POWER QUALITY ISSUES IN GRID CONNECTED WIND FARMS

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Wind Power across India

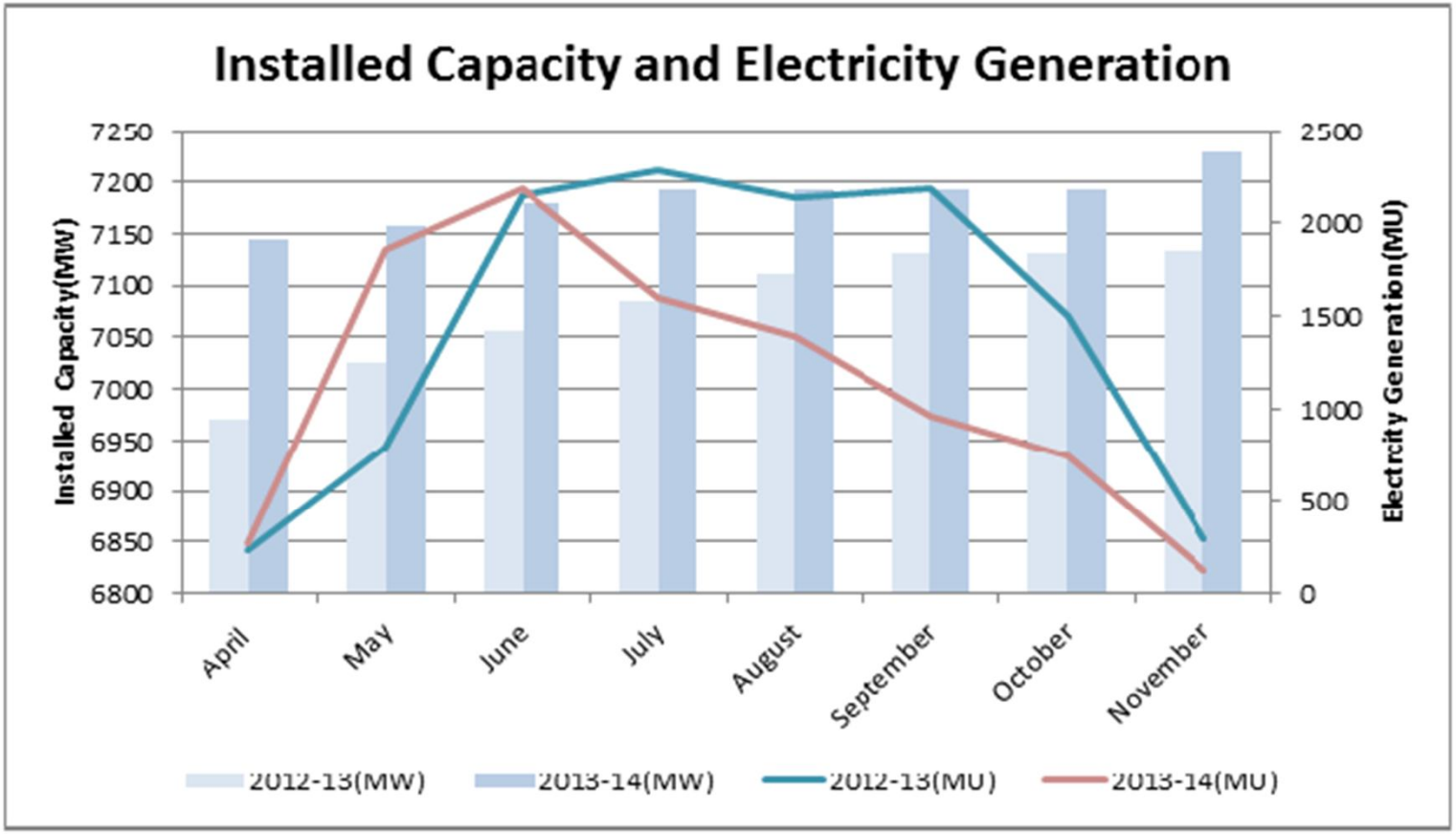
Sl. No.	States	As of March31, 2013 (MW)	Capacity Addition in 2013-14 (Till January 31, 2014)	Achievement in MW (Upto January31, 2014)	%Share (as of January 2014)
1	Tamil Nadu	7,162	89	7,251	35.85%
2	Maharashtra	3,175	297	3,472	17.17%
3	Gujarat	3,022	362	3,384	16.73%
4	Rajasthan	2,685	49	2,734	13.52%
5	Karnataka	2,135	177	2,312	11.42%
6	Andhra Pradesh	448	200	648	3.20%
7	Madhya Pradesh	386	-----	386	1.91%
8	Kerala	35	------	35	**0.18%**
9	Others	4	-----	4	**0.02%**
	Total	**19,052**	**1,174**	**20,226**	**100.00%**

Wind Power Contribution

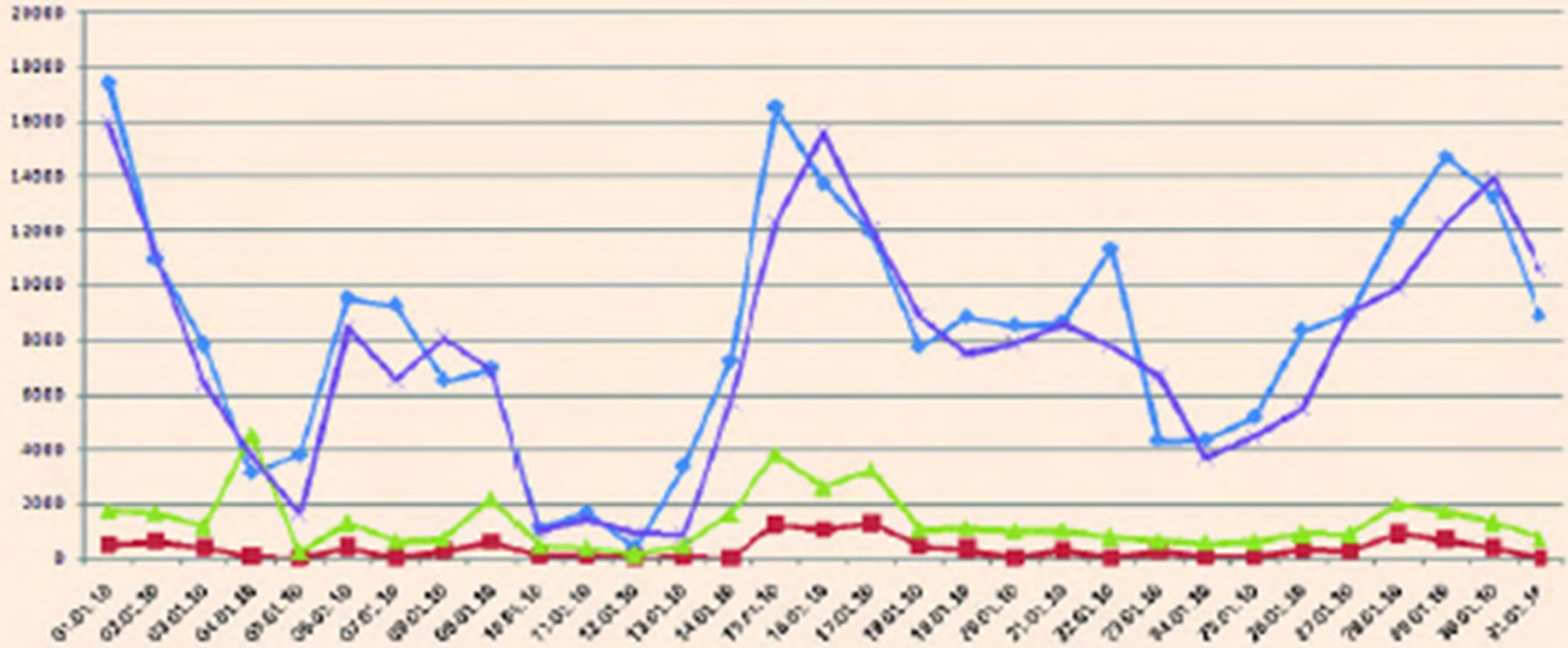
4	(ii)	TNEB wind	*17.465	2799	1352	1480	57.588
	(iii)	Private wind	*(7127.760)				
5		**Central Generatimg Stations**					
a)		Neyveli TS1	475	230	235	235	6.258
b)		Capacity TNEB Share	3045				
	(i)	NTPC (2600) + SIMHADRI (1000) 909					
	(ii)	Neyveli TS2 (1470) 474					
	(iii)	NeyveliTS1Expansion (420) 226		2218	2347	2297	51.944
	(iv)	Talcher St 2 (2000) 503					
	(v)	MAPS (440) 331					
	(vi)	KAPS (880) 227					
	(vii)	VALLUR (500) 375					
6		**External Assistance**					
	(i)	Eastern region power.	50	28	29	29	0.624
7	(i)	**Purchase thro IEX , PXIL & From NVVN , Jindal**		852	852	852	20.745
		Total	**10515**	**11162**	**9851**	**10254**	**257.271**

TN wind power – Evacuation Issues

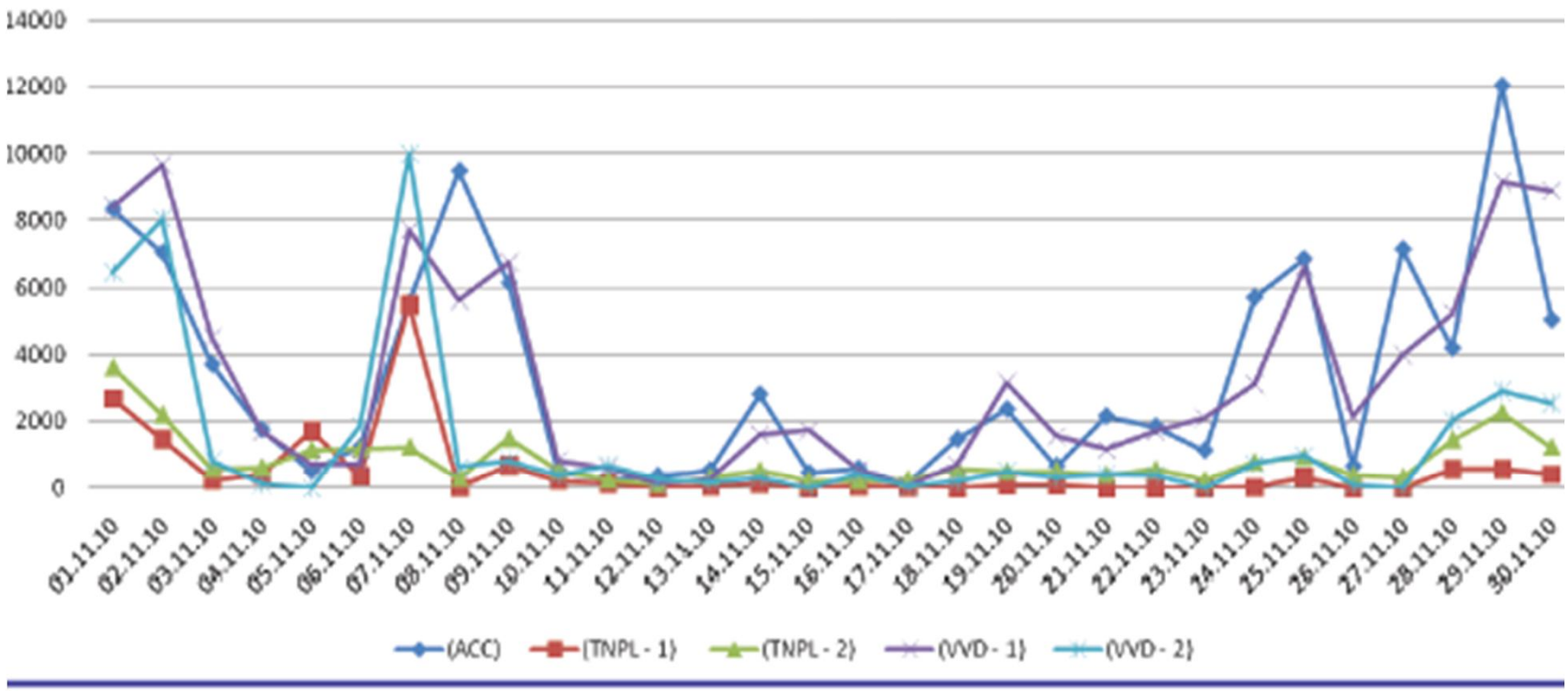
- Evacuation has not kept pace with wind power generation capacity growth due to lack of real time monitoring and prediction/forecasting/scheduling
- **40% of energy lost** during peak wind season

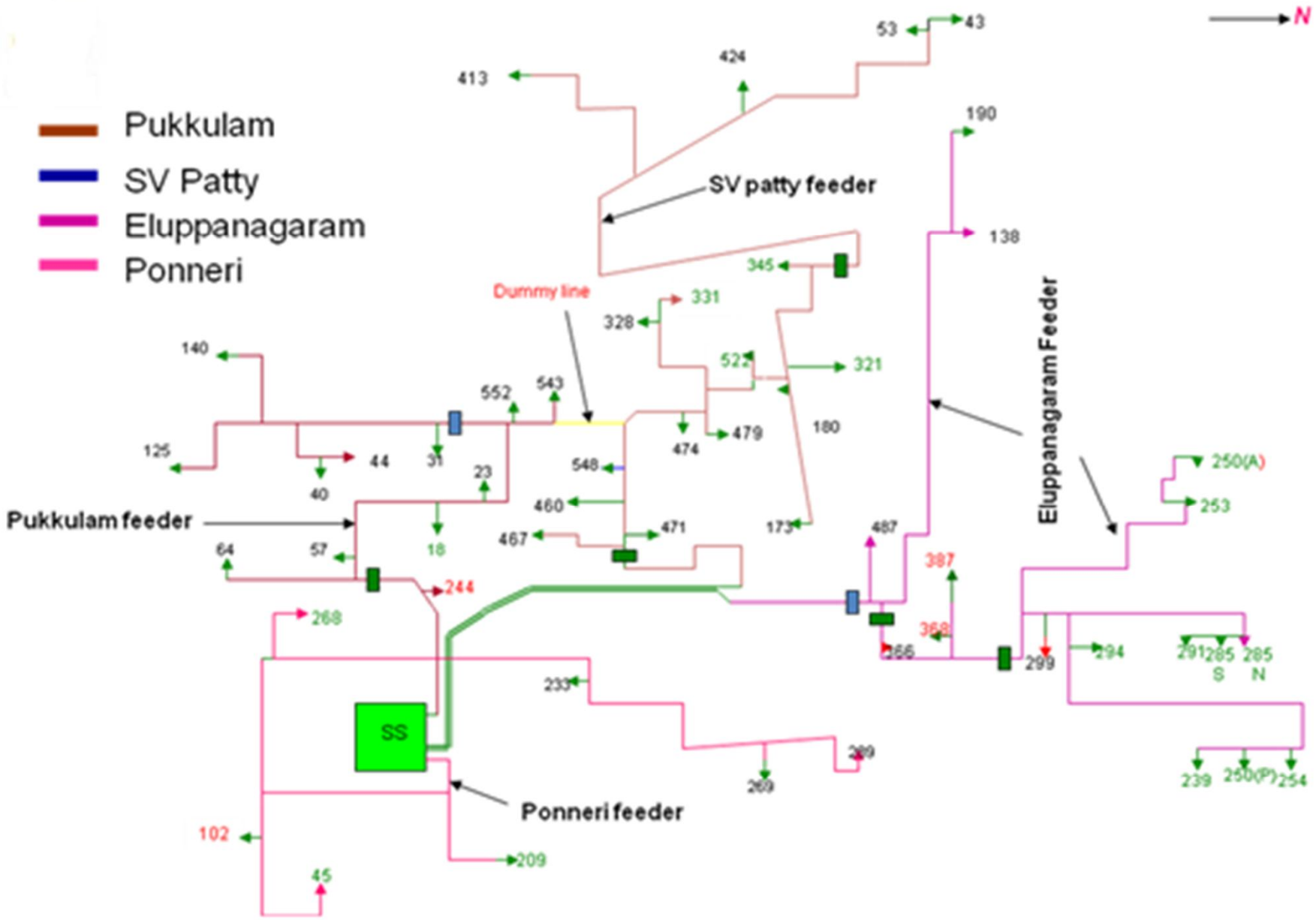


WIND MONITOR GRAPH

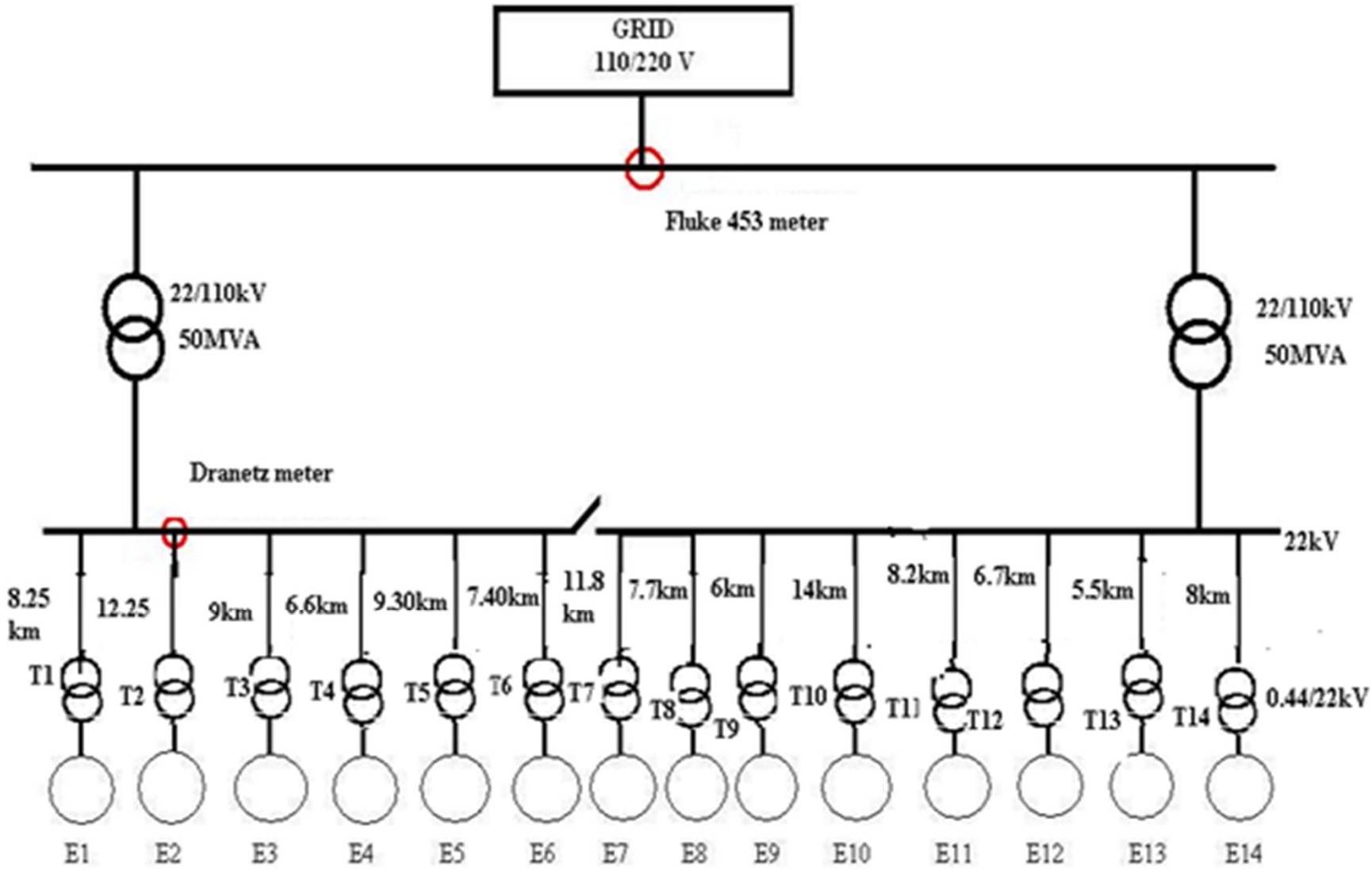


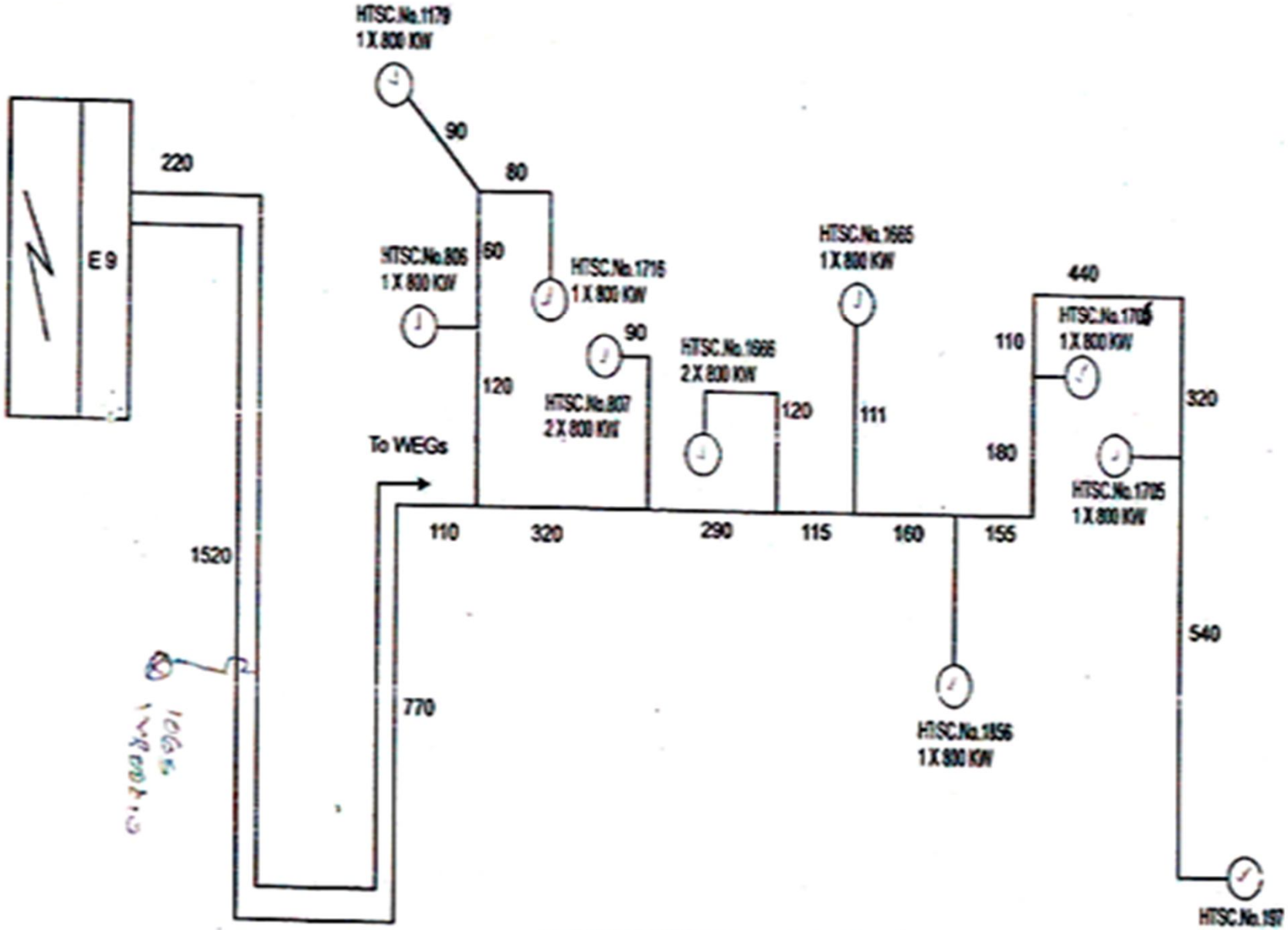
WIND MONITOR - GRAPH FOR THE MONTH OF NOVEMBER 2010





PETHAPPAMPATTY WINDFARM LAYOUT


GRID
110/220 V
Fluke 453 meter
22/110kV
50MVA
22/110kV
50MVA
Dranetz meter
22kV
8.25 km
12.25
9km
6.6km
9.30km
7.40km
11.8 km
7.7km
6km
14km
8.2km
6.7km
5.5km
8km
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
0.44/22kV
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14



CHINNAPUTHUR E- 9 FEEDER

Objectives

1. To identify the power quality problems in wind farms in Tamilnadu .
2. To collect data from selected wind farms in Tamilnadu.
3. To record and analyze the occurrence of various events and their causes.
4. To propose suitable models for WECS with squirrel cage induction generator and converter-synchronous machine.

5. To perform dynamic analysis of grid connected wind farms and to study the effects of frequency variations, voltage variations, transients, flicker and harmonics on the wind farms. Dynamic analysis includes the effects of faults, wind variation and load variation

6. To summarize the study and to recommend guidelines for connecting wind farms to weak grids.

Power quality problems in wind farm .

- I**mpulses/Transient:** High voltage magnitude for extremely for short duration(a few millisecond)
- **Sag: A** momentary voltage dip(for few seconds)
- **Swell : A** momentary Voltage rise
- **Overvoltage** :A steady state voltage rises for several seconds

- **Under voltage**: A steady state voltage dip last for several few seconds
- **Interruption**: A complete loss of voltage for few second to several hours
- **Flicker** :A perceptible change in lamp output for due to sudden change in the voltage
- **Harmonics**: Non -fundamental frequency components

Data from selected wind farms in Tamilnadu.

- Data collected from pedampally SS

  Wind Generator Feeder -105 events

  Substation Feeder -55 events

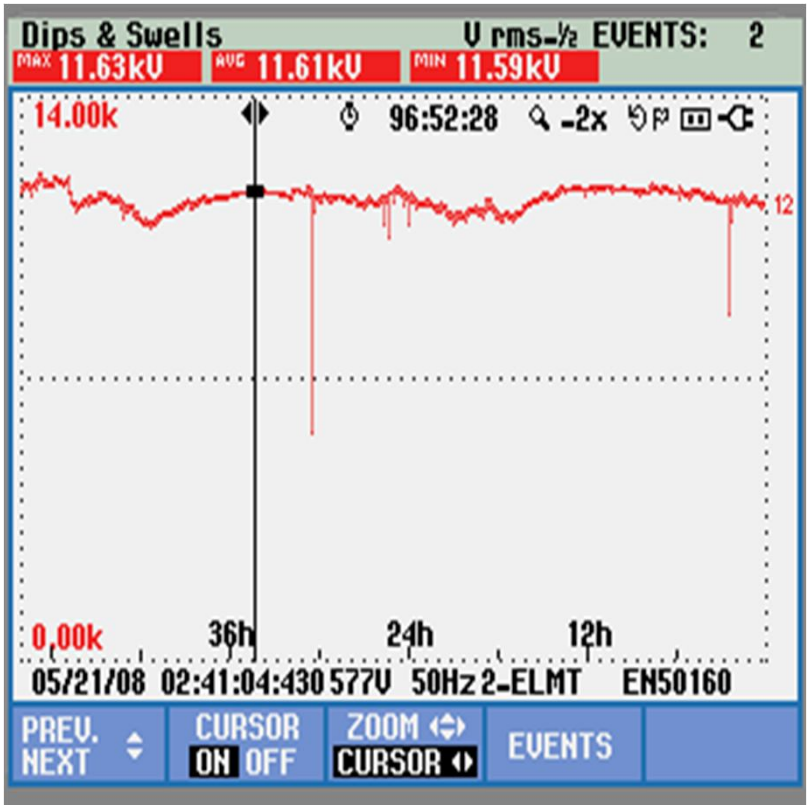
  Events matches between these Feeders -27 events

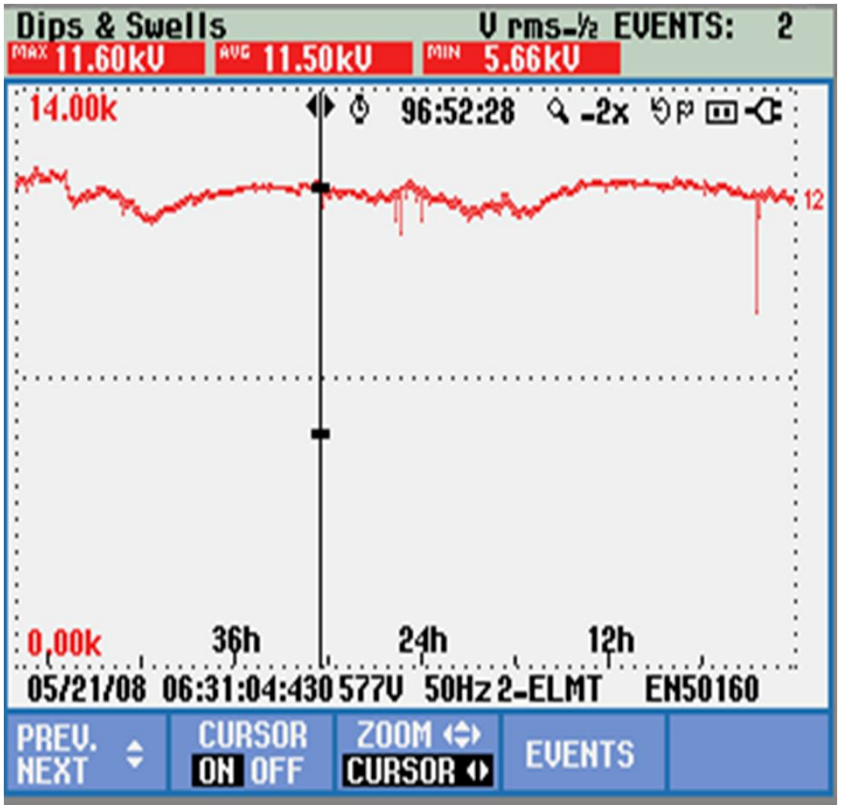
- Mostly Short duration impulse transient, Sag , Switching events occurred repeatedly for various short duration intervals.
- Samples of data were taken for each event and simulated using DIgSILENT software.

Simulation Model for Peedampally Substation

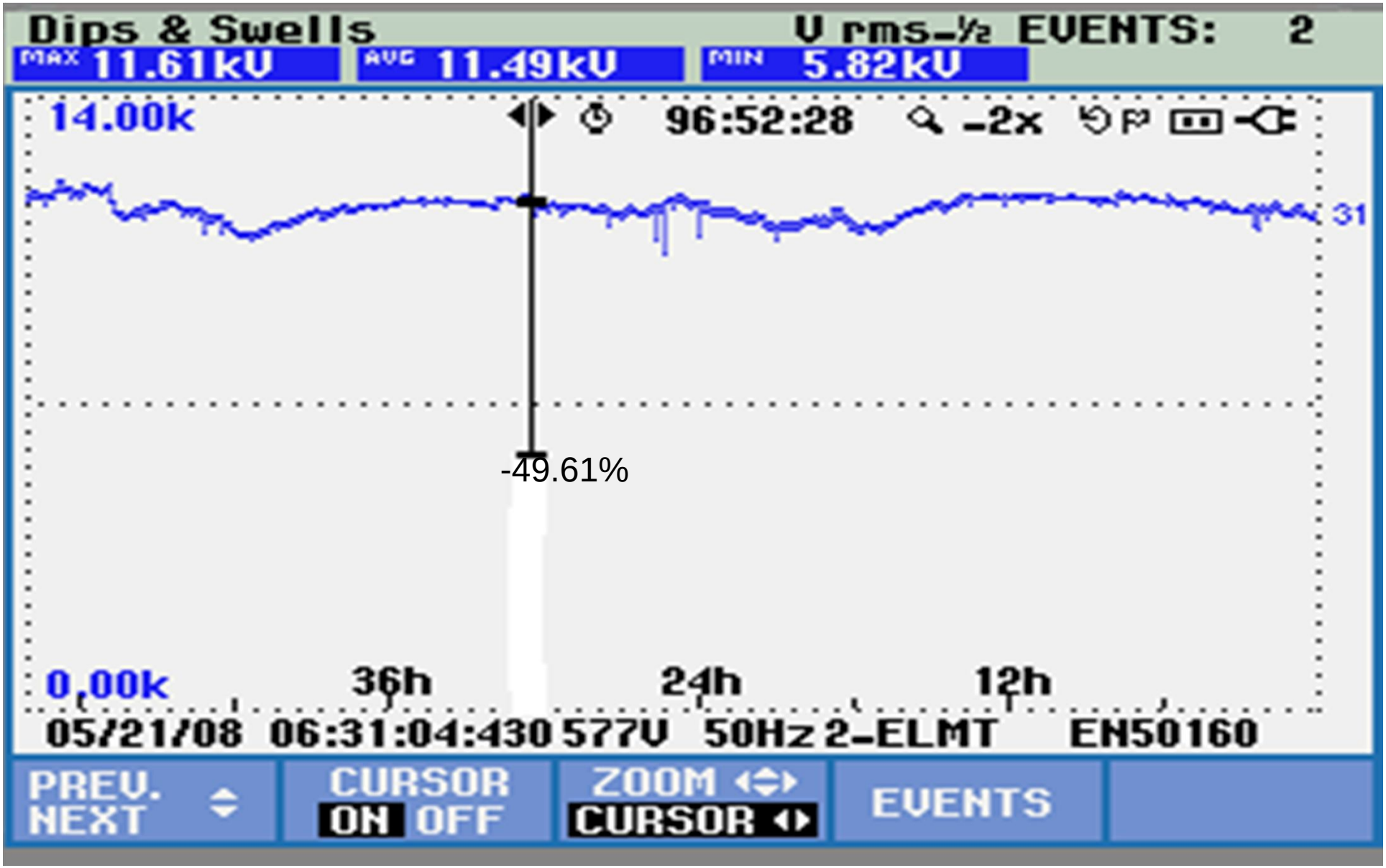
- The Peedampalli wind farm has been simulated using DIgSILENT power factory simulation software (ver 14.1).
- Using this software, steady state and dynamic stability studies, harmonic load flow, flickers, reliability and time domain simulations ranging microseconds to hours (EMT and RMS simulations) can be simulated.
- The fixed speed wind turbine model has been developed using Dynamic Simulation Language available in this software.

Voltage Dip

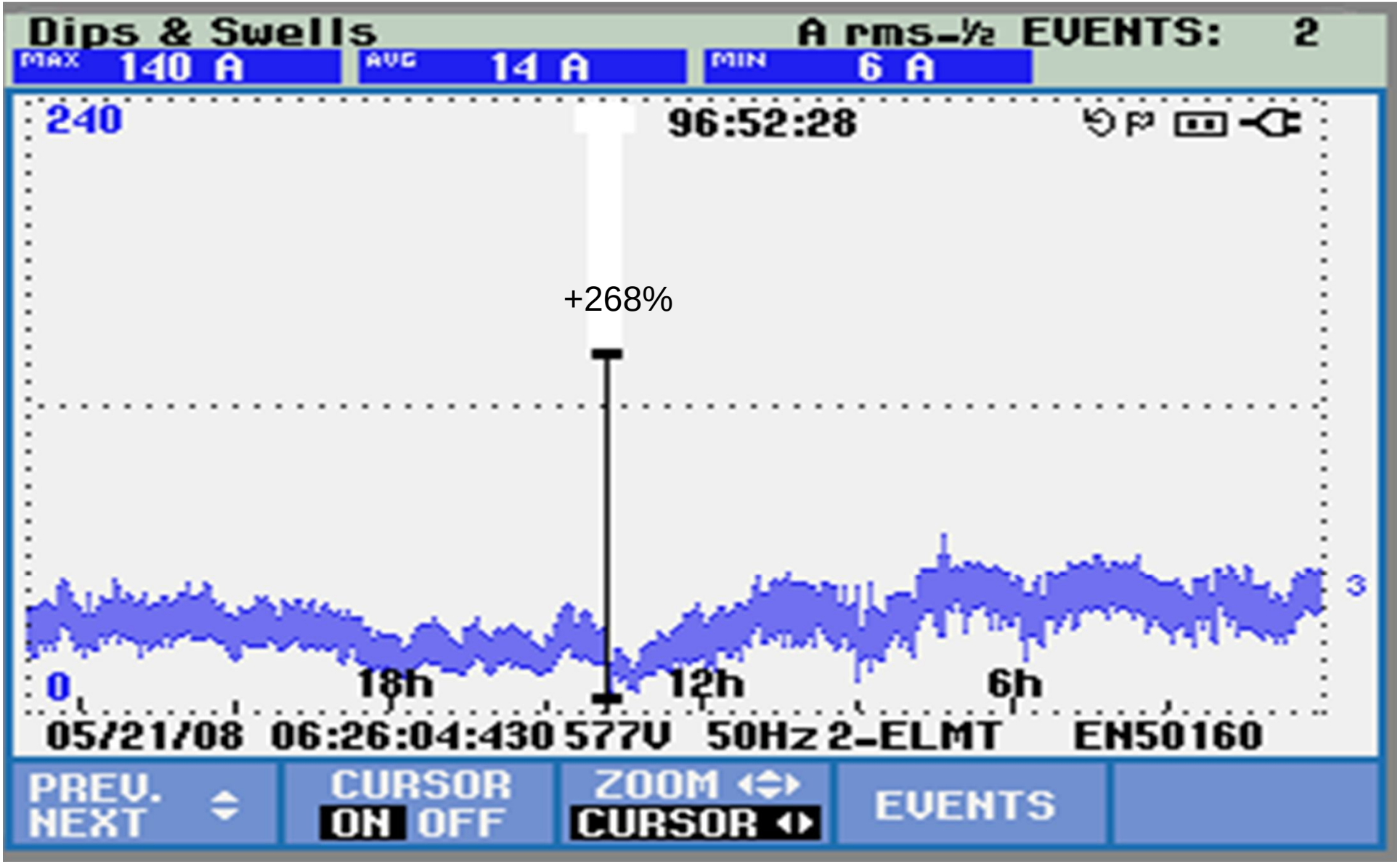

Dips & Swells
V rms-½ EVENTS: 2
MAX 11.63kV
AVG 11.61kV
MIN 11.59kV
14.00k
96:52:28
-2x
12
0,00k
36h
24h
12h
05/21/08 02:41:04:430 577V 50Hz 2-ELMT EN50160
PREV. NEXT
CURSOR ON OFF
ZOOM CURSOR
EVENTS


Dips & Swells
V rms-½ EVENTS: 2
MAX 11.60kV
AVG 11.50kV
MIN 5.66kV
14.00k
96:52:28
-2x
12
0,00k
36h
24h
12h
05/21/08 06:31:04:430 577V 50Hz 2-ELMT EN50160
PREV. NEXT
CURSOR ON OFF
ZOOM CURSOR
EVENTS

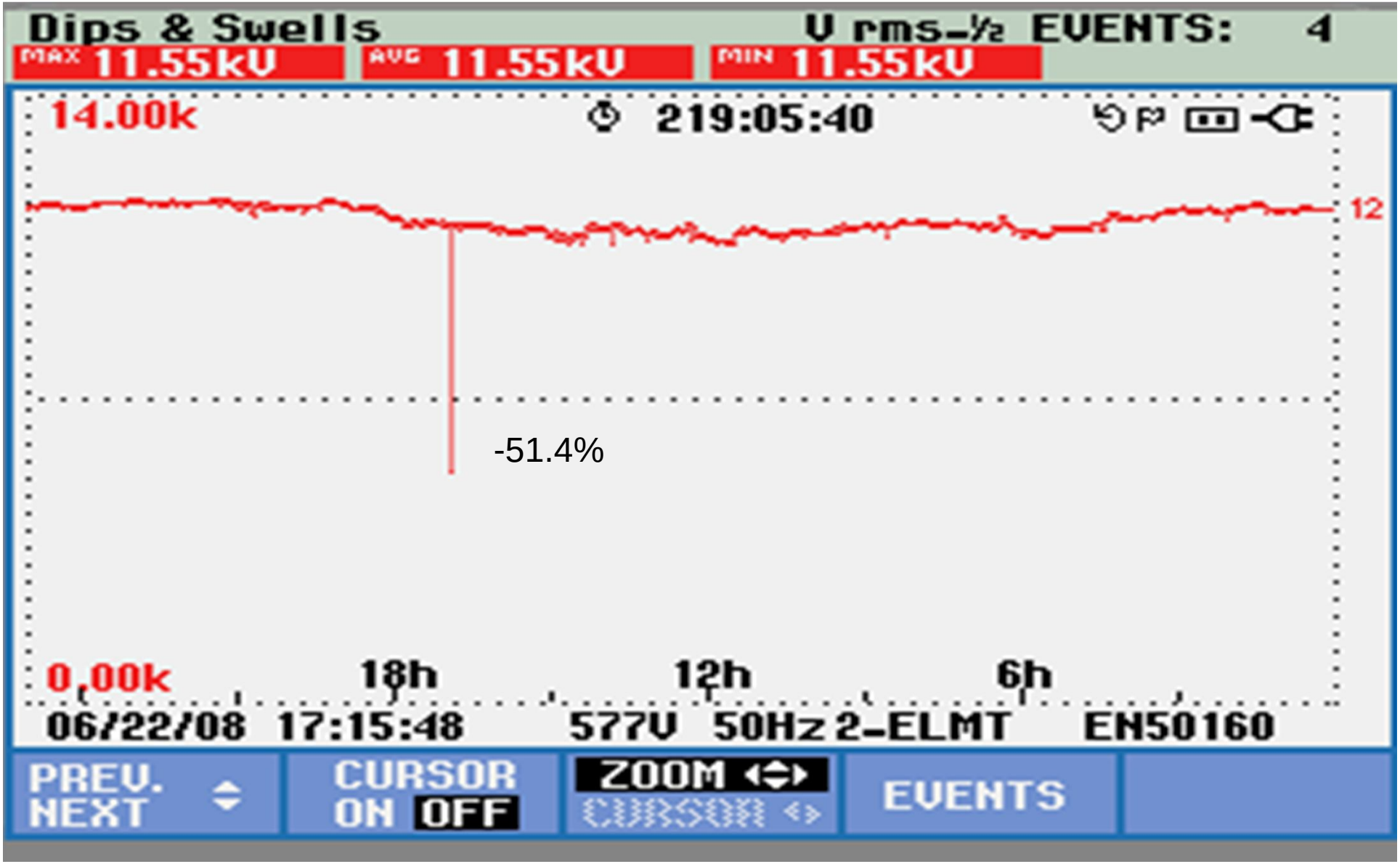
Voltage Dip in WM Feeder



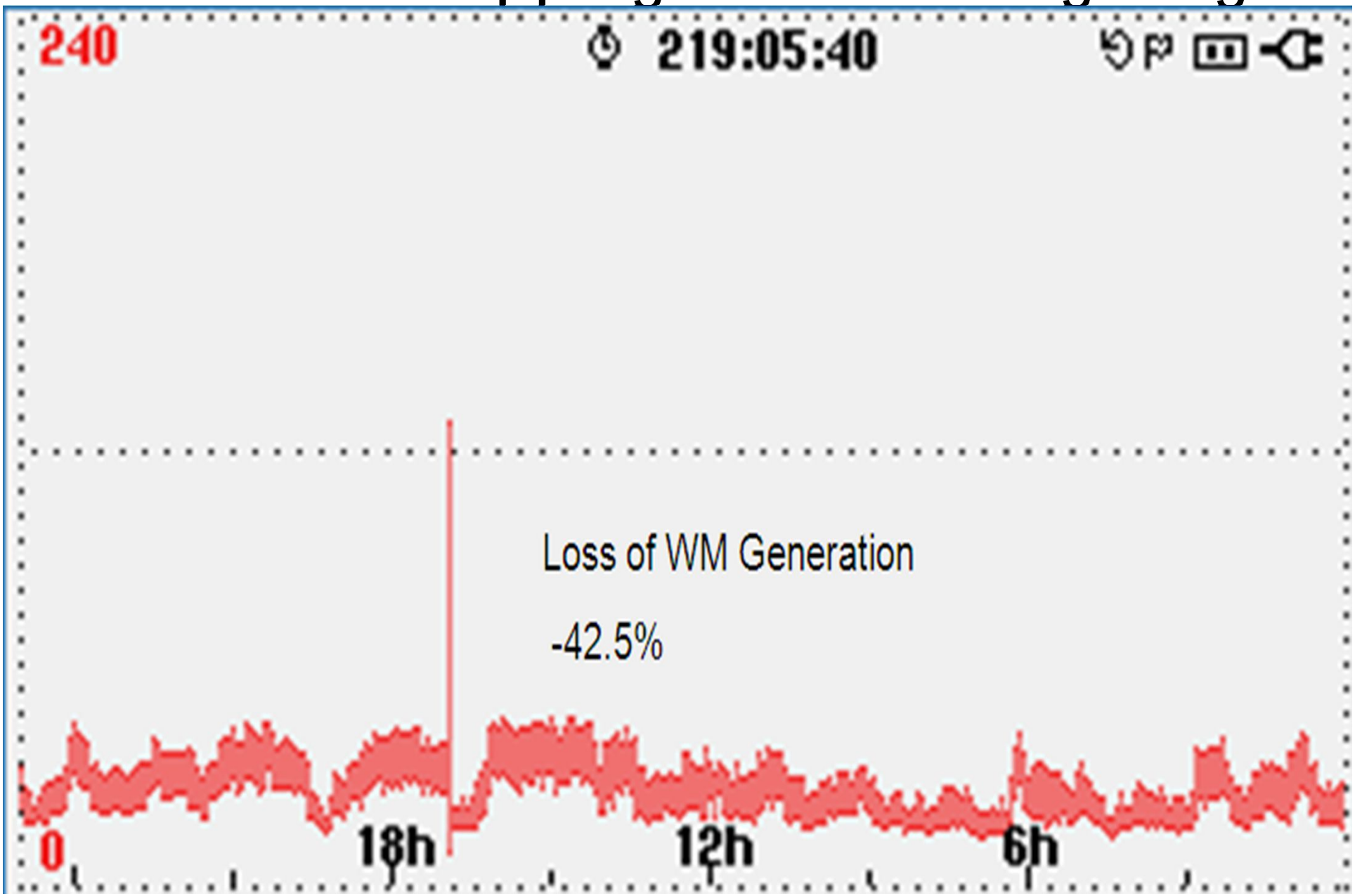
Current rise in WM Feeder



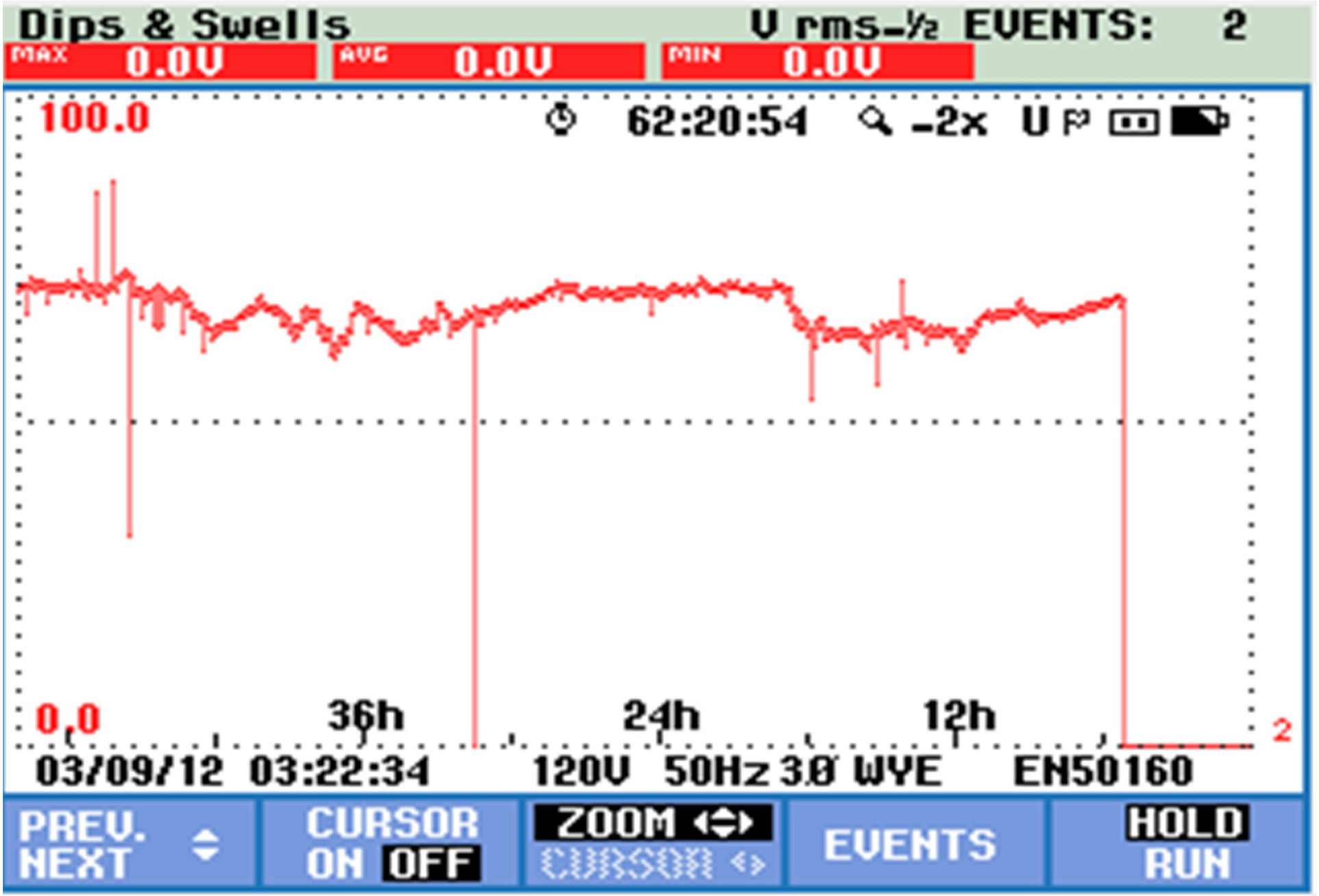
Voltage Dip

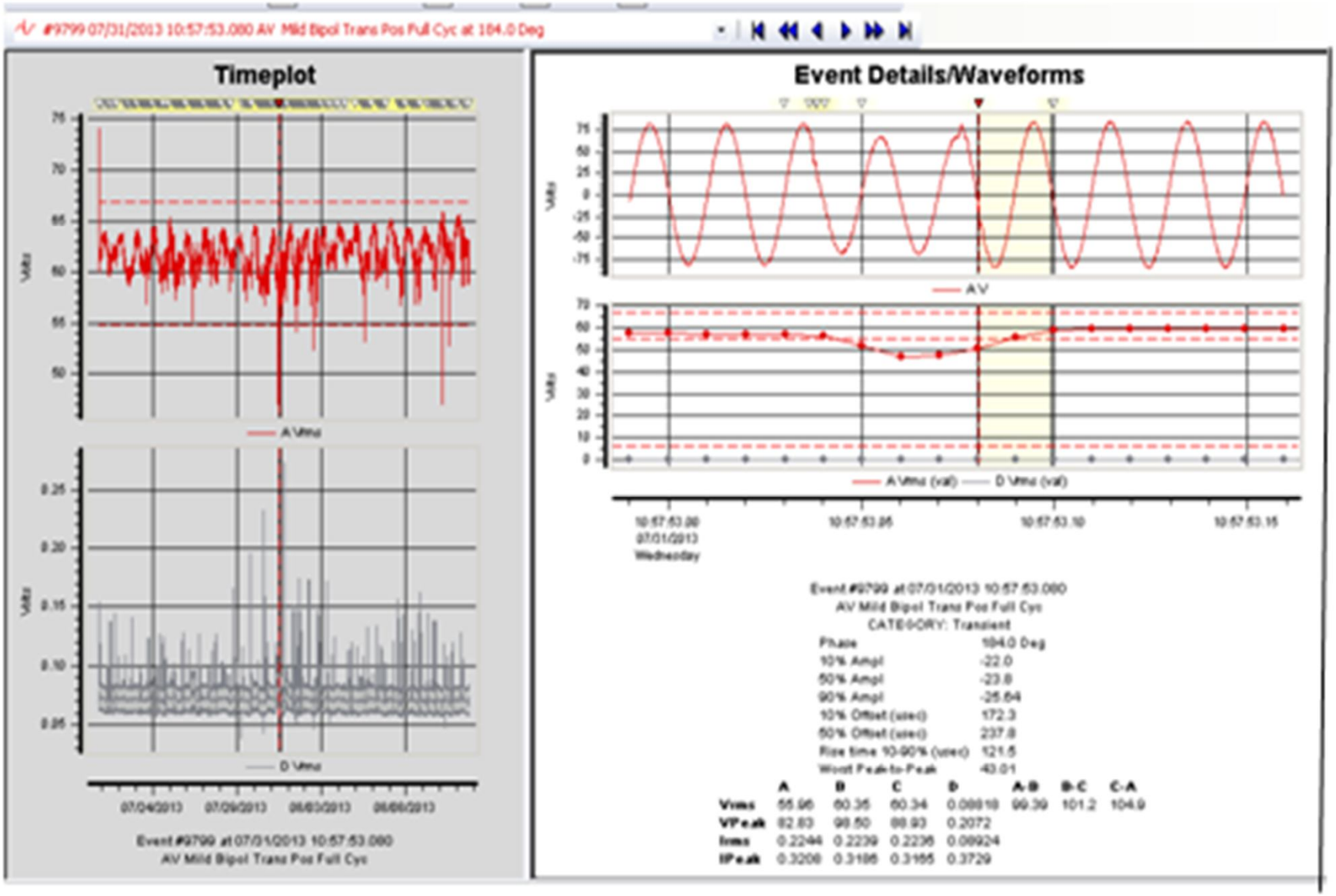

Dips & Swells
U rms-½ EVENTS: 4
MAX 11.55kU
AVG 11.55kU
MIN 11.55kU
14.00k
219:05:40
12
-51.4%
0.00k
18h
12h
6h
06/22/08 17:15:48
577U 50Hz 2-ELMT EN50160
PREV.
NEXT
CURSOR
ON OFF
ZOOM
EVENTS

Wind Mill Tripping Due to Voltage sag

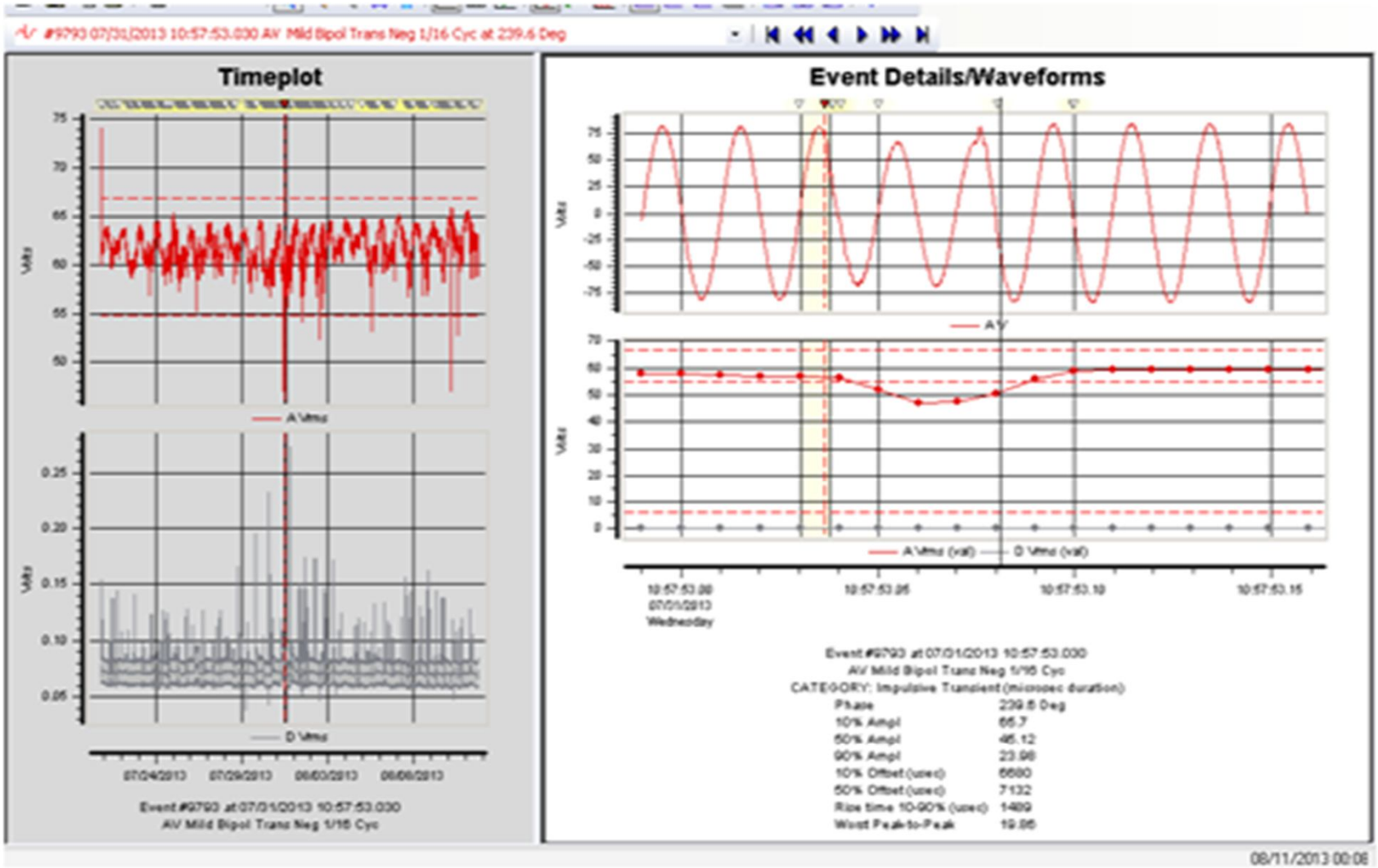


Event Recorded in Kinathukadavu



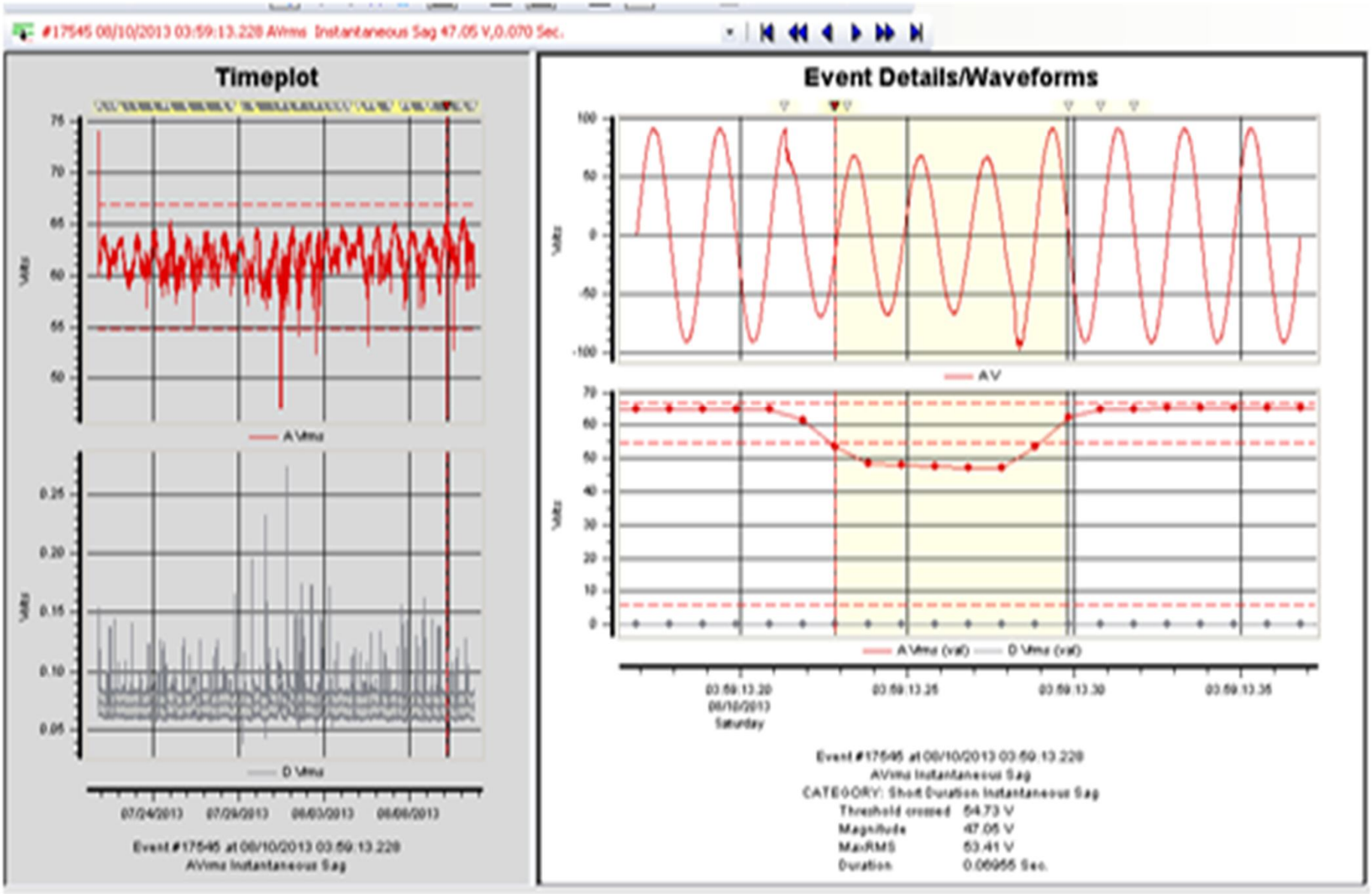


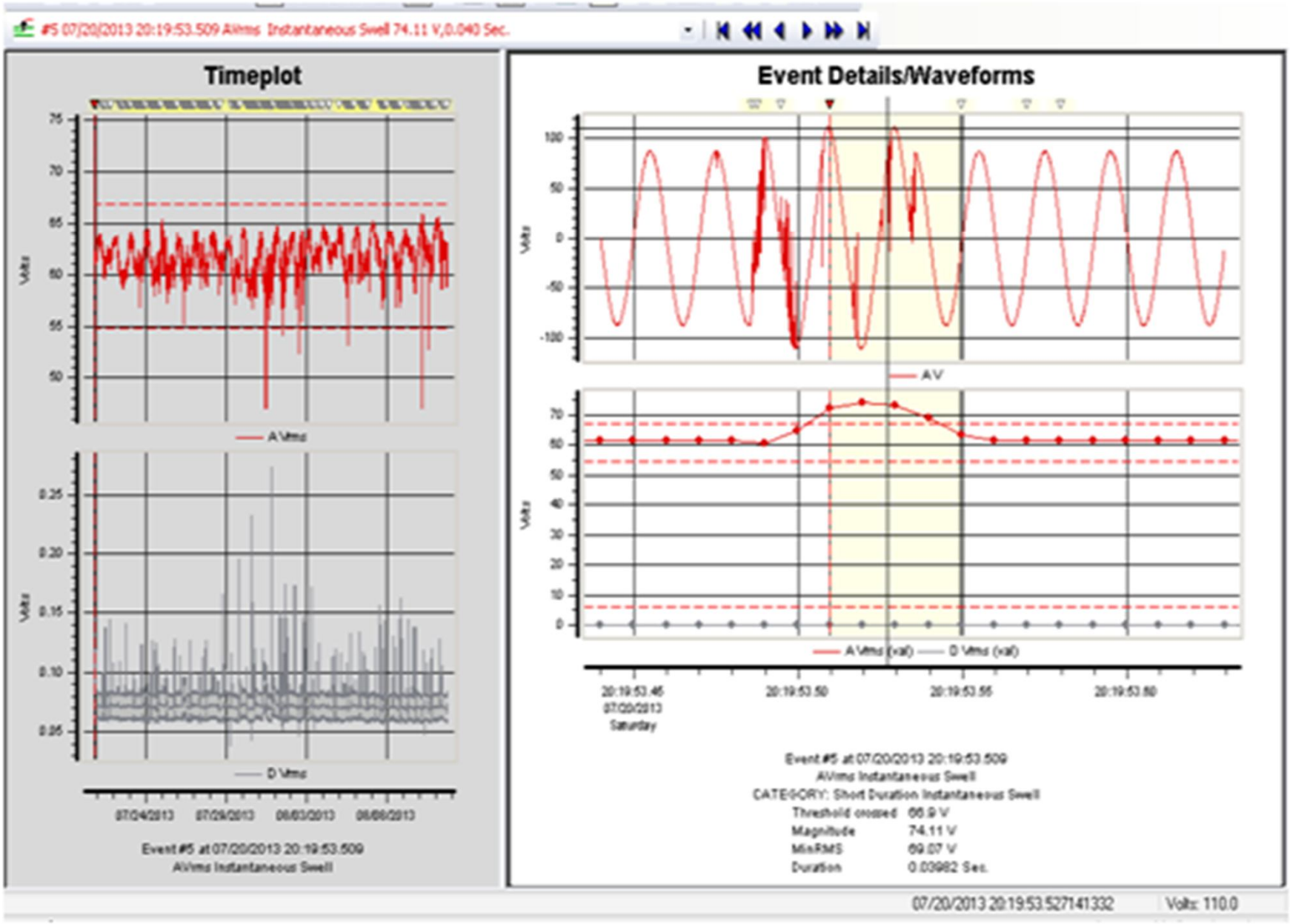
Transient Event 9799 on 31.7.13



Impulsive Transient Event 9793 on 31.7.13

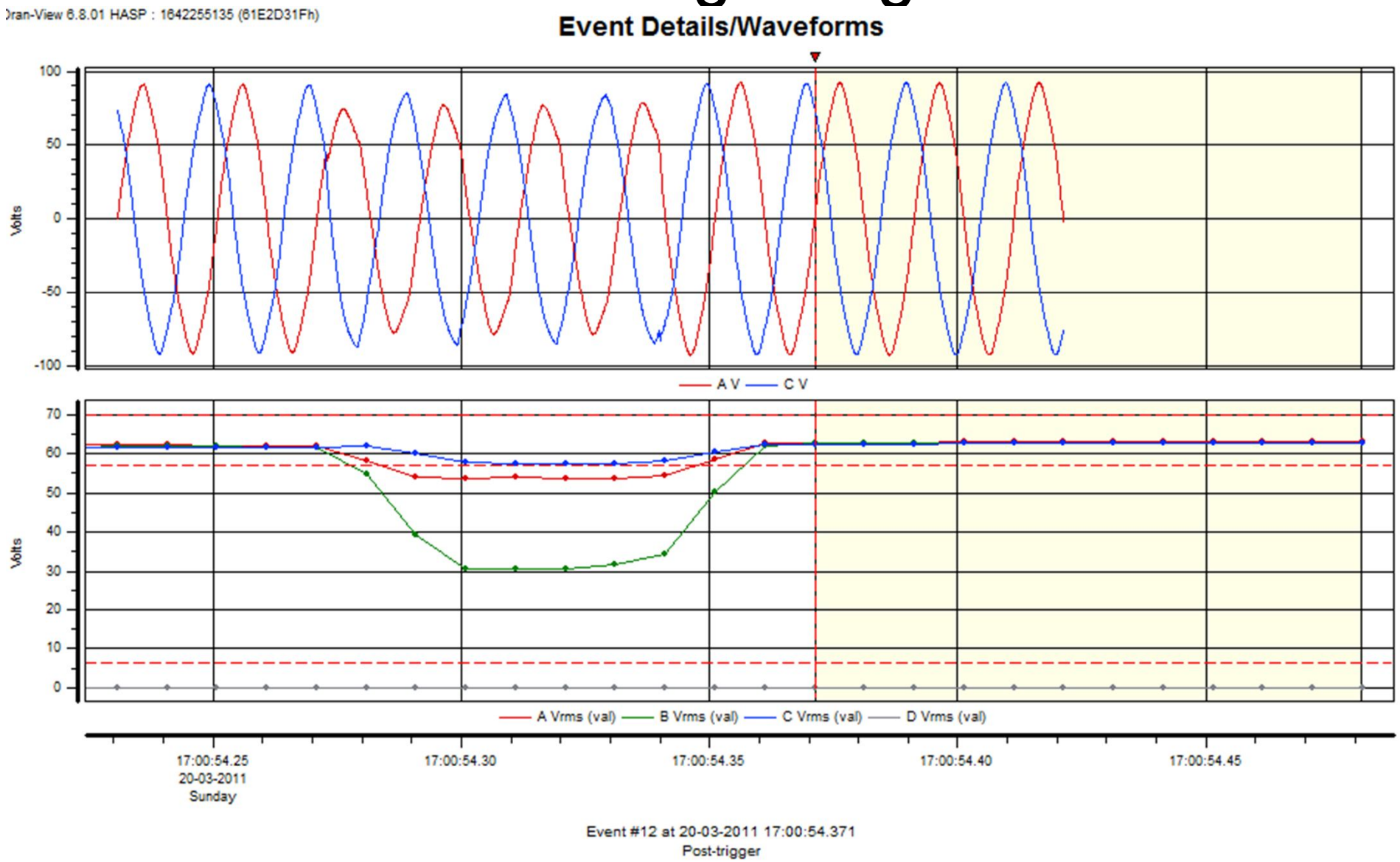
Short duration instantaneous sag event 13854 on 5.8.13



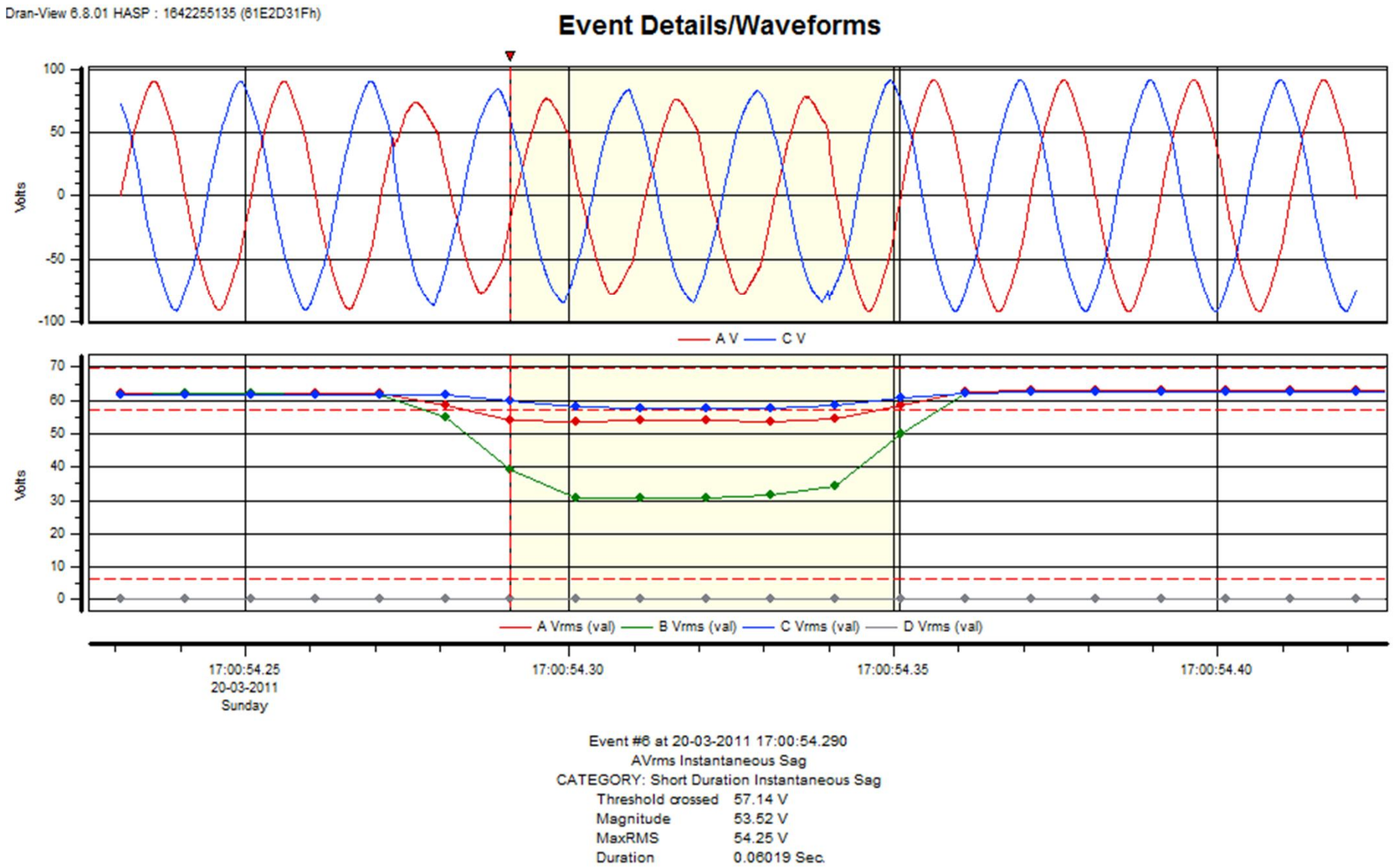


Instantaneous Swell event 03 on 20.7.13

Voltage Sag


)ran-View 6.8.01 HASP : 1642255135 (61E2D31Fh)
Event Details/Waveforms
Volts
100
50
0
-50
-100
A V
C V
Volts
70
60
50
40
30
20
10
0
A Vrms (val)
B Vrms (val)
C Vrms (val)
D Vrms (val)
17:00:54.25
20-03-2011
Sunday
17:00:54.30
17:00:54.35
17:00:54.40
17:00:54.45
Event #12 at 20-03-2011 17:00:54.371
Post-trigger

Voltage Sag

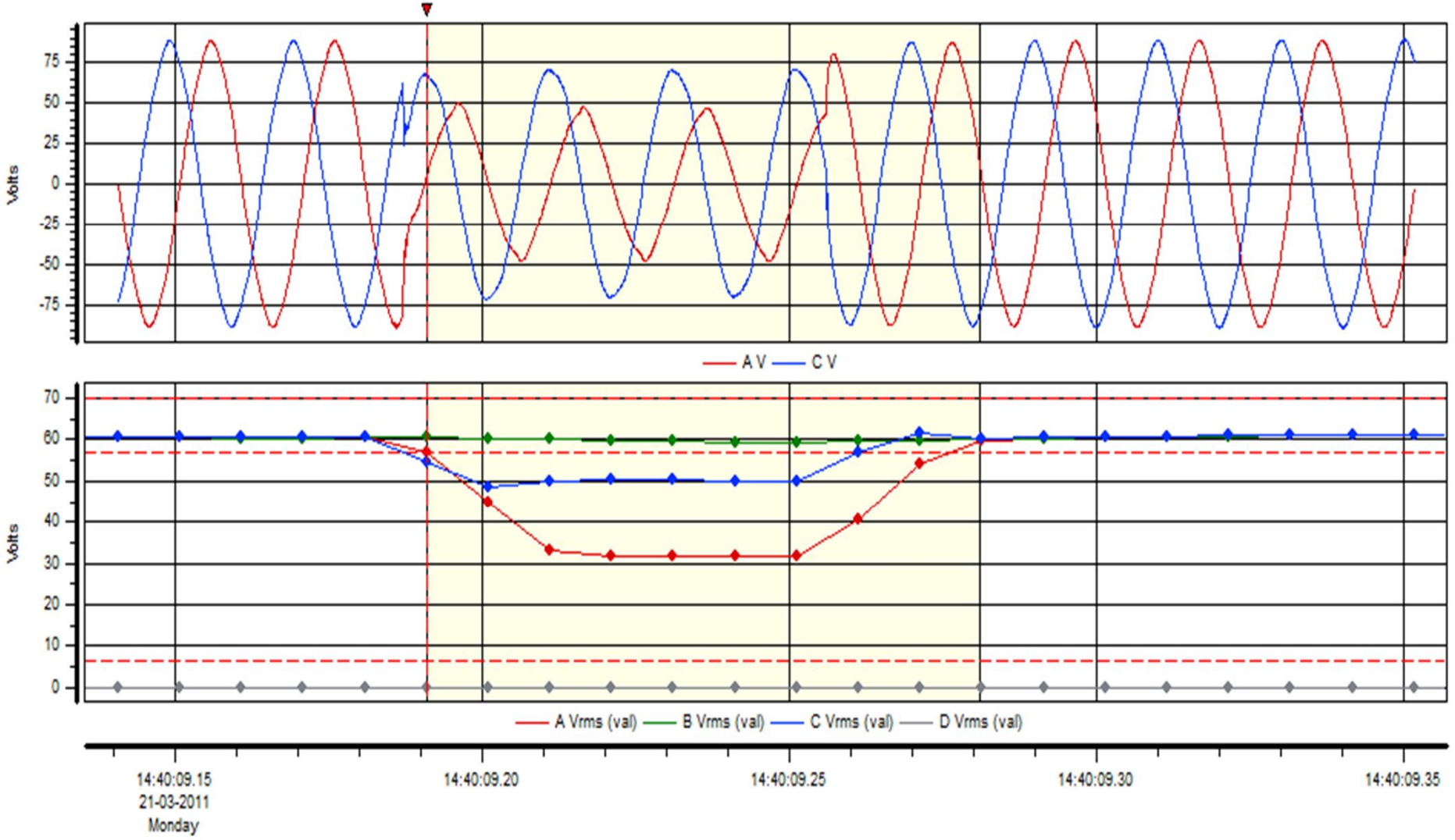


Event #6 at 20-03-2011 17:00:54.290
AVrms Instantaneous Sag
CATEGORY: Short Duration Instantaneous Sag

Threshold crossed	57.14 V
Magnitude	53.52 V
MaxRMS	54.25 V
Duration	0.06019 Sec.

Dran-View 6.8.01 HASP : 1642255135 (61E2D31Fh)

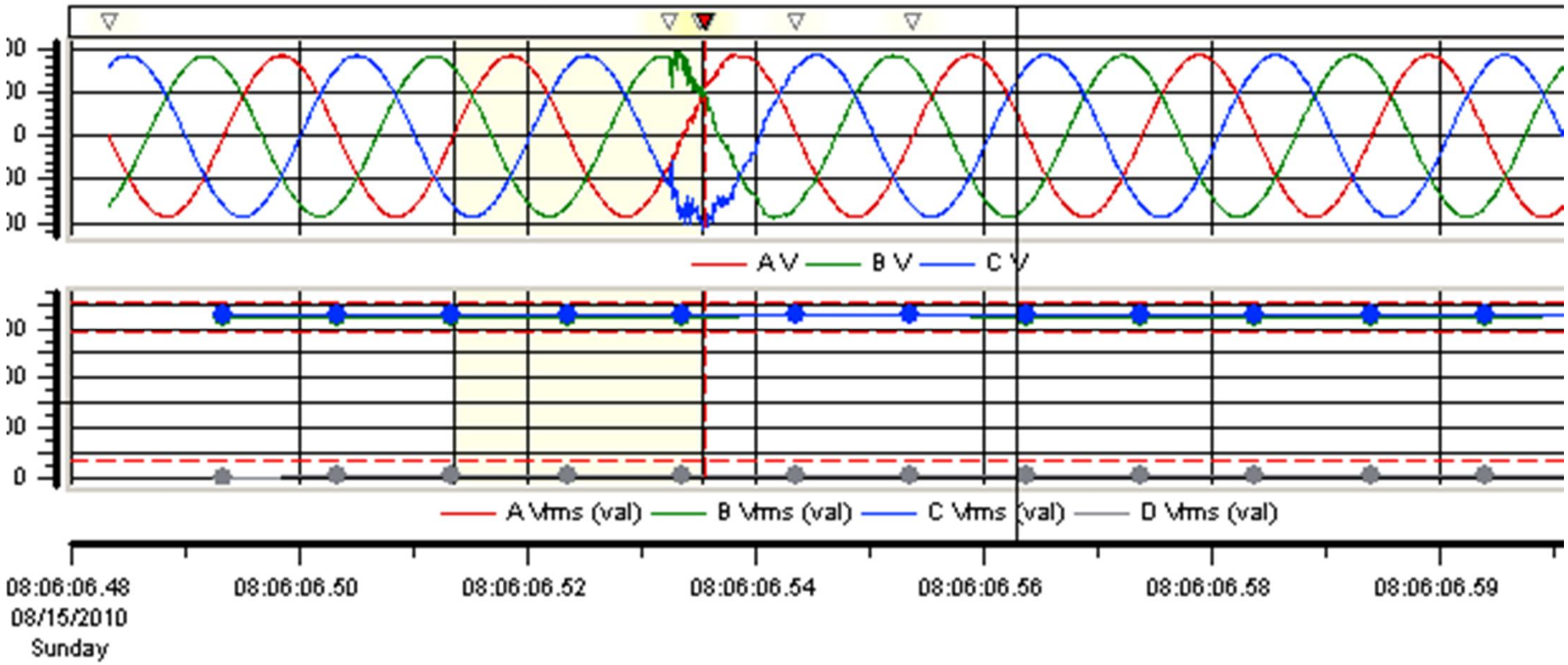
Event Details/Waveforms



Event #13430 at 21-03-2011 14:40:09.191
AVrms, CVrms Instantaneous Sag
CATEGORY: Short Duration Instantaneous Sag

	AV	CV
Threshold crossed (V)	57.14	57.14
Magnitude (V)	31.53	48.65
MaxRMS (V)	54.22	57.1
Duration (sec.)	0.09036	0.09036

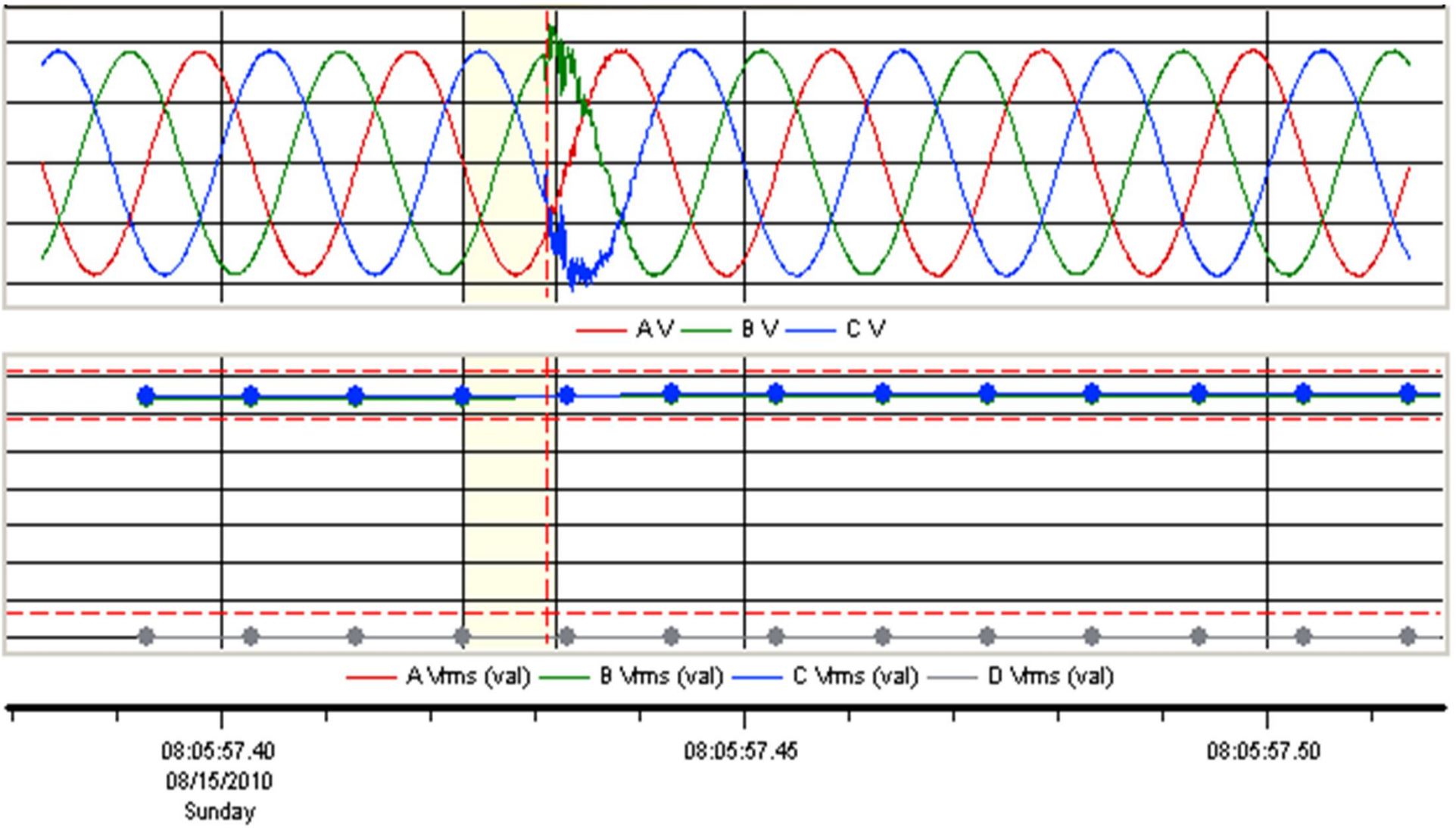
Bipolar Transient



Event #43383 at 08/15/2010 08:06:06.513
CV Mild Bipol Trans Pos 1/16 Cyc
CATEGORY: Impulsive Transient (microsec duration)

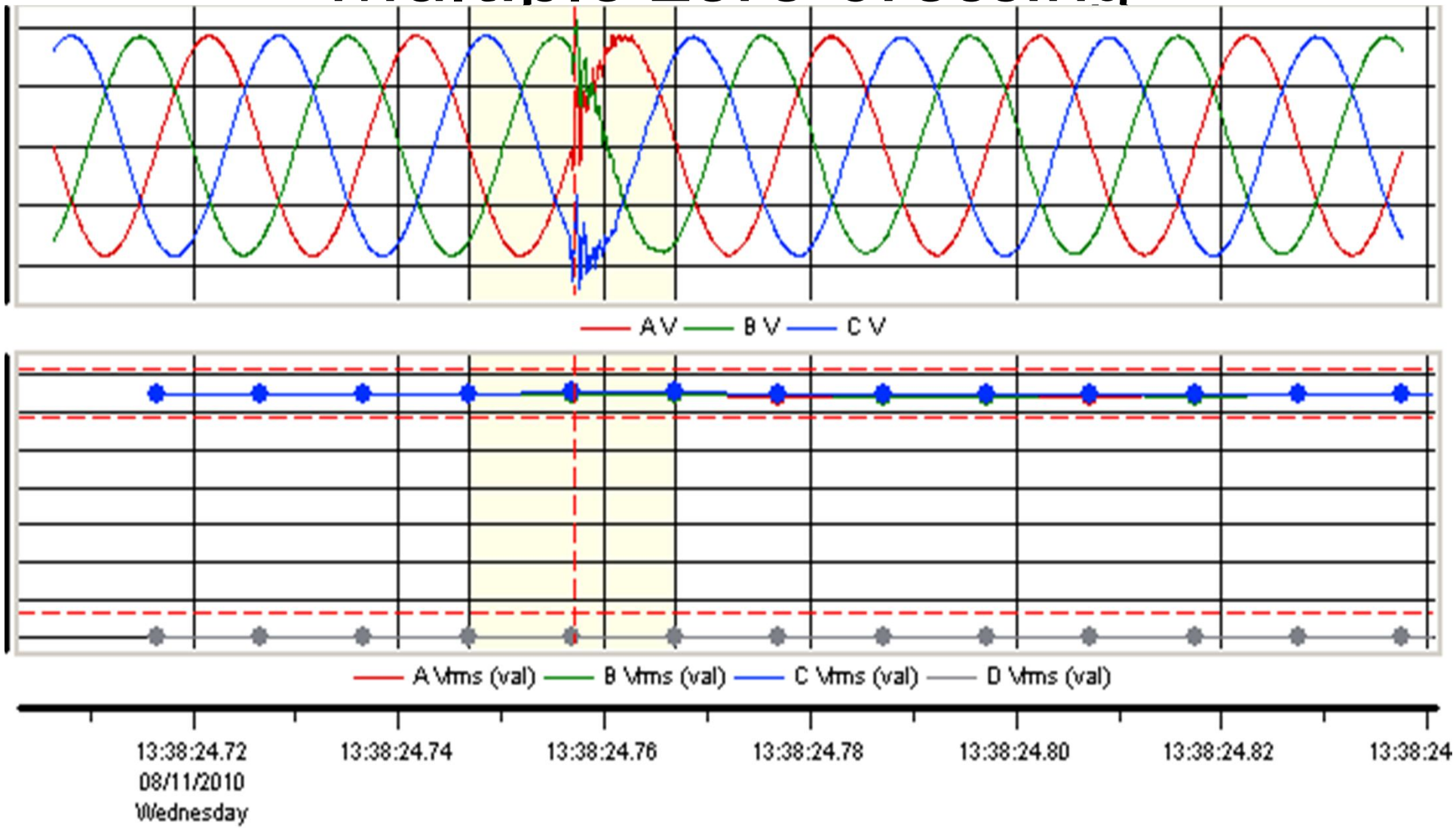
10% Ampl	-98310
50% Ampl	-101311
90% Ampl	-104346
10% Offset (usec)	22110
50% Offset (usec)	22141
Rise time 10-90% (usec)	62.0

B-Phase voltage Drop put



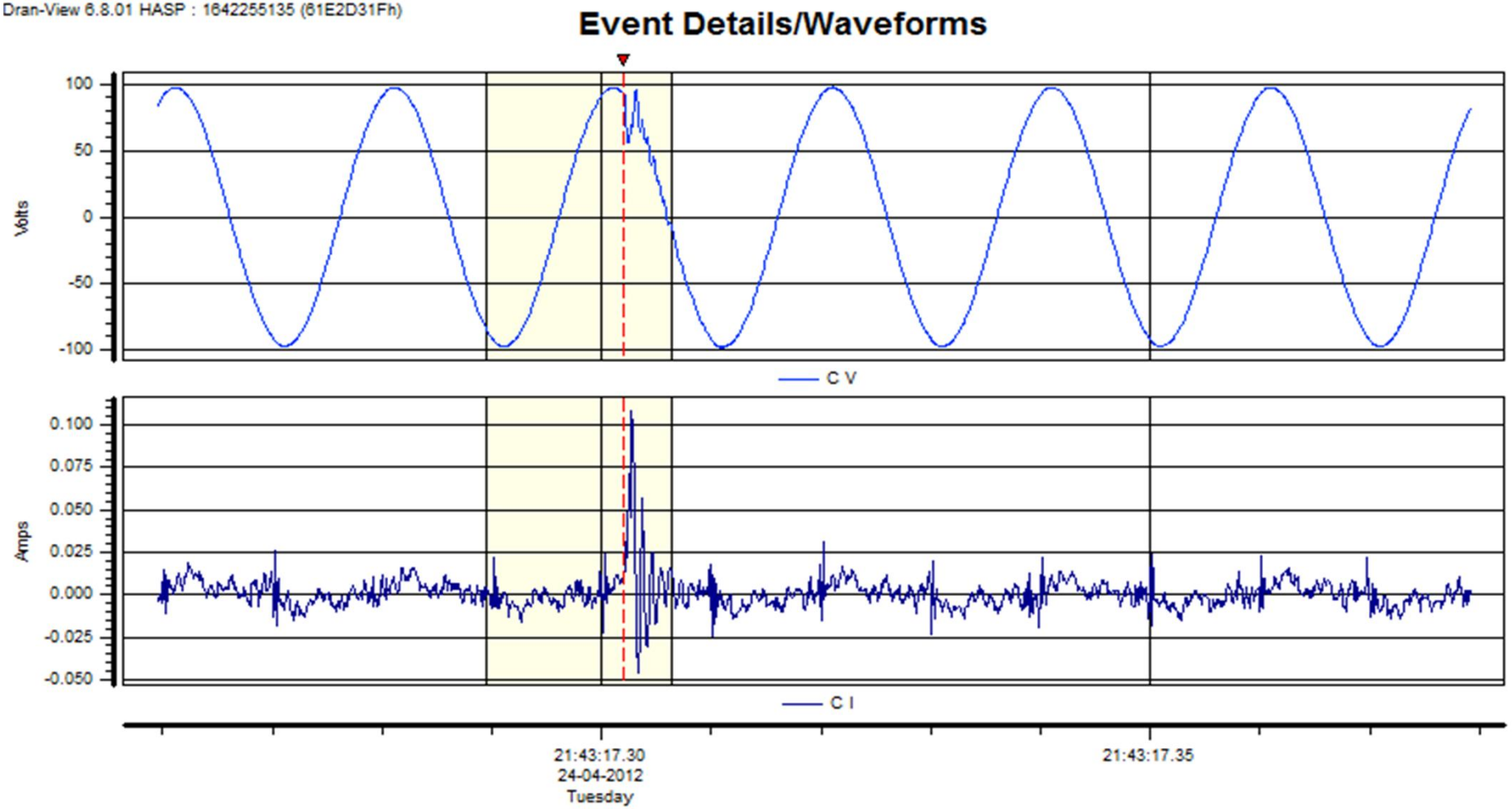
Event #43373 at 08/15/2010 08:05:57.423
CV Dropout 1/16 Cyc

Multiple Zero Crossing



Phase Shift Event

Dran-View 6.8.01 HASP : 1642255135 (61E2D31Fh)

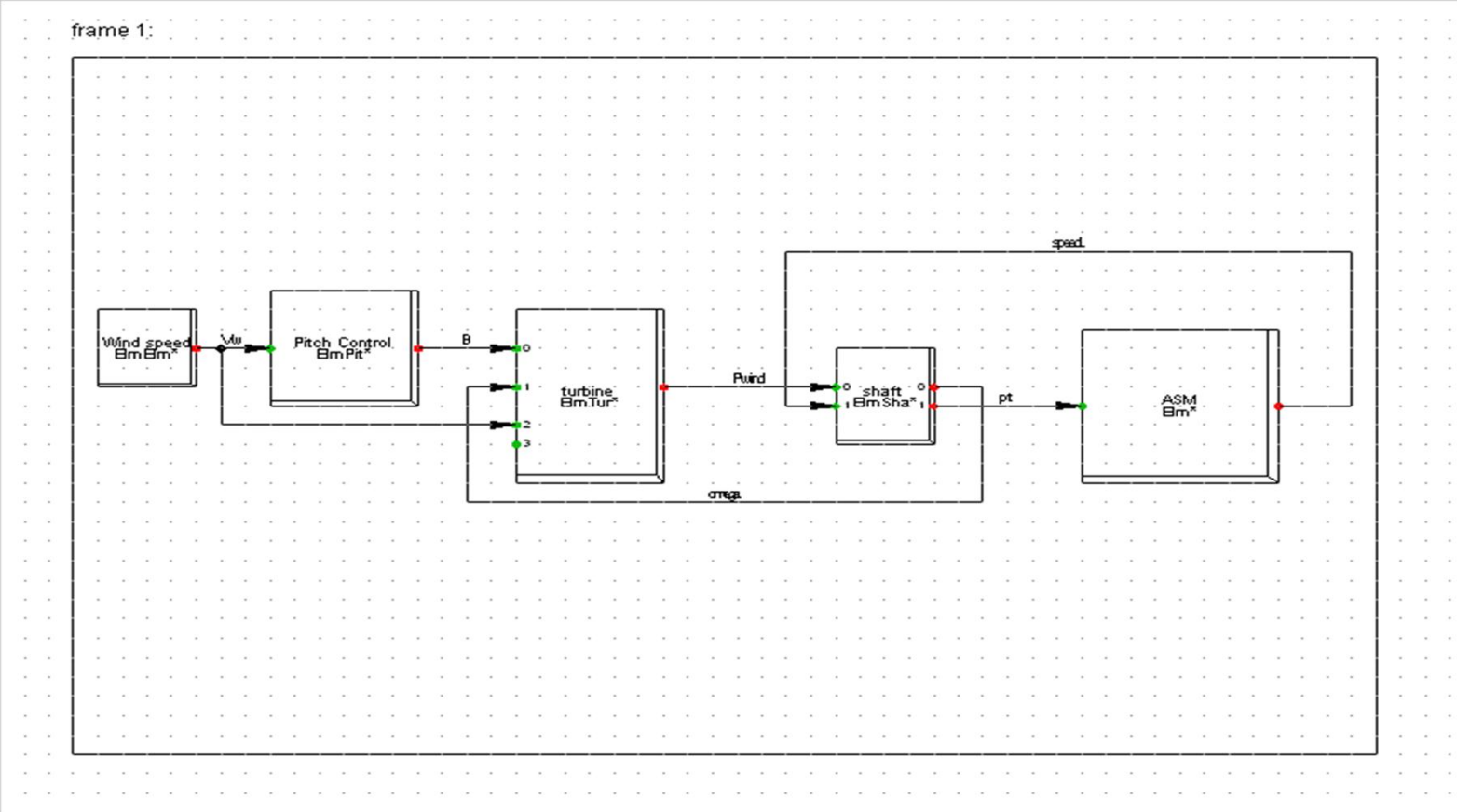


Event #3145 at 24-04-2012 21:43:17.289
CV Mild Phase Shift Neg 1/8 Cyc
Phase 336.9 Deg

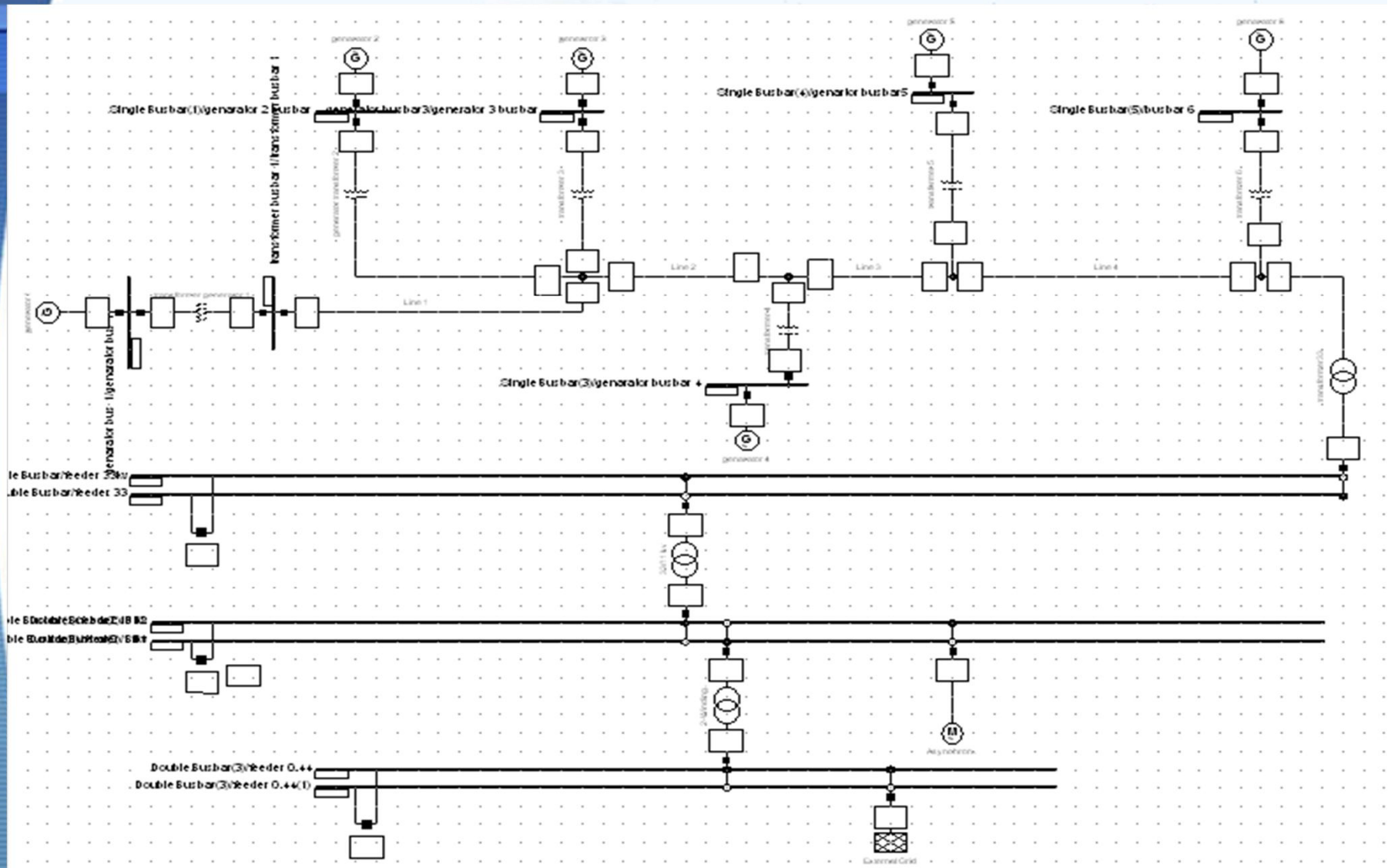
	A	B	C	D	A-B	B-C	C-A
Vrms	67.89	69.03	68.62	0.1291	118.8	119.4	117.7
VPeak	96.39	97.82	97.34	0.4835			
Irms	0.009542	0.01029	0.006334	0.1124			
IPeak	0.02984	0.03167	0.02048	0.4662			

Complete Model Of Induction Generator

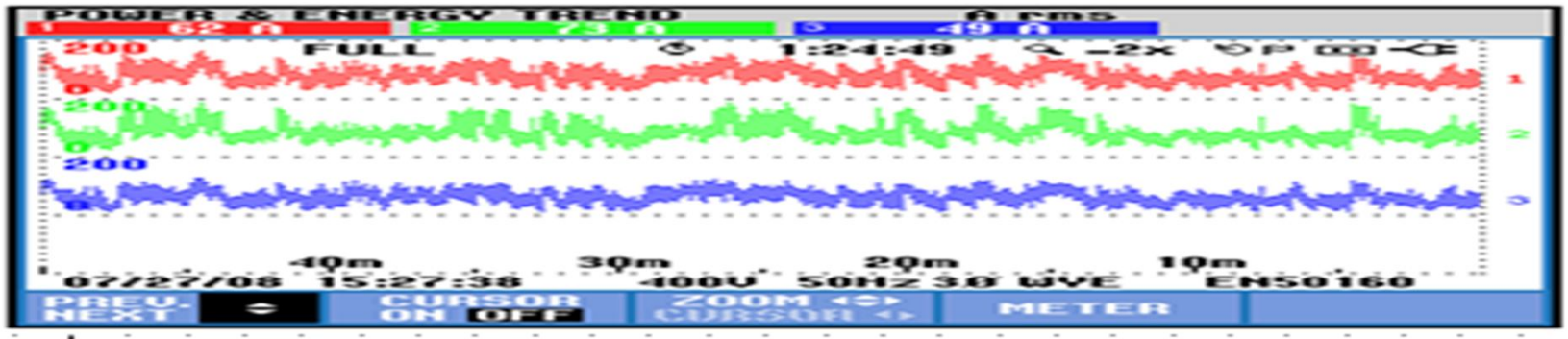
- Frame



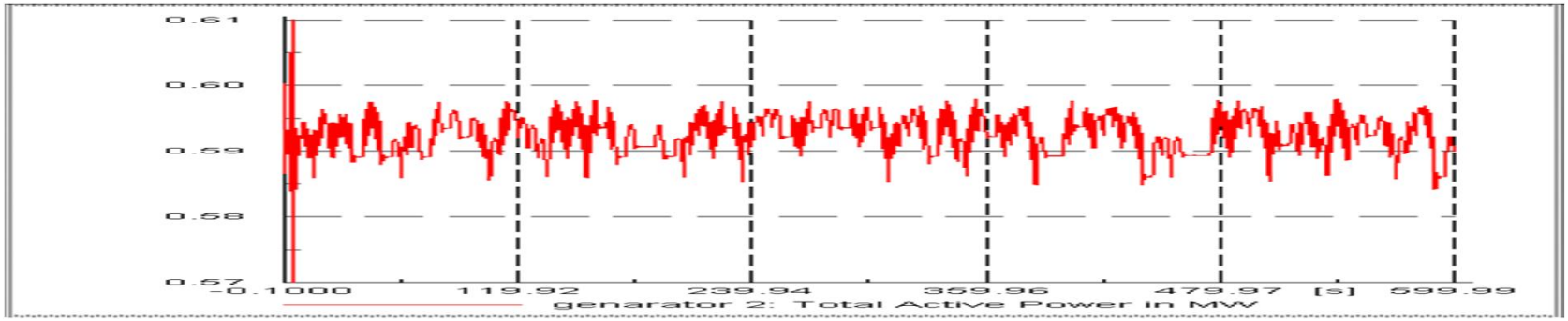
Wind farm single line diagram



Simulation results and case studies

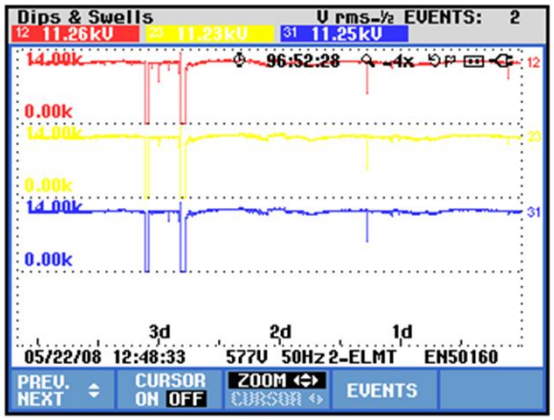


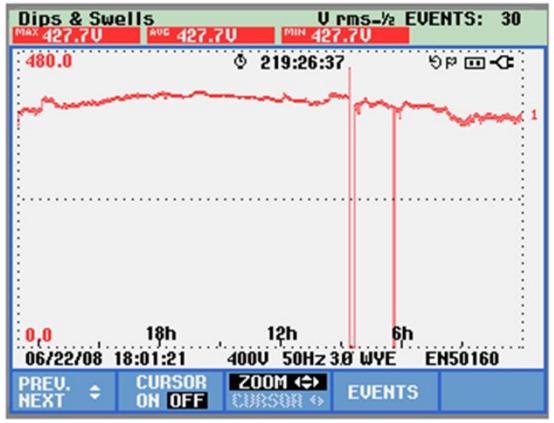
Recorded Real power



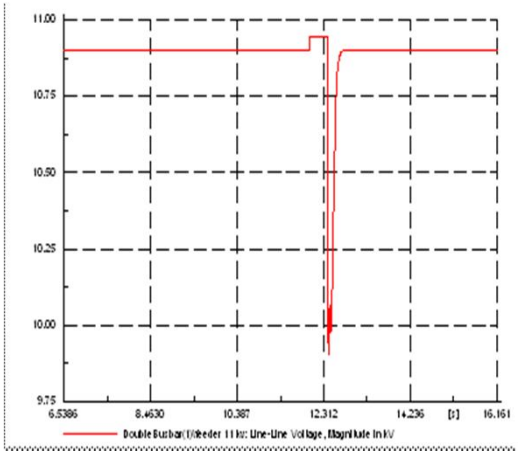
Simulated Real Power

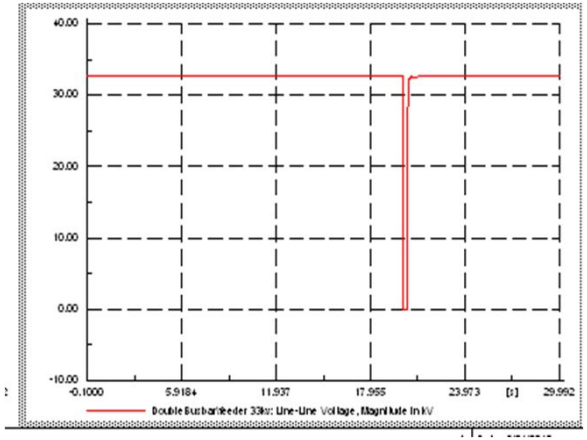
Sag in the Bus bar Voltage due to Sudden Removal of Load at 11kV Bus bar.





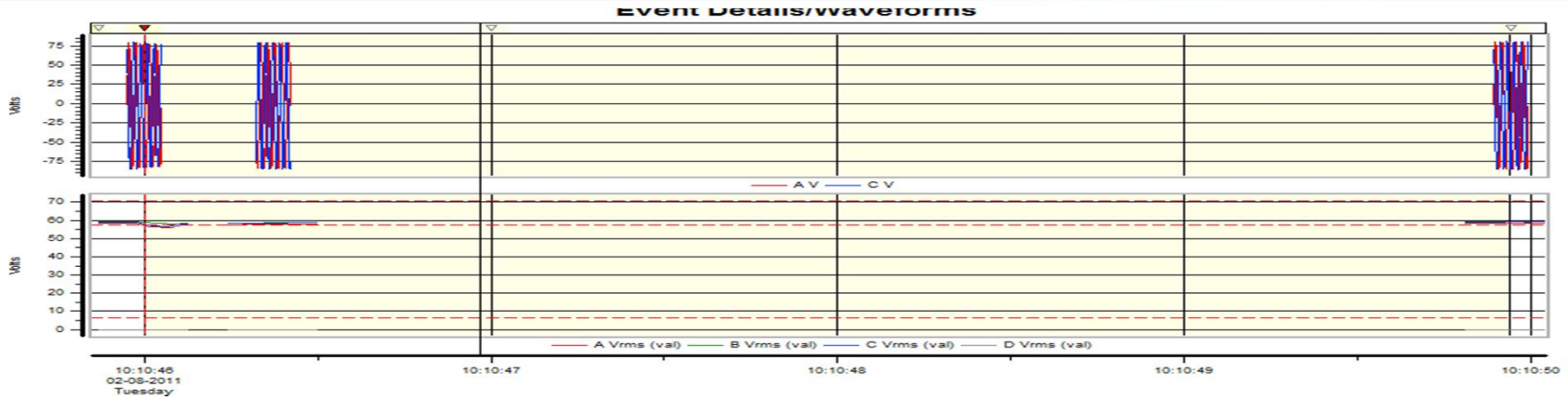
Recorded sag waveform



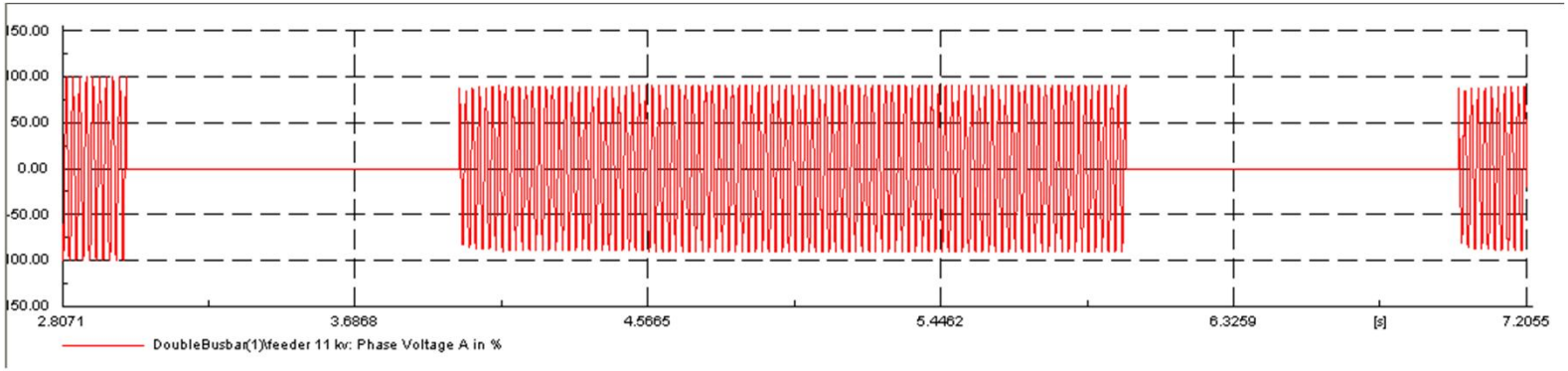


Simulation result of sag waveform

Voltage sag due to short circuit at the 11kV wind farm feeder.

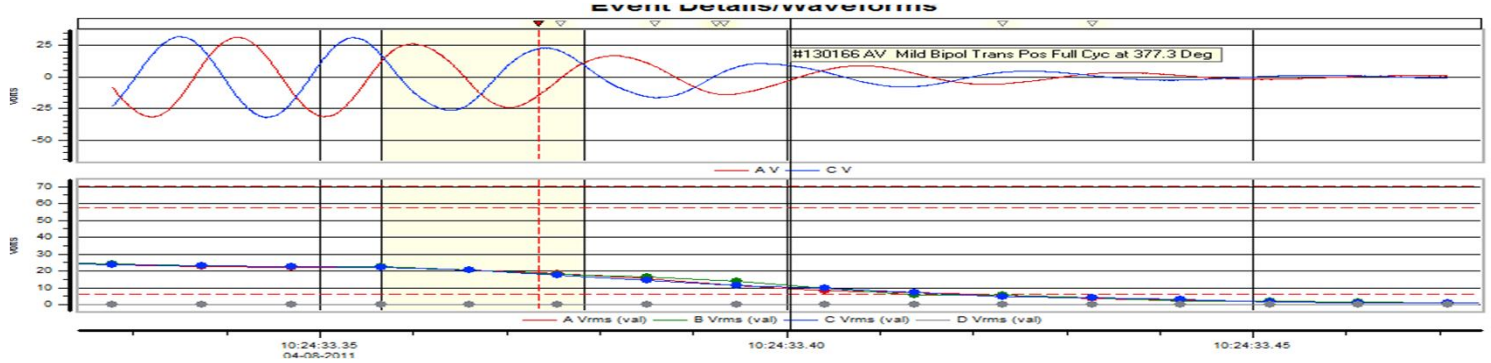


Recorded sag waveform

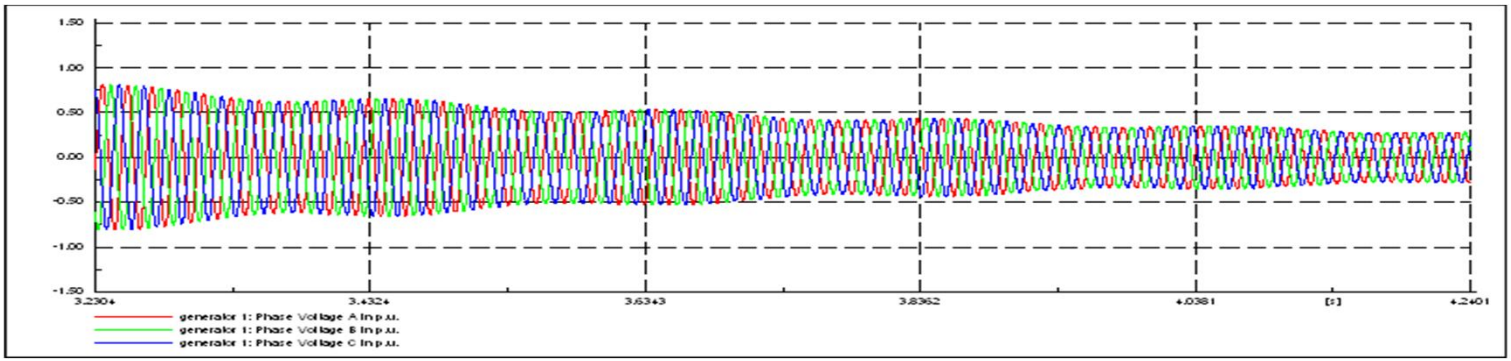


Simulation result of sag waveform

Generator voltage due to switching

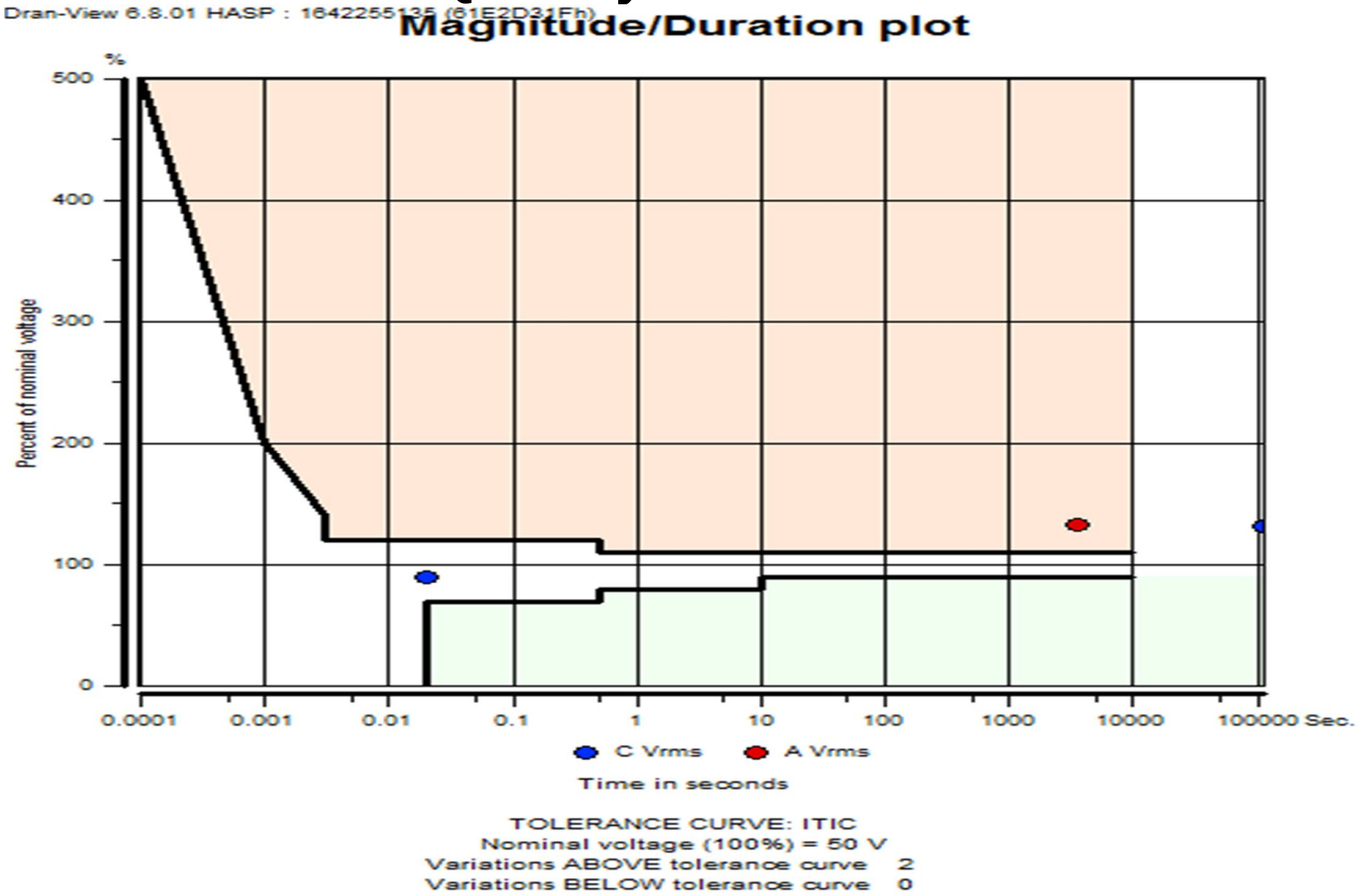


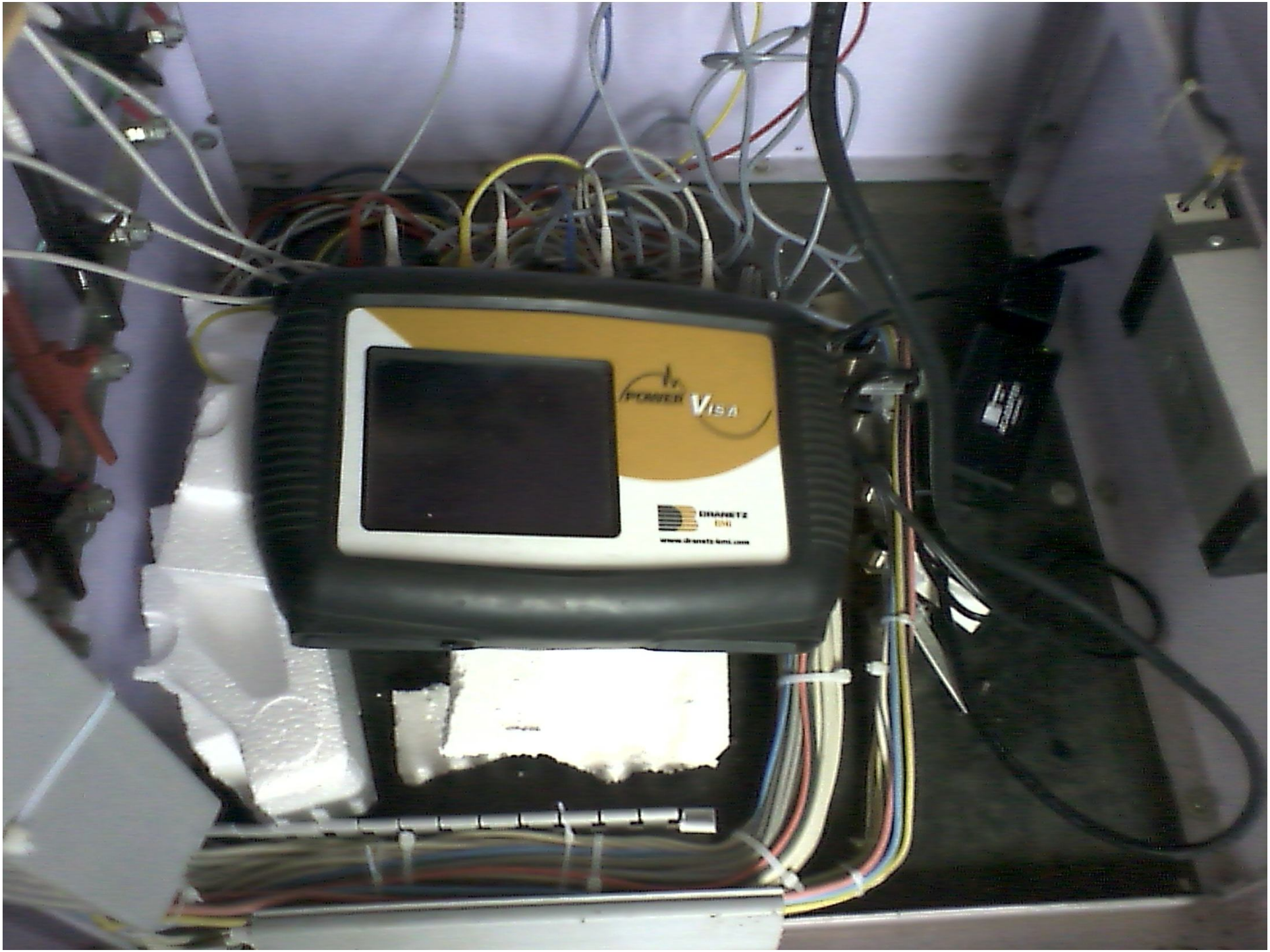
Recorded waveform



Simulation result

Quality of Power




PowerVisa
DRANETZ


RF - 01
KAJINI KANTH FOUNDATION
COMMISSIONING YEAR - 1998
SC NO : 1641