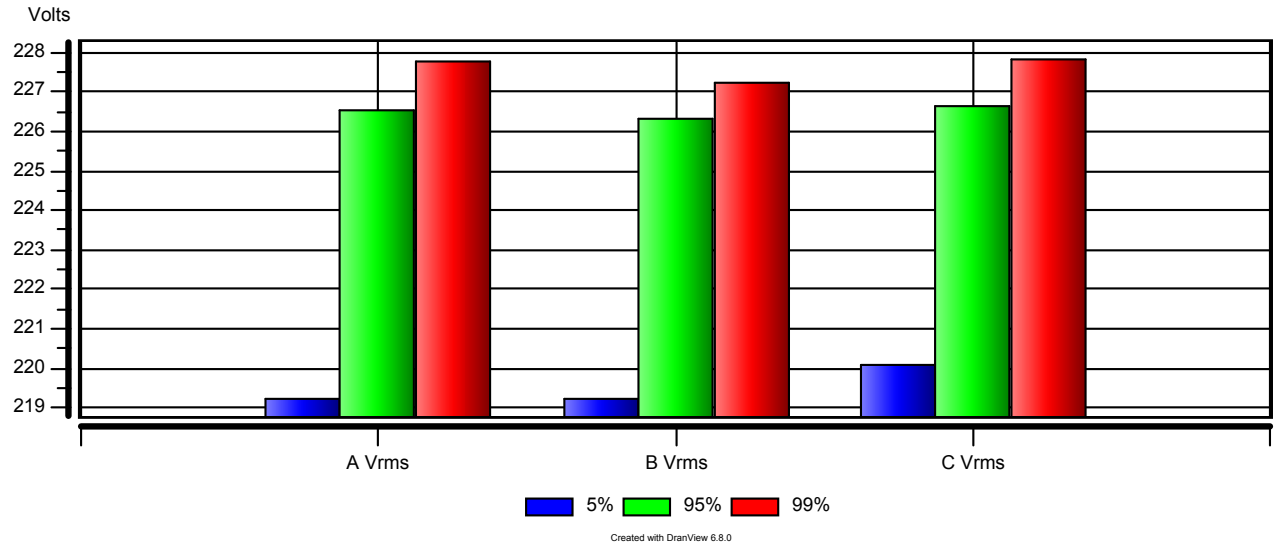
Interharmonic Voltage

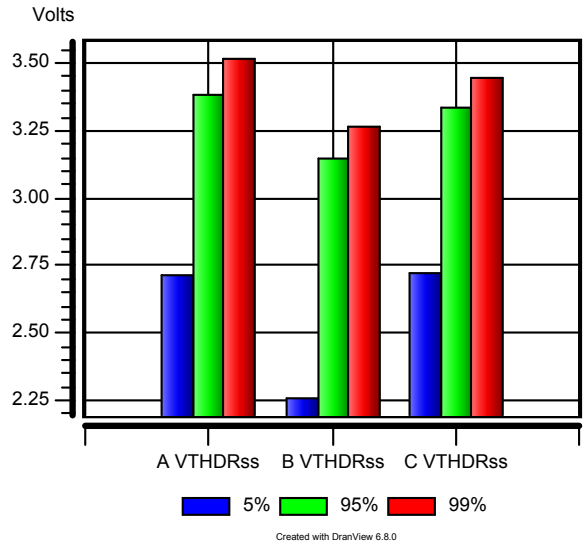
(EN50160 does not specify limits for this category. All shown figures are 95% values)

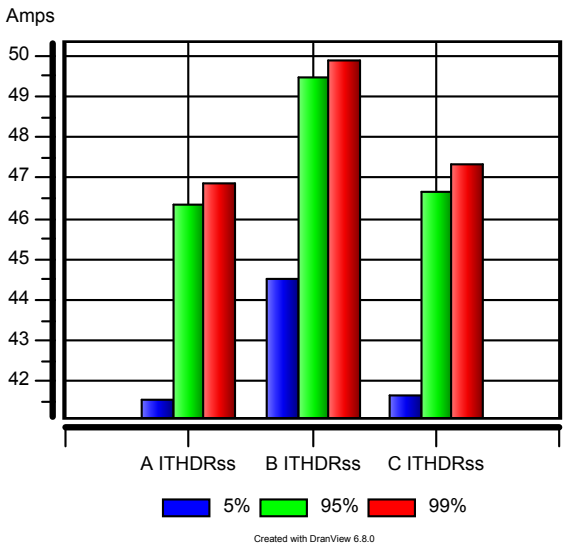
	A	B	C
TID	0.31%	0.27%	0.27%
IH00	0.05%	0.05%	0.05%
IH01	0.06%	0.05%	0.05%
IH02	0.05%	0.04%	0.04%
IH03	0.07%	0.06%	0.06%
IH04	0.08%	0.06%	0.06%
IH05	0.06%	0.05%	0.05%
IH06	0.04%	0.04%	0.04%
IH07	0.07%	0.06%	0.07%
IH08	0.07%	0.06%	0.07%
IH09	0.05%	0.04%	0.04%
IH10	0.05%	0.04%	0.04%
IH11	0.05%	0.04%	0.04%
IH12	0.05%	0.04%	0.04%
IH13	0.04%	0.04%	0.04%
IH14	0.05%	0.04%	0.04%
IH15	0.05%	0.04%	0.04%
IH16	0.04%	0.03%	0.04%
IH17	0.05%	0.04%	0.04%
IH18	0.05%	0.04%	0.04%
IH19	0.04%	0.03%	0.04%
IH20	0.04%	0.04%	0.04%
IH21	0.04%	0.04%	0.04%
IH22	0.04%	0.04%	0.04%
IH23	0.04%	0.04%	0.04%
IH24	0.04%	0.04%	0.04%
IH25	0.04%	0.03%	0.04%

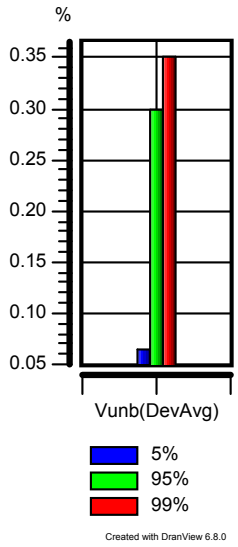
4. QUALITY OF SUPPLY

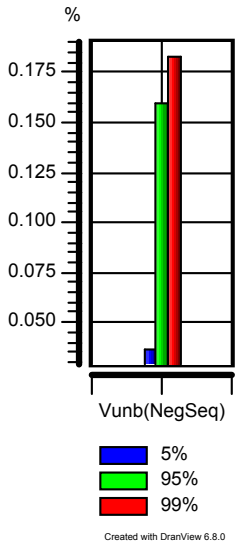
Site: RR NN-ups
Measured from 22.02.2009 12:00:00,0 to 27.02.2009 12:00:00,0

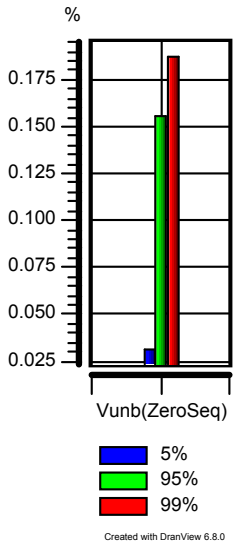


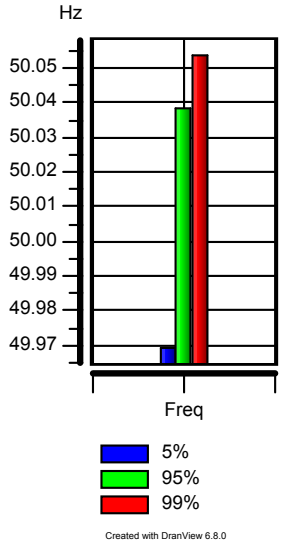





%
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Vunb(DevAvg)
5%
95%
99%
Created with DranView 6.8.0


%
0.175
0.150
0.125
0.100
0.075
0.050
Vunb(NegSeq)
5%
95%
99%
Created with DranView 6.8.0


%
0.175
0.150
0.125
0.100
0.075
0.050
0.025
Vunb(ZeroSeq)
5%
95%
99%
Created with DranView 6.8.0


Hz
50.05
50.04
50.03
50.02
50.01
50.00
49.99
49.98
49.97
Freq
5%
95%
99%
Created with DranView 6.8.0

5. SAŽETAK

5.1. Parametri napona

5.1.1. Iznos napona (spore promjene)

Granične vrijednosti prema EN 50160

Nazivni napon:	Unom =	230 V
Minimalni napon:	Umin = Unom – 10% =	207 V
Maksimalni napon:	Umax = Unom + 10% =	253 V

Izmjerene vrijednosti

Faza L1	Umin = 213,97 V	**ZADOVOLJAVA**
	Umax = 229,00 V	**ZADOVOLJAVA**
Faza L2	Umin = 213,41 V	**ZADOVOLJAVA**
	Umax = 228,49 V	**ZADOVOLJAVA**
Faza L3	Umin = 215,08 V	**ZADOVOLJAVA**
	Umax = 229,14 V	**ZADOVOLJAVA**

5.1.2. Tranzijentni prenaponi (brze promjene)

Granične vrijednosti prema EN 50160

Maksimalni prenapon: Umax = Unom + 10% = 253 V

Izmjerene vrijednosti

Nisu zabilježeni prenaponi **ZADOVOLJAVA**

5.1.3. Flikeri

Granične vrijednosti prema EN 50160

Broj flikera u periodu 2 h: Plt < 1

Izmjerene vrijednosti

Faza L1	Plt = 0,5	**ZADOVOLJAVA**
Faza L2	Plt = 0,5	**ZADOVOLJAVA**
Faza L3	Plt = 0,5	**ZADOVOLJAVA**

5.1.4. Harmoničko izobličenje

Granične vrijednosti prema EN 50160

Totalno harmoničko izobličenje: THD ≤ 8%

Izmjerene vrijednosti

Faza L1	V_{THD} max = 1.52%	**ZADOVOLJAVA**
Faza L2	V_{THD} max = 1.42%	**ZADOVOLJAVA**
Faza L3	V_{THD} max = 1.50%	**ZADOVOLJAVA**

5.1.5. Nesimetrija napona

Granične vrijednosti prema EN 50160

Napon nesimetrije: Vnes ≤ 2%

Izmjerene vrijednosti

Vimax	= 0,95 %	**ZADOVOLJAVA**
Vomax	= 0,28 %	**ZADOVOLJAVA**

5.1.6. Frekvencija napona

Granične vrijednosti prema EN 50160

minimalna frekvencija: fmin = 49,5 Hz
maksimalna frekvencija: fmax = 50,5 Hz

Izmjerene vrijednosti

fmin	= 49,89 Hz	**ZADOVOLJAVA**
fmax	= 50,11 Hz	**ZADOVOLJAVA**

5.2. ZAKLJUČAK

Parametri napona mrežnog napajanja zadovoljavaju standardnu kvalitetu opskrbe električnom energijom prema EN 50160.

S obzirom da je snimanje parametara kvalitete napona pokazalo da se ne pojavljuju odstupanja izvan dozvoljenih granica, uzrok prethodnog pregaranja elemenata nadzorne opreme (kontrolnici napona) bio je u lošoj kvaliteti navedene opreme.

FAKULTET ELEKTROTEHNIKE I RAČUNARSTVA
Zavod za visoki napon i energetiku
10000 ZAGREB, Unska 3

IZVJEŠĆE

ispitivanja automatike elektroenergetskog napajanja

Objekt: **PBZ**
Radnička c. 42-46, ZAGREB

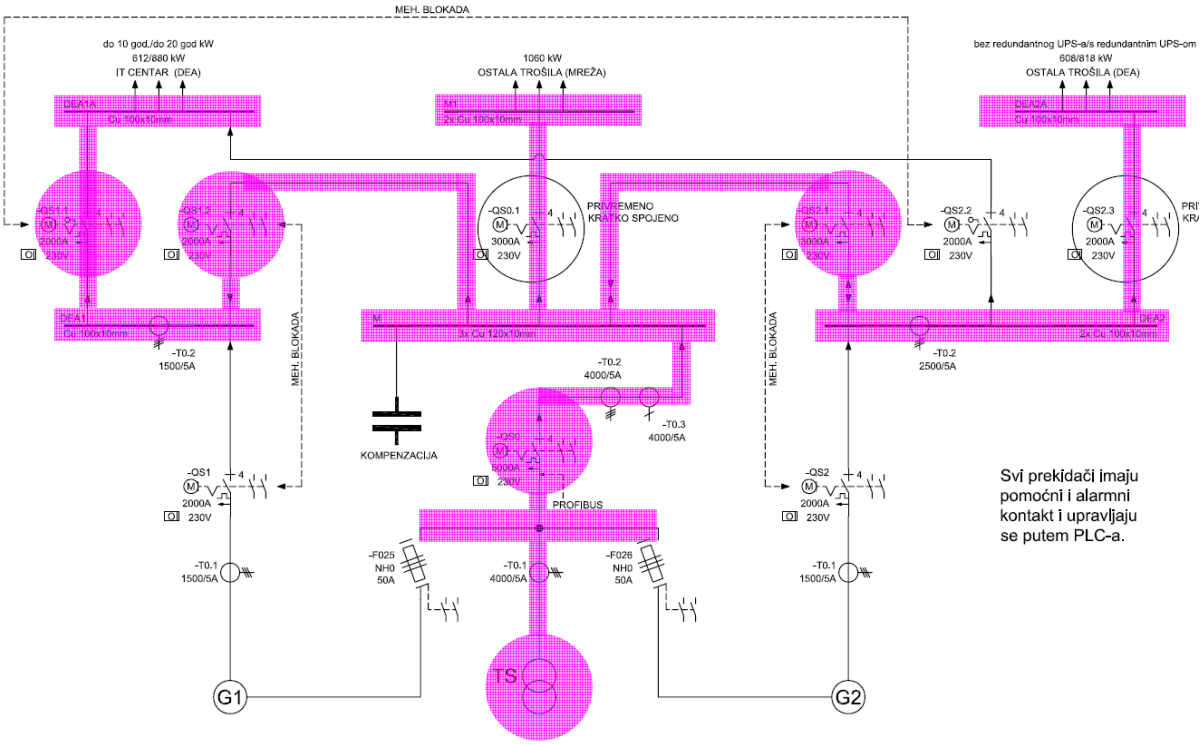
Datum: **22.02.2009.**

Zagreb, veljača 2009.

1. ISPITIVANJE

1.1 PKUS 1 ispad mreže

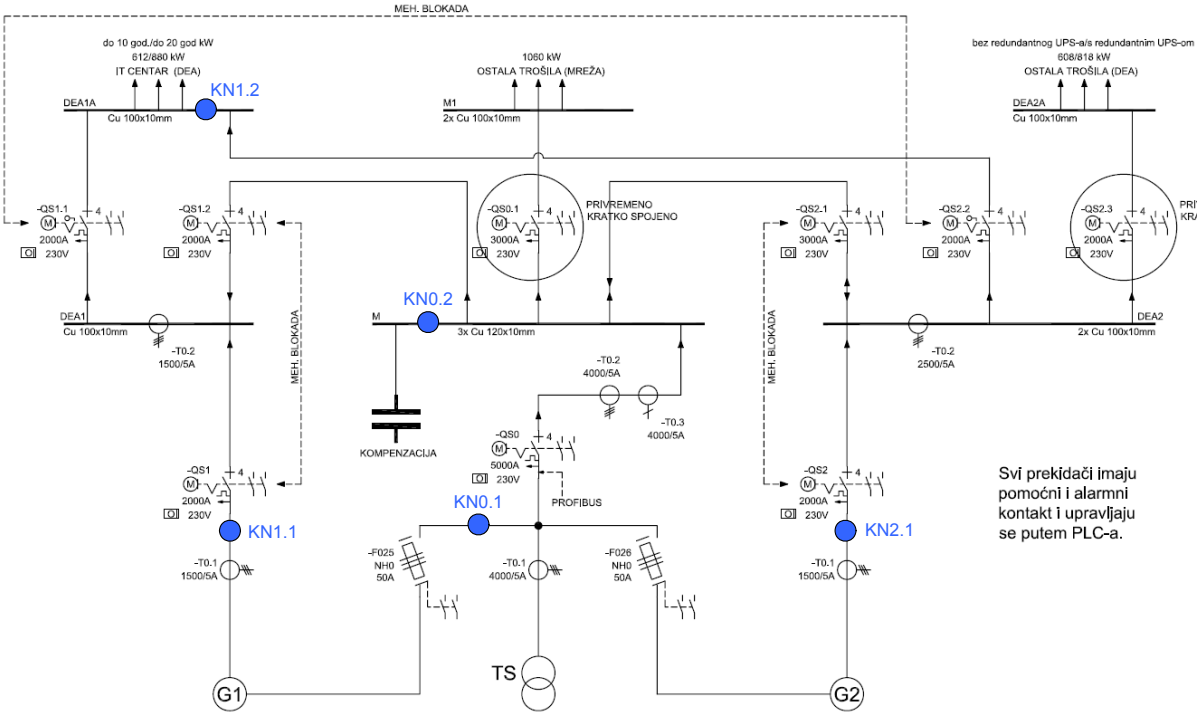
Početno stanje: - normalno napajanje iz mreže
- sve izborne preklopke u položaju **1 - AUTOMATSKI** (daljinski)



Slika 1. Normalno pogonsko stanje

Sabirnice	izvor	prekidač	stanje
M	TS	QS0	1
M1	M	QS0.1	1
DEA1	M	QS1.2	1
DEA1	G1	QS1	0
DEA1A	DEA1	QS1.1	1
DEA1A	DEA2	QS2.2	0
DEA2	M	QS2.1	1
DEA2	G2	QS2	0
DEA2A	DEA2	QS2.3	1

Poticaj: - isklop prekidača na visoko-naponskoj strani transformatora



Slika 2. Lokacije kontrolnika napona

Slijed: - podnaponski okidač isključuje QS0

- kontrolnik KN0.1 inicira sljedeće PLC sekvence:

1. isključenje QS1.2
2. isključenje QS2.1
3. START G1
4. START G2

- kontrolnik KN1.1 inicira sljedeće PLC sekvence:

1. uključenje QS1

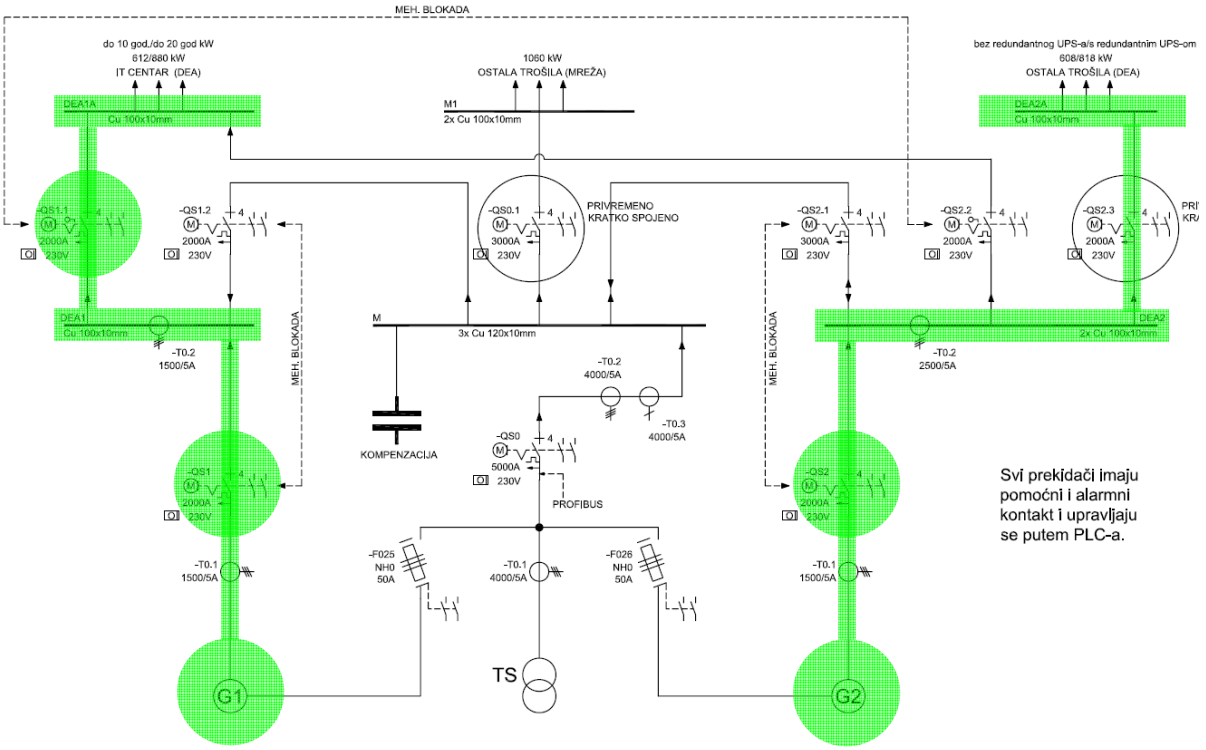
- kontrolnik KN2.1 inicira sljedeće PLC sekvence:

1. uključenje QS2

Navedene sekvence treba provjeriti u PLC programu !!!

NAPOMENA:

Pogonsko stanje napajanja sabirnica DEA1A odnosno DEA2A iz agregata G1 odnosno G2 nakon ispada mreže uspostavlja se automatski (Slika 3.)



Slika 3. Napajanje iz agregata G1 i G2 (normalni pogon)

Sabirnice	izvor	prekidač	stanje
M	TS	QS0	0
M1	M	QS0.1	0
DEA1	M	QS1.2	0
DEA1	G1	QS1	1
DEA1A	DEA1	QS1.1	1
DEA1A	DEA2	QS2.2	0
DEA2	M	QS2.1	0
DEA2	G2	QS2	1
DEA2A	DEA2	QS2.3	1

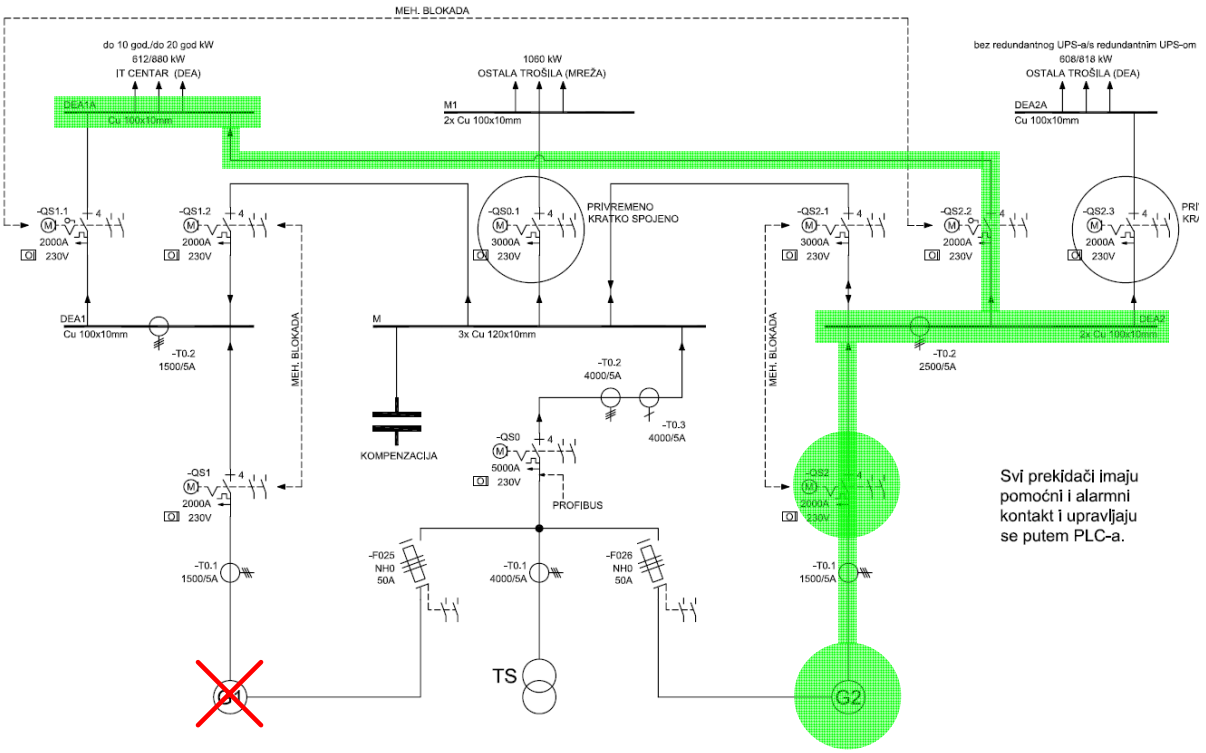
1.2 POKUS 2 ispad G1

Početno stanje: - napajanje iz agregata (normalni pogon)

Poticaj: - automatika G1 u položaj RUČNO
- STOP G1

Slijed: - kontrolnik KN1.1 inicira sljedeće PLC sekvence:

1. uključenje QS1.1
2. **isključenje QS2.3** (rasterećenje DEA2)
3. uključenje QS2.2



Slika 4. Napajanje iz agregata G2 (nužni pogon)

Sabirnice	izvor	prekidač	stanje
M	TS	QS0	0
M1	M	QS0.1	0
DEA1	M	QS1.2	0
DEA1	G1	QS1	0
DEA1A	DEA1	QS1.1	0
DEA1A	DEA2	QS2.2	1
DEA2	M	QS2.1	0
DEA2	G2	QS2	1
DEA2A	DEA2	QS2.3	0

1.3 POKUS 3 prorada G1

Početno stanje: - napajanje iz agregata G2 (nužni pogon)

Poticaj: - automatika G1 u položaj AUTOMATSKI
- START G1

Slijed: - kontrolnik KN1.1 inicira sljedeće PLC sekvence:

1. isključenje QS2.2
2. ukključenje QS2.3
3. uključenje QS1.1
4. uključenje QS1

NAPOMENA:

Proradom agregata G1 automatski se uspostavlja napajanje iz agregata G1 i G2 (normalni pogon) kao što prikazuje Slika 3.

1.4 POKUS 4 povrat mreže

Početno stanje: - napajanje iz agregata (normalni pogon)

Poticaj: - uklop prekidača na visoko-naponskoj strani transformatora

Slijed: - kontrolnik KN 0.1 inicira sljedeće PLC sekvence:

1. STOP agregata G1
2. STOP agregata G2
3. isključenje prekidača QS1
4. isključenje prekidača QS2
5. uključenje prekidača QS0
6. uključenje prekidača QS0.1
7. uključenje prekidača QS1.2
8. uključenje prekidača QS2.1
9. uključenje prekidača QS1.1
10. uključenje prekidača QS2.3

NAPOMENA:

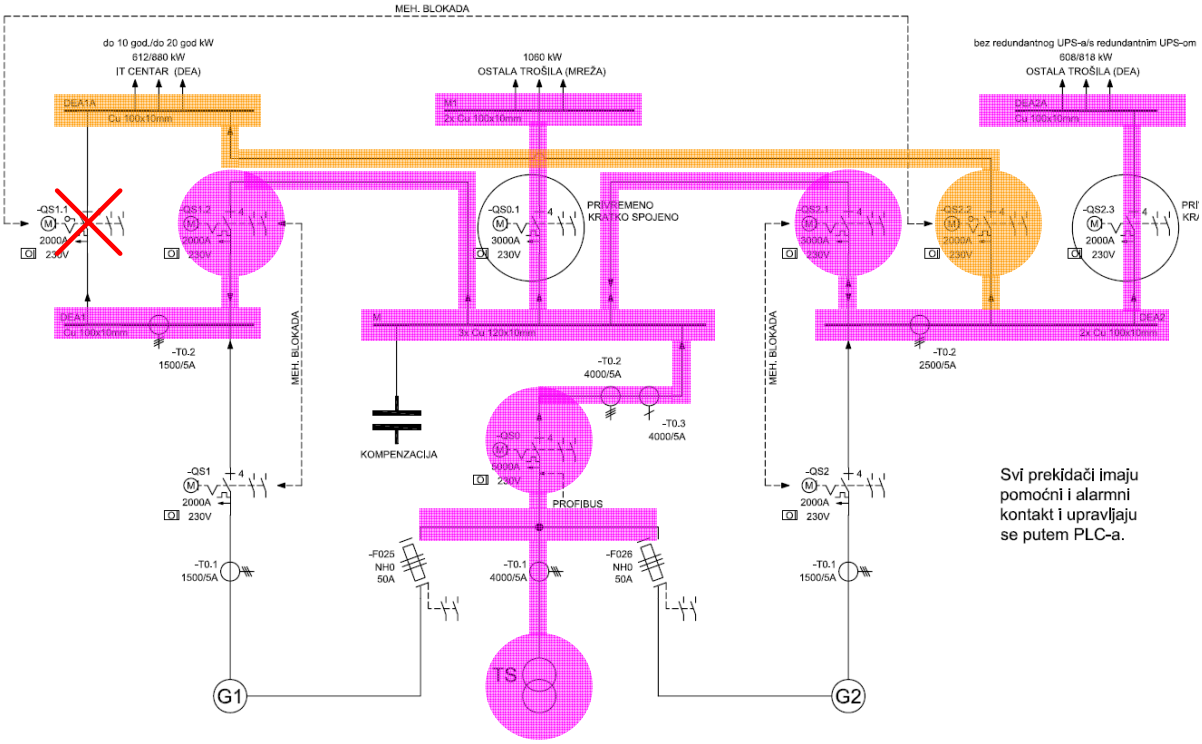
Povratom mreže automatski se uspostavlja normalno pogonsko stanje napajanja iz mreže kao što prikazuje Slika 1.

1.5 POKUS 5 kvar prekidača QS1.1

Početno stanje: - normalno napajanje iz mreže

Poticaj:
- izborna preklopka QS1.1 u položaj **2- RUČNO**
- isključenje QS1.1

Slijed:
- **ne inicira** se automatski preklop – sabirnice DEA1 bez napona
- izborna preklopka QS2.2 u položaj **2 - RUČNO**
- uključenje QS2.2



Slika 5. Kvar prekidača QS1.1

Sabirnice	izvor	prekidač	stanje
M	TS	QS0	1
M1	M	QS0.1	1
DEA1	M	QS1.2	1
DEA1	G1	QS1	0
DEA1A	DEA1	QS1.1	0 (kvar)
DEA1A	DEA2	QS2.2	1
DEA2	M	QS2.1	1
DEA2	G2	QS2	0
DEA2A	DEA2	QS2.3	1

Povrat:
- isključenje QS2.2
- uključenje QS1.1
- izborne preklopke QS1.1 i QS2.2 u položaj **1 - AUTOMATSKI**

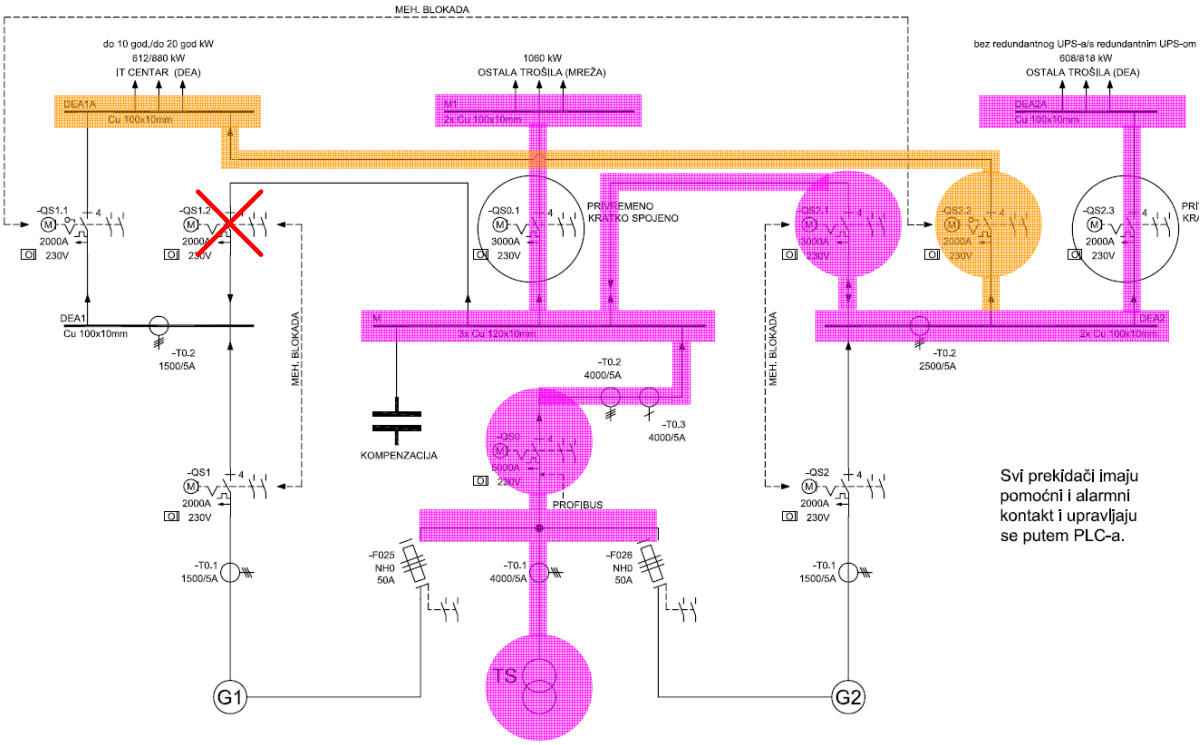
1.6 POKUS 6 kvar prekidača QS1.2

Početno stanje: - normalno napajanje iz mreže
- sve izborne preklopke u položaju **1 - AUTOMATSKI** (daljinski)

Poticaj: - automatika G1 u položaj **RUČNO** (blokiranje starta)
- izborna preklopka QS1.2 u položaj **2 - RUČNO**
- isključenje QS1.2

Slijed: - kontrolnik KN1.2 inicira slijedeće PLC sekvence:

1. isključenje QS1.1
2. isključenje QS2.3
3. uključenje QS2.2



Slika 5. Kvar prekidača QS1.2

<u>NAPOMENA:</u>

Uspostava napona na DEA1A odvija se automatski uključenjem QS2.2 na DEA2, ali se nepotrebno isključuje QS2.3 iako postoji mreža !

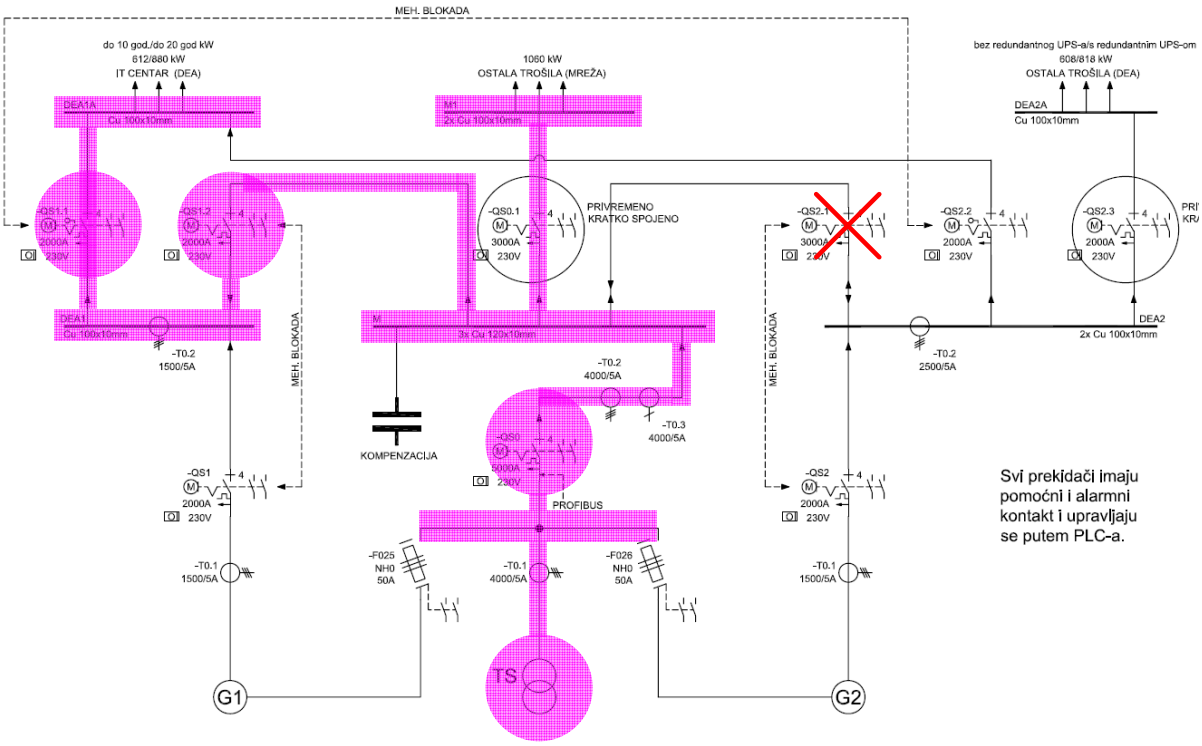
Povrat: - isključenje QS2.2
- uključenje QS1.2
- izborna preklopka QS1.1 u položaj 2 - RUČNO
- uključenje QS1.1
- izborne preklopke QS1.1, QS1.2 i QS2.2 u položaj 1 - AUTOMATSKI

1.7 POKUS 7 kvar prekidača QS2.1

Početno stanje: - normalno napajanje iz mreže
- sve izborne preklopke u položaju **1 - AUTOMATSKI** (daljinski)

Poticaj: - izborna preklopka QS2.1 u položaj **2 - RUČNO**
- isključenje QS2.1

Slijed: - agregat G2 **ne starta** automatski
- automatika G2 u položaj **RUČNO**
- start G2
- uspostava napona na DA2A (Q2.3 ostao uključen)



Slika 5. Kvar prekidača QS2.1

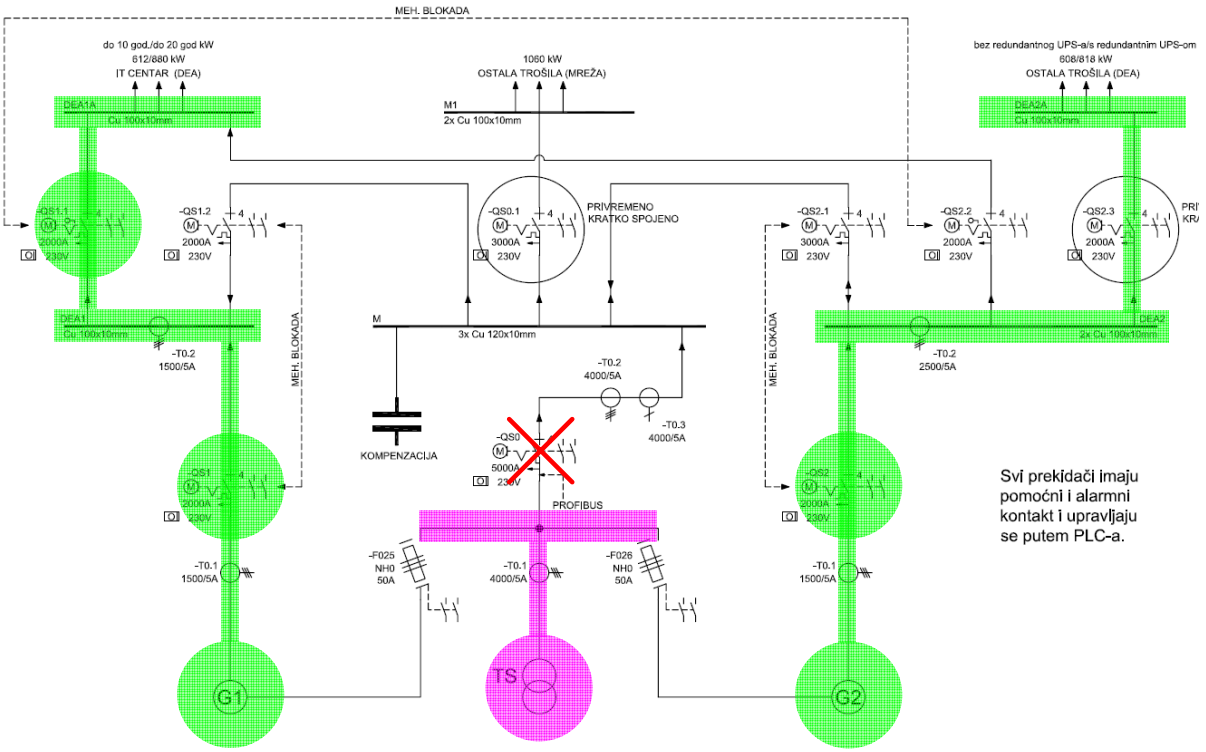
NAPOMENA:

Agregat G2 ne starta automatski, jer dobiva poticaj od kontrolnika KN0.1 (prisutnost mreže)

1.8 POKUS 8 kvar prekidača Q0

Početno stanje: - normalno napajanje iz mreže
- sve izborne preklopke u položaju **1 - AUTOMATSKI** (daljinski)

Poticaj: - izborna preklopka QS0 u položaj **2 - RUČNO**
- isključenje QS0



Slika 6. Kvar prekidača QS0

NAPOMENA:

Ispad prekidača QS0 (uz prisutnost mreže) **ne pokreće** automatske PLC sekvence startanja agregata!

Prekidači QS1.2, QS0.1 i QS2.1 **ostaju uključeni** (nemaju podnaponske okidače)

Slijed: - izborne preklopke QS1.2 i QS2.1 u položaj 2 **- RUČNO**
- isključenje QS1.2
- isključenje QS2.1
- automatike agragata G1 i G2 u položaj RUČNO
- START G1
- START G2
- izborne preklopke QS1 i QS2 u položaj 2 **- RUČNO**
- isključenje QS1.1 > uključenje QS1
- uključenje QS1.1
- isključenje QS2.3 > uključenje QS2
- uključenje QS2.3

Povrat: - izborne preklopke (osim QS0) u položaju **1 – AUTOMATSKI**
- uklop QS0
- STOP agregata G1 i G2
- automatski uklop prekidača QS1.2, QS1.1 i QS2.1
- izborna preklopka QS0 u položaj AUTOMATSKI (daljinski)

2. ZAKLJUČAK

Provedena ispitivanja pokazala su slijedeće:

- u slučaju ispada mreže PLC automatski uspostavlja napajanje iz agregata
- nakon povrata mreže PLC automatski uspostavlja napajanje iz mreže
- pri ispadu mreže i zatajenju agregata G1, PLC automatski uspostavlja nužno napajanje sabirnica DEA1A (IT CENTAR) iz agregata G2 – pri tom se isključuju sabirnice DEA2A (OSTALA TROŠILA)
- u slučaju kvara mrežnog prekidača QS1.2, PLC automatski uspostavlja napajanje sabirnica DEA1A iz sabirnica DEA2 preko QS2.2
- u slučaju kvara prekidača QS1.1 potrebno je ručno uspostaviti napajanje sabirnica DEA1A iz sabirnica DEA2 preko QS2.2
- u slučaju kvara glavnog mrežnog prekidača QS0 PLC ne pokreće automatsku sekvencu uspostave napajanje iz agregata – potrebno je ručno startati agregate i uključiti odgovarajuće prekidače za napajanje sabirnica DEA1A odnosno DEA2A

Nadzorni sustav (SCADA) u sistemskoj prostoriji računarskog centra ne registrira stanja izbornih preklopki "0-1-2-3" za upravljanje prekidačima, što je bitan nedostatak.

Zbog složenosti postrojenja ručna uspostava pogonskih stanja koja se u slučaju kvarova ne uspostavljanju automatski zahtijeva posebnu obučenost osoblja koje može obavljati manipulacije prekidačima.

Kritični element cijelog sustava napajanja je glavni mrežni prekidač QS0 koji nema redundanciju – u slučaju kvara tog prekidača onemogućeno je napajanje iz mreže, a napajanje iz agregata potrebno je uspostaviti ručnim manipulacijama.

Radi povećanja pouzdanosti napajanja predlaže se rekonstrukcija postrojenja koja bi obuhvatila zamjenu glavnog mrežnog prekidača 5000 A s dva nezavisna prekidača po 2000 A za svaki dovod iz transformatorske stanice.

Zagreb, 22.02.2009.

Nadzorni inženjer:

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