eMS

The only Power System Monitor with embedded expert software in each unit sending professional reports immediately

At eMS we use the latest technologies to meet the evolving needs and demands of the power supply industry.

Our sub.net substation monitor delivers visibility of today's ageing electrical grid, and tomorrow's smart grid, to maximise efficiency and reduce risk.

To maintain a secure and reliable electrical power supply - Information from the analysis of network events provides insight into the operation of the power system and assets.

sub.net introduces Automatic analysis to the substation, monitoring and identifying problems throughout grid installations – reducing costs, saving time and money.

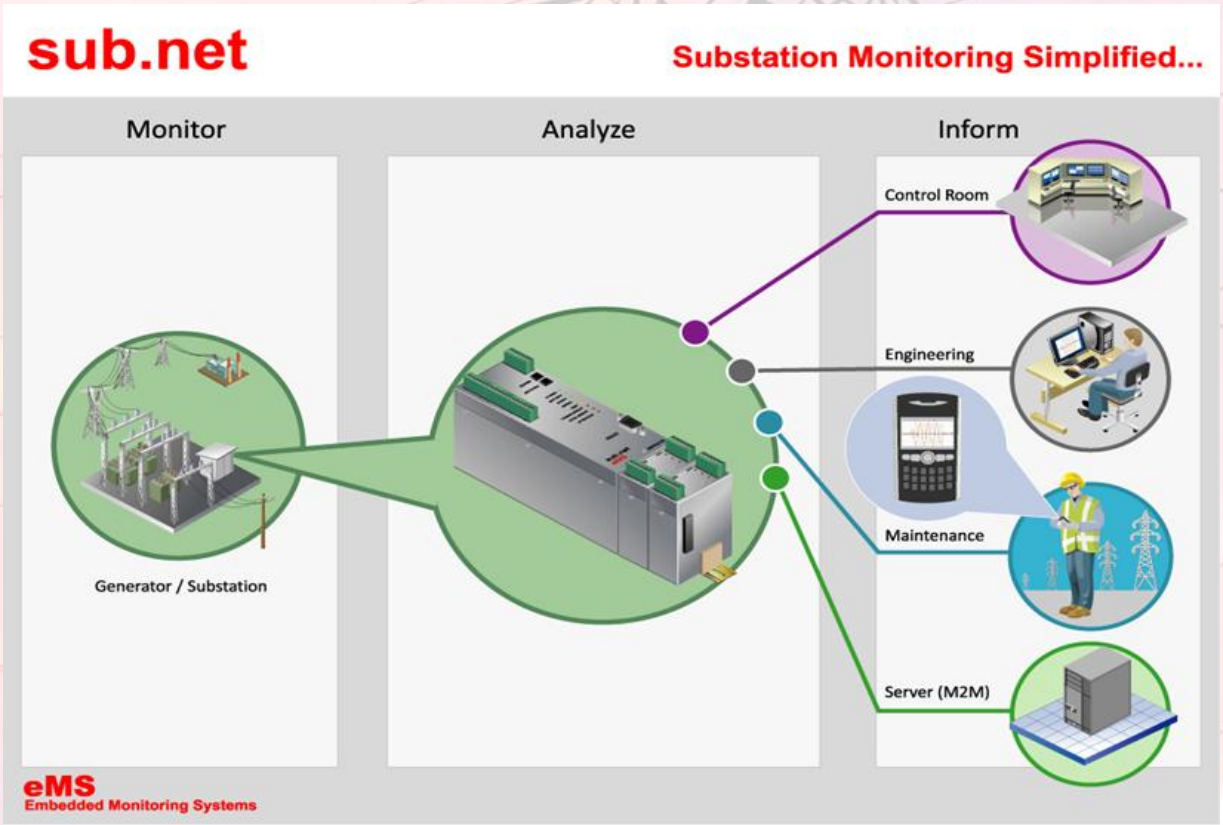
sub.net…

1.monitors your network looking for asset and feeder faults 24/7.

2.performs automatic fault analysis, to verify substation performance of network assets.

3.e-mails ready analysed and prioritised event reports within moments, ensuring that the right people get the right information right away.

sub.net can be installed anywhere, providing knowledge of operational behaviour in the field. Monitoring of equipment performance, essential for reliability and maintenance



sub.net Features

Multiple functionality

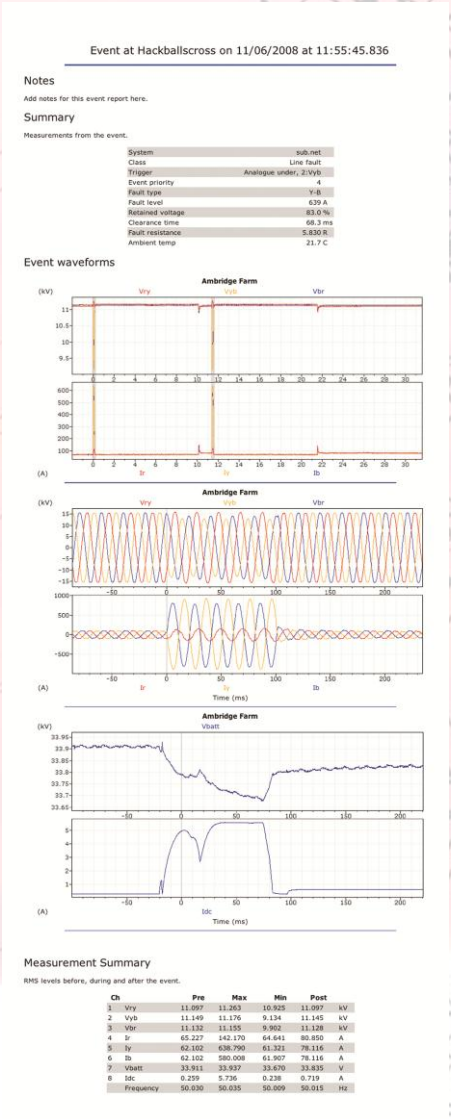
sub.net covers the majority of sub-station monitoring requirements using four concurrent recording rates. See Appendix 1 for details.

Embedded event classifier

Prioritised reports are generated within sub.net and exported with the most **important issues** appearing in order of importance as set by the administrator.

Event reports sent via email

Events are analysed automatically immediately after occurrence and sub.net sends these reports to everywhere, certain information is required. For example a fault location report can be sent immediately to the maintenance crew. This function greatly reduces potential bottleneck situations caused during major outages by supplying the most important information directly to those who need to know within seconds.



Event at Hackballscross on 11/06/2008 at 11:55:45.836

Notes

Add notes for this event report here.

Summary

Measurements from the event.

System	sub.net
Class	Line fault
Trigger	Analogue under, 2:Vyb
Event priority	4
Fault type	Y-B
Fault level	639 A
Retained voltage	83.0 %
Clearance time	68.3 ms
Fault resistance	5.830 R
Ambient temp	21.7 C

Event waveforms

Ambridge Farm

Ambridge Farm

Ambridge Farm

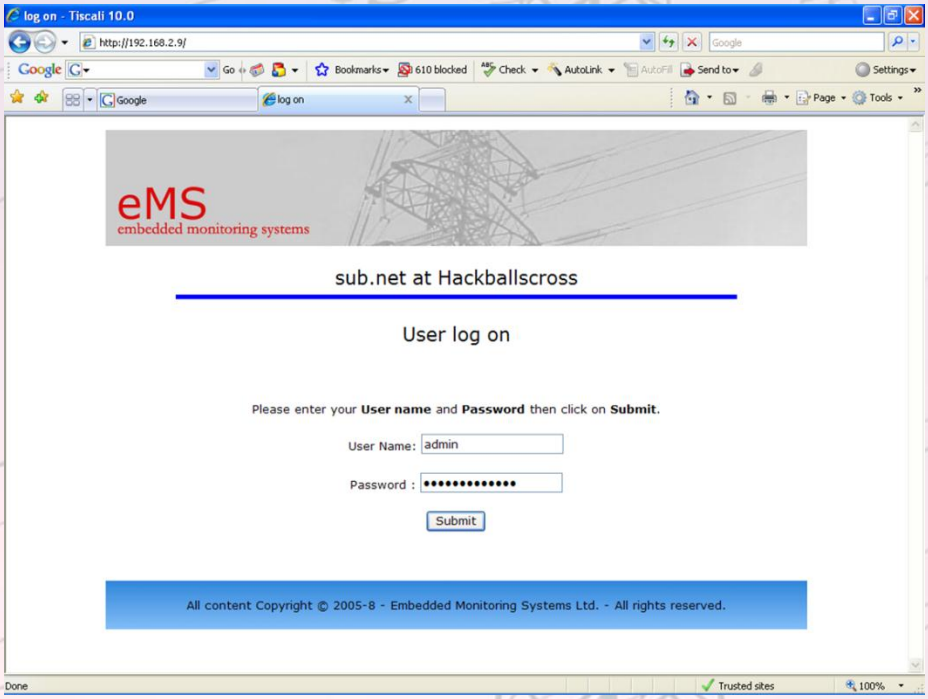
Measurement Summary

RMS levels before, during and after the event.

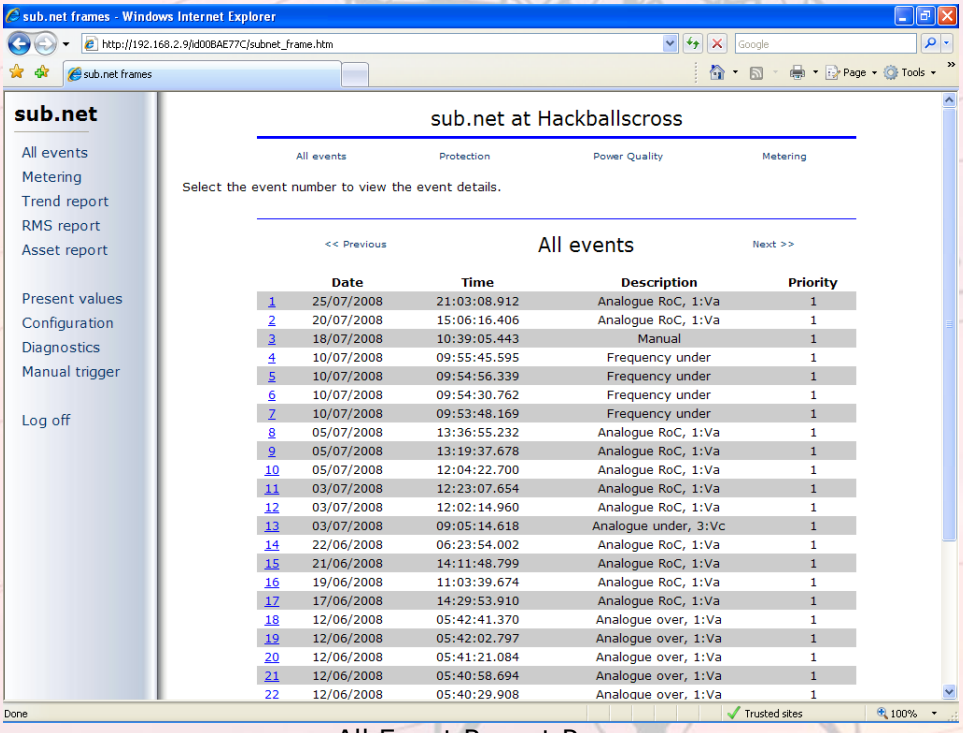
Ch		Pre	Max	Min	Post	
1	Vry	11.097	11.263	10.925	11.097	kV
2	Vyb	11.149	11.176	9.134	11.145	kV
3	Vbr	11.132	11.155	9.902	11.128	kV
4	Ir	65.227	142.170	64.641	80.850	A
5	Iy	62.102	638.790	61.321	78.116	A
6	Ib	62.102	580.008	61.907	78.116	A
7	Vbatt	33.911	33.937	33.670	33.835	V
8	Idc	0.259	5.736	0.238	0.719	A
	Frequency	50.030	50.035	50.009	50.015	Hz

Embedded web pages for set-up, viewing inputs and reports.

sub.net is unique in that all reports can be viewed very quickly on any web-browser.



Log On Page



All Event Report Page

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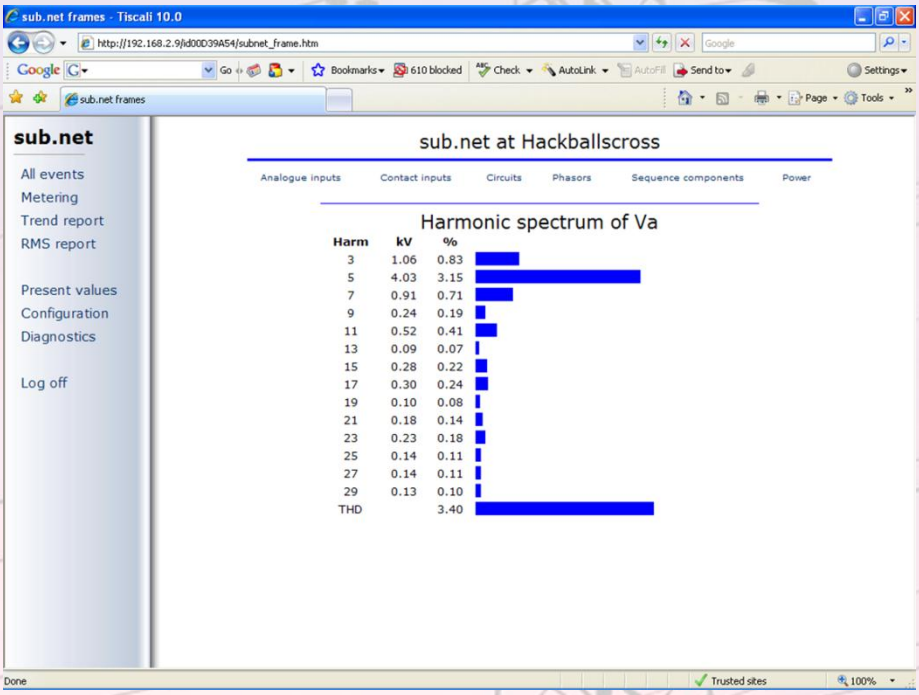
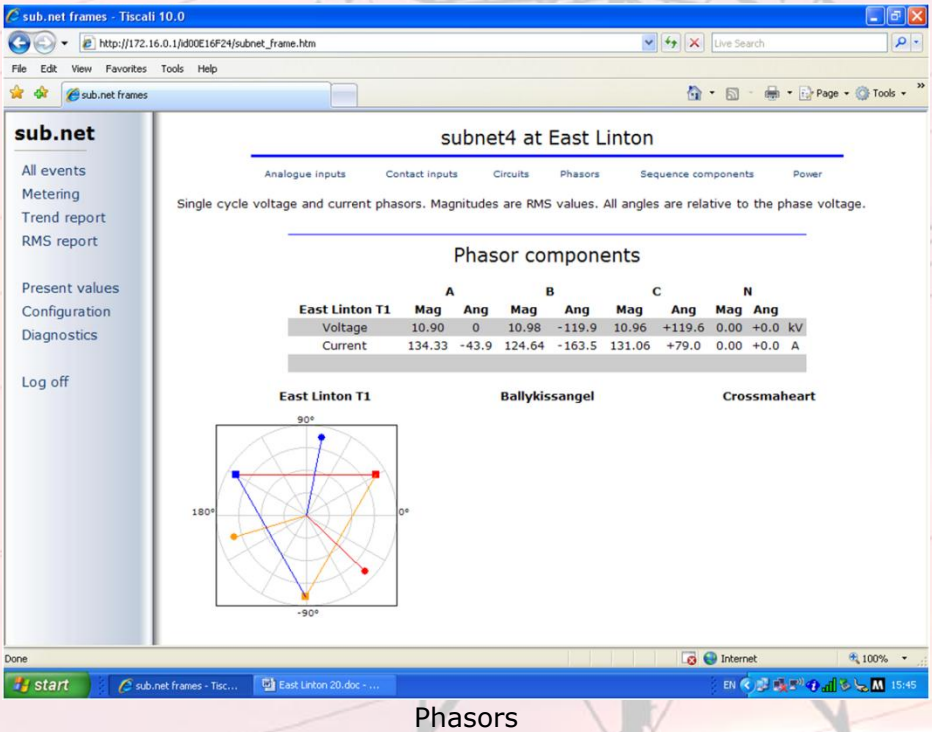


Real Time Harmonics Page



Phasors

Master-station options

If a remote Master-station is required sub.net COMTRADE and CSV formats are used to view reports on most dedicated commercial display packages such as PQView.

Compact din-rail mounted enclosure

Sub.net because of its size can be installed almost anywhere and long cable runs are generally not required. There are wall mount, portable and pole-mounted (temperature range extended down to -40C) options.

Fully solid state

No moving parts and a cool running PSU brings a five year warranty.

Very low power requirement

sub.net draws less than 4 watts.

Ease of use / Training

Any power engineer familiar with a web browser can set-up and use sub.net with ease. Time has shown that a brief overview and a little 'hands-on' experience is all that is required. The manual covers every eventuality.

SCADA

sub.net enhances customers **SCADA** packages by storing over 800 pieces of information including asset condition analysis and alarms, in easy to access registers supported by **Modbus** and **DNP3**.

This allows the control room to receive this **vital** information immediately.

Relays versus sub.net.

Some manufacturers argue that all of the information power engineers need comes built into 'their' smart relays. We suggest that this is certainly not the case.
Please read appendix 2.

Industry standards.

COMTRADE

MODBUS

DNP3

SYNCHROPHASOR

NERC

ISO9001

CE mark. (EU)

sub.net Applications

Asset Monitoring

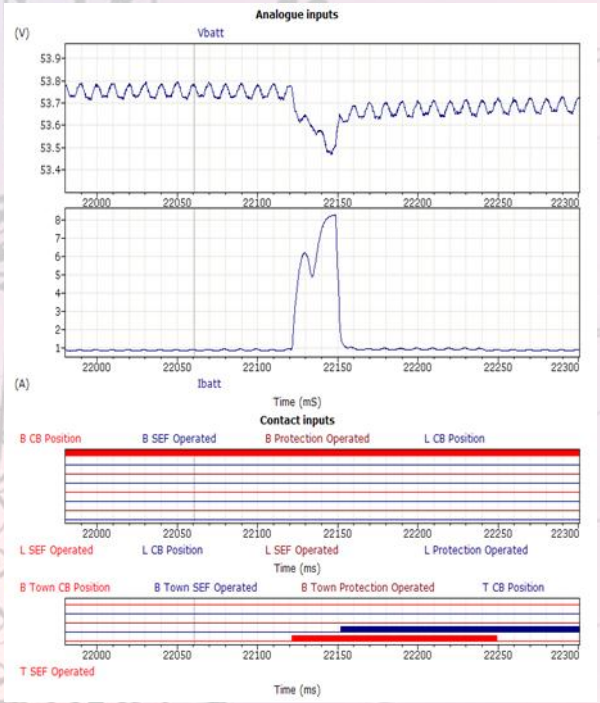
Breaker Health - Relay Operation Checked - Transformer Condition - Station Battery / Battery Charger Operation

One sub.net can monitor the conditions of a range of key assets within a substation. It records every operation of every breaker in a switchyard and reports any problem immediately via email.

Both mechanisms and main contacts are monitored. Use sub.net to reduce your maintenance costs by continuously monitoring any plant movements.

sub.net can integrate with existing asset databases to create a condition based or reliability centered maintenance strategy. Information on other key assets such as transformers, relays and batteries may be included with sub.net reports.

This information is also stored in the Modbus & DNP3 registers for SCADA applications. See appendix 3.



- CT and VT circuits supervision
- Interrupted fault current
- Protection relay operation
- Breaker operation timing and contacts monitoring
- Trip coil monitoring
- Station battery

68968F (Trip) 836-06 at 66.4 mS

Operate time	102.6	ms
Coil current	6.785	A
Pulse width	90.5	ms
Aux contact	122.81	ms
Battery Vm	53.735	V
Battery impedance	0.060	R

68968F (Close) 836-06 at 4131.9 mS

Operate time	38.5	ms
Coil current	3.984	A
Pulse width	25.4	ms
Aux contact	23.33	ms
Battery Vm	54.080	V
Battery impedance	0.029	R

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Synchrophasor (PMU)

sub.net supports the IEEE standard C37.118-2005 for synchrophasors so it can act as a phasor measurement unit (PMU) within a power system. The standard includes a communication protocol where regular data frames are sent from the PMU to a phasor data concentrator (PDC) which receives data from many such PMUs. The data frames include a very accurate time stamp which is derived from sub.net's embedded GPS receiver and selected voltage and current measurements with their absolute phase angles.

Compliance:	IEEE C37.118 (2005)
Accuracy:	Static & Transient performance < 1% TVE
Streaming rate:	Selectable up to 60Hz
Filtering:	Selectable decimation filters
Communications:	RS232 or TCP

Distance To Fault

As part of the embedded event classification system sub.net can report on the possible locations of a multi-phase fault in a distribution network. This uses a local impedance model of the outgoing circuits to list the distance to the nearest named nodes in the network. The model can also include a map reference and an asset database identifier. This information can be sent to the field crew within a matter of minutes which can improve the supply restoration time and hence reduce the Customer Minutes Lost (CML).

If an event is classified as a downstream fault an algorithm is used to identify the fault type and the phases involved. The fault impedance is then computed and this is looked up in the local model and the distance from named nodes are added to the event report. If a local impedance model is not available the fault resistance listed in the event report summary may be used with a suitable digital mapping system to show the possible fault locations.

Location of fault

Line	Location	Easting	Northing	UDB
836-02	0.291 km past Line 1052 Pole 17 08/2731/001/P-BRN SPUR (towards Line 1052 Pole 25 SPUR)	227701.44	330790.78	12531161
836-02	0.135 km before Line 1061 Pole 4 08/2730/001/P-CAU	227472.87	330594.95	10260873

Renewables

(For our sub.net ECO brochure please visit our website www.emsni.com)

Installation and Commissioning Compliance

Grid Code Compliance

Fault Ride Through

Reactive capability

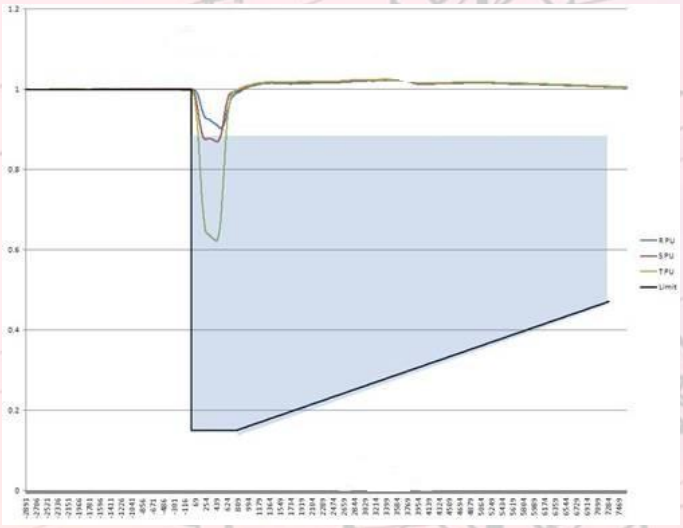
Continuous Monitoring of Power Quality

Harmonic Content, Voltage unbalance

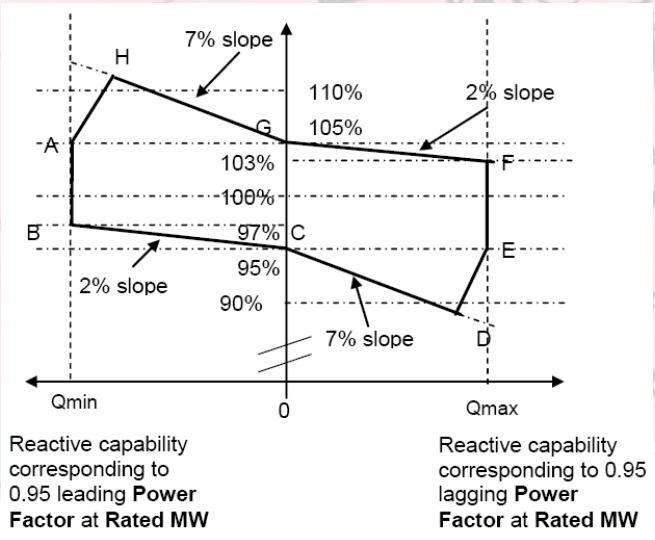
Flicker, Voltage fluctuations

Advanced Fault Reporting

Multiple circuits



Fault Ride Through Graph



Steady state voltage control

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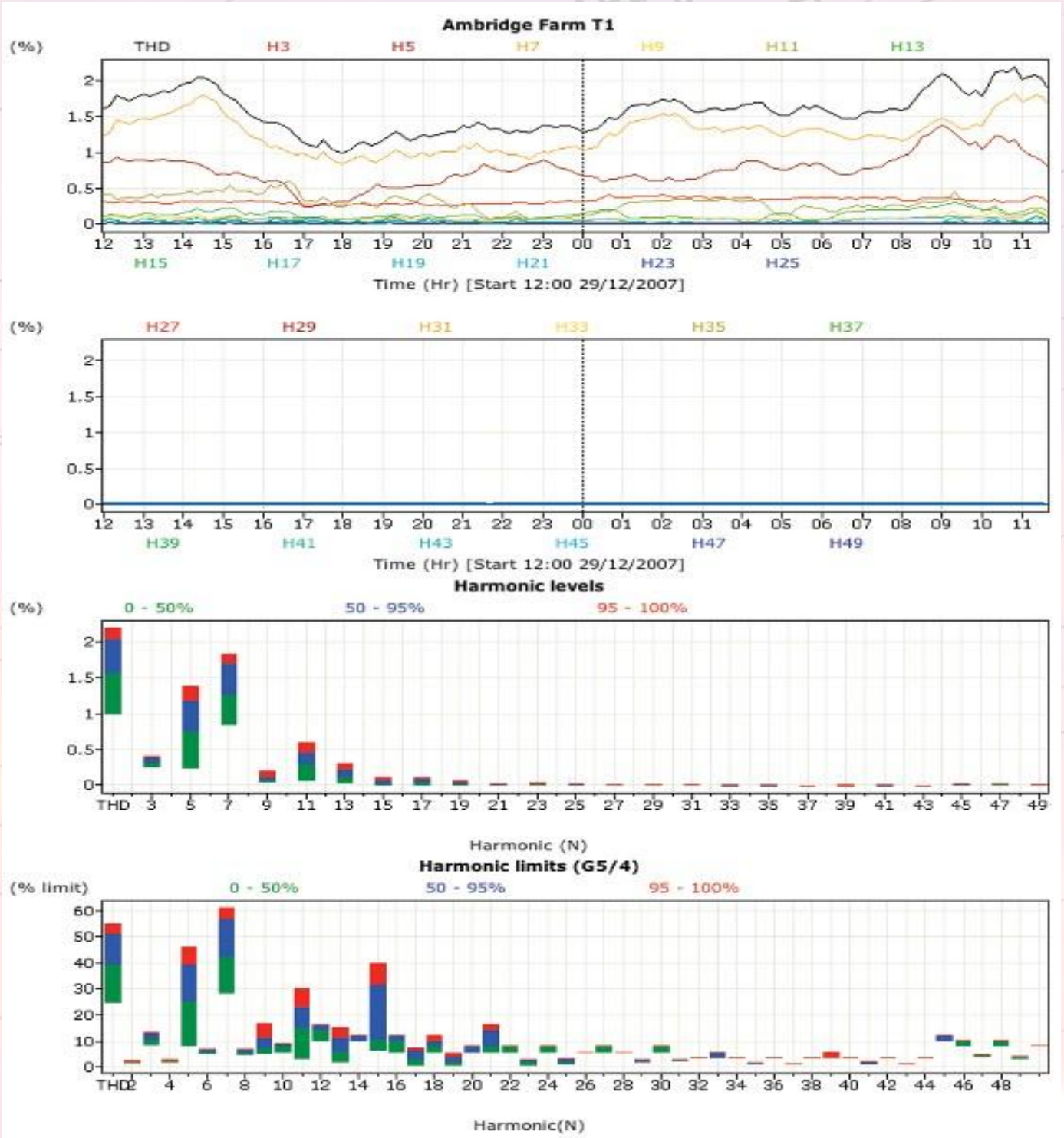
Quality of Supply

Use sub.net to continuously monitor the quality of supply delivered to key customers or at your service entrance. Voltage limits, dips, steps and harmonics are all recorded to EN61000-4-30 and transient events are reported via email, fax or text message.

sub.net also records continuous high speed RMS measurements as well as long term trend data. PQ reports can be created and sent on demand.



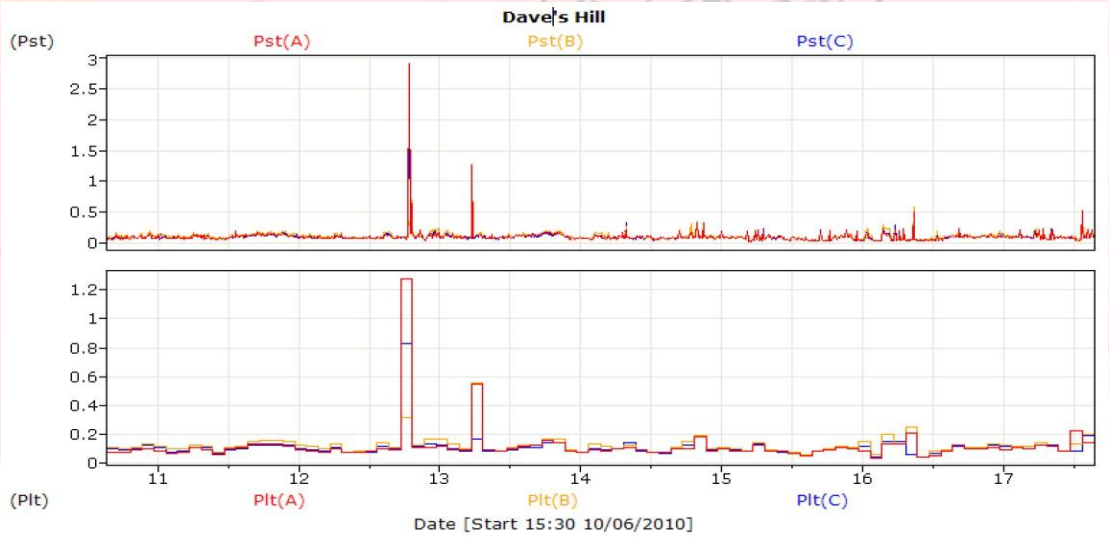
RMS Graph

The RMS Log records 12 selected parameters in a circular buffer at 10 samples per second for the previous 14 days. The report interval defined by setting the Start time and date and selecting a duration. The volume of recorded data is large so the maximum report duration is limited to 60 minutes.

Flicker Report

As part of its power quality monitoring functionality sub.net records the individual voltage flicker values on a 3 phase circuit. The measurements comply with IEC61000-4-15 with scaling values from 0.1 to 20. A report including both Pst (10 min) and Plt (2 Hr) values may be created over a user defined time interval.

The flicker trend report includes both graphs and a table with the maximum, minimum and average flicker values over the trend interval. All sub.net trend reports may be viewed on-line and emailed to the current user.



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Smartgrid & LV

(For our sub.net Smart LV brochure please visit our website www.emsni.com)

As utility companies look for more visibility of their distribution network, sub.net moves into LV substations and also offers pole mounting options.

Below is an example of where sub.net is being used in LV distribution.

sub.net being installed

sub.net fits anywhere from Generation to LV distribution. The installation shown, as you can see, is fairly old but still functioning perfectly. As are many of the the LV installations in the field today.

Our customer wanted to install a monitoring device at this location with all the features that they use in modern substations.

The space for such a device in this environment is very restricted and communications are non-existent.

sub.net was the answer:

Communications are via GSM/GPRS and the CTs are Rogowski shown under the 3 meters at the top.

Regular reports include the phase and line voltages, transformer and feeder phase and neutral currents, per phase real, reactive powers, power factor and per feeder metered values. The real time measurements are available as maximum, minimum and average values every 10 minutes for the previous 26 weeks.

For an LV substation with 6 feeders there are over 140 parameters available. Additionally sub.net can report on line faults and power quality including voltage dips, frequency, harmonics and flicker.

The system can be extended to include any number of feeders. Formatted reports including graphs are sent to users via email over a GSM/GPRS network. The information from these reports may also be automatically integrated with other utility systems.

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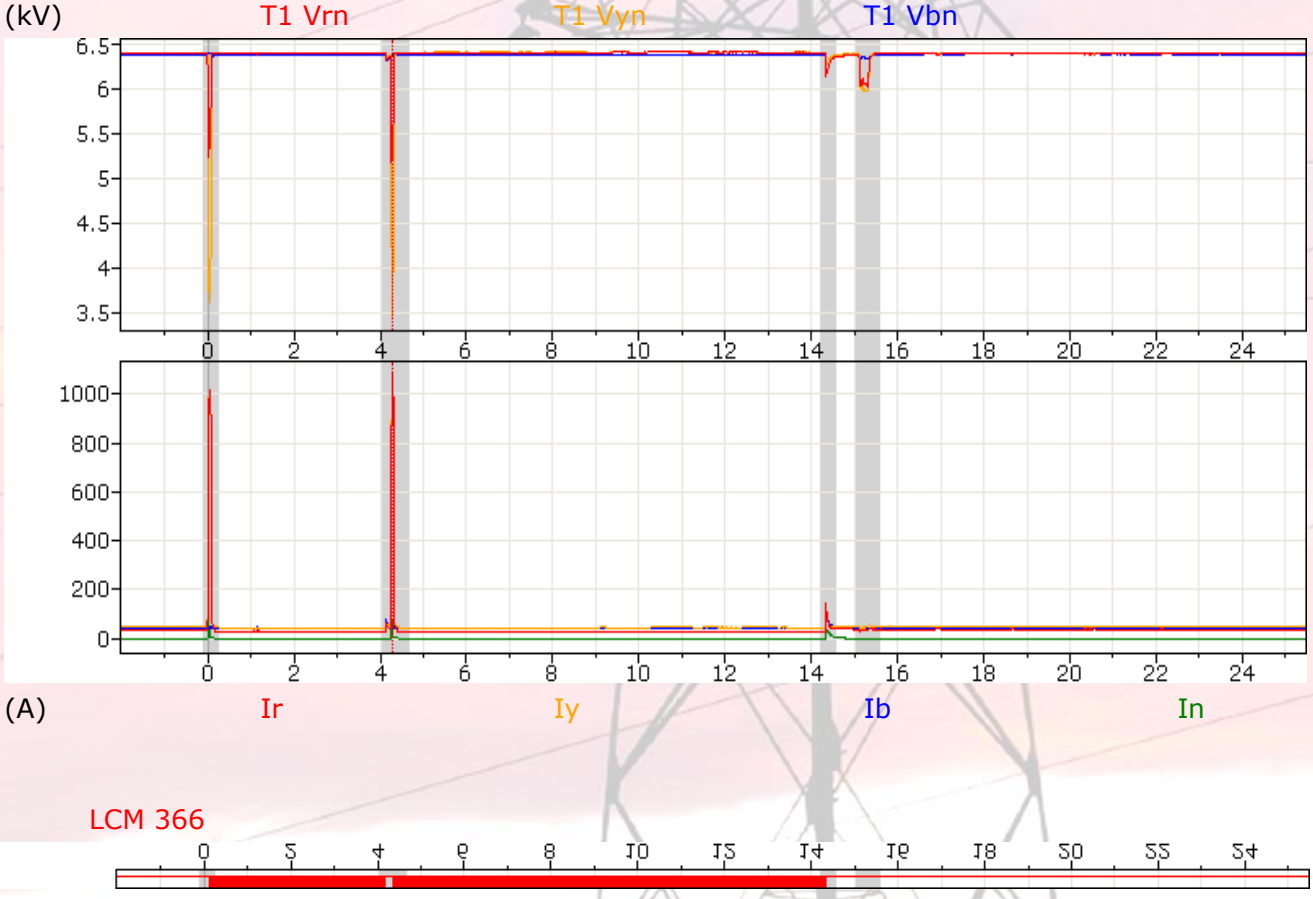
sub.net Report

Overview Report

Below is the first part of a report generated by sub.net. What this allows the user to achieve is a complete picture of the event from start to finish. In traditional systems the user would be sorting through large amounts of data to make sense of an event. sub.net provides this in seconds of the event taking place.
As you can see below a complete picture is presented from the voltage and current behaviour to how the station battery and circuit breakers performed and a table detailing the type of event.

System	Btown Primary Transformer
Class	Line fault - self clearing (transient fault)
Trigger	Analogue under, 1:T1 Vrn
Event priority	1
Fault type	R-Y
Fault level	1080.5 A
Fault resistance	2.838 R
Ambient temperature	28.8 C

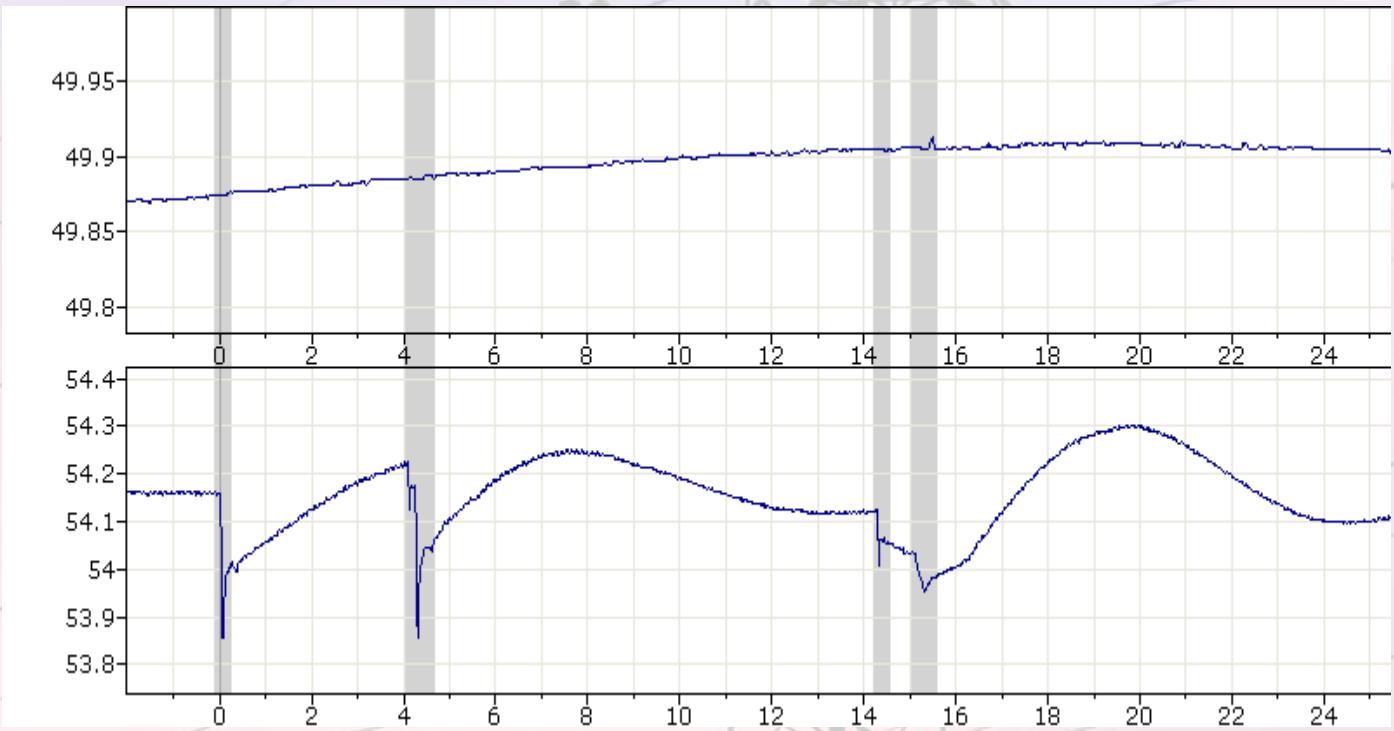
Event waveforms



Time (S)

Analogue inputs

(Hz) Frequency



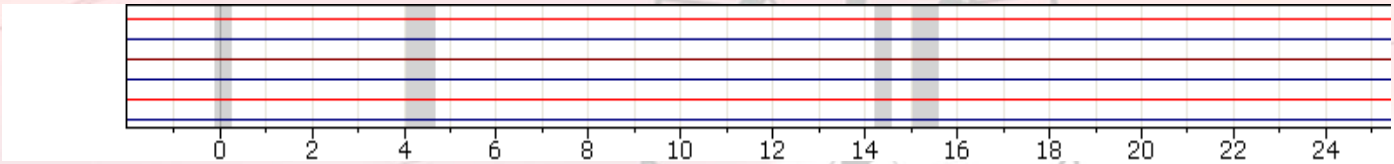
(V) Vbatt

Time (S)

(A) Ibatt (J551) 11kV trip/close

Contact inputs

MCM 362 HCM 363 11/33 kV Transformer BCM 364



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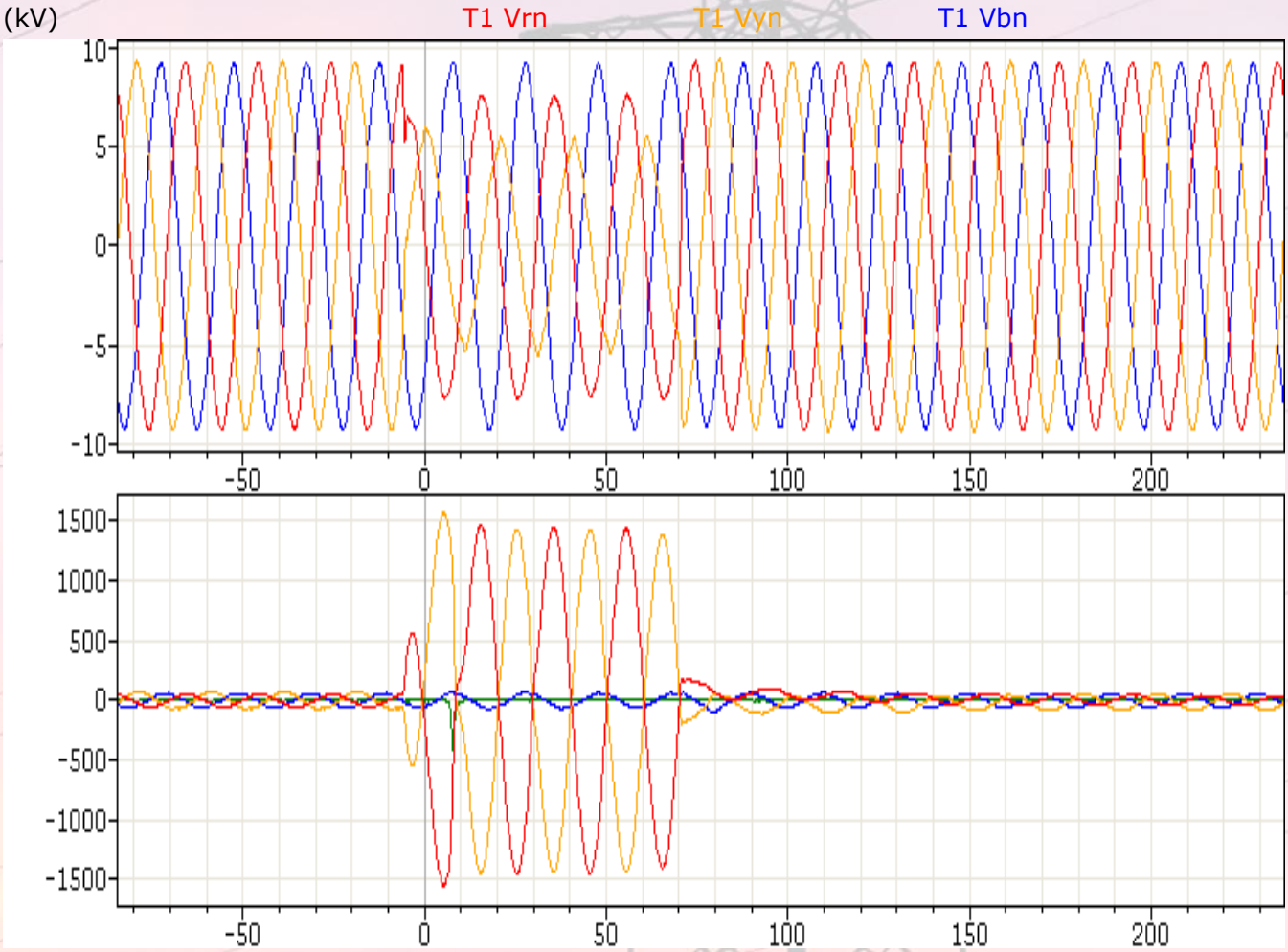
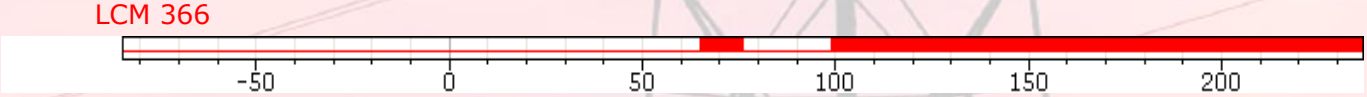
Detailed View

When an event takes place an overview report is generated showing all the tasks the substation has performed and how the voltage and current behaved for the full duration of the event. sub.net then breaks these down so more detail can be viewed of each occurrence. The graphs below show the 3 phase voltage and current returning to normal when the circuit breaker trips. Also a detailed picture of how the station battery and breakers performed.



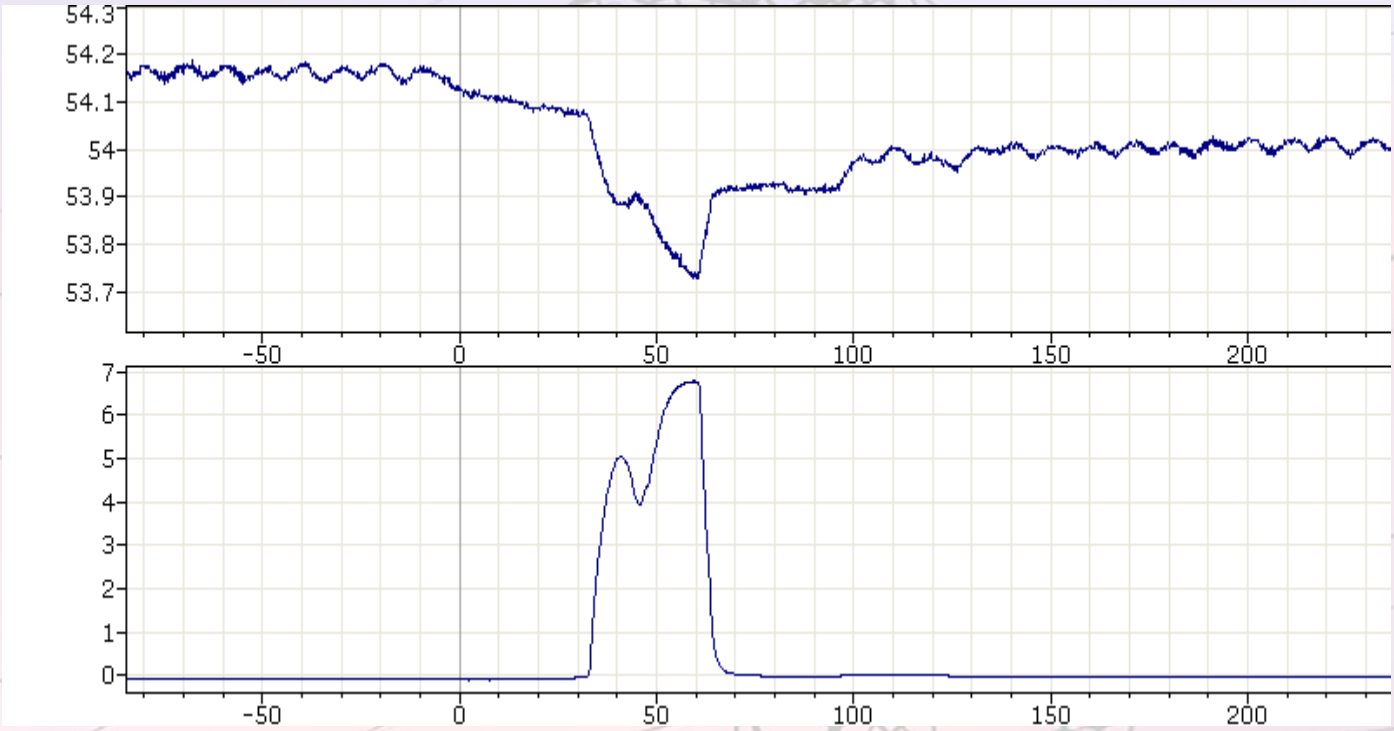


Time (ms)

eMS

Analogue inputs

(V) Vbatt

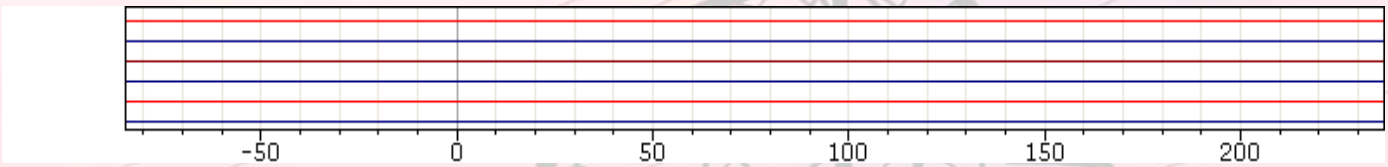


(A) Ibatt (J551) 11kV trip/close

Time (mS)

Contact inputs

MCM 362 HCM 363 11/33 kV Transformer BCM 364



SCM 365 BCM 361

eMS

Event Summary

The last item on sub.net report is the summary and figure tables. The detail shown here can be as brief or detailed as required. Below the tables show how the RMS values for how the different channels performed, a list of how the assets behaved and a DTF report (Distance to Fault).

Measurement Summary

RMS levels before, during and after the event.

Ch		Pre	Max	Min	Post	
1	T1 Vrn	6.411	6.421	5.188	6.408	kV
2	T1 Vyn	6.409	6.420	3.460	6.404	kV
3	T1 Vbn	6.394	6.411	6.280	6.392	kV
4	Ir	34.185	1081.699	28.813	36.626	A
5	Iy	48.054	1072.225	42.291	49.324	A
6	Ib	41.510	93.275	39.752	43.366	A
7	Vbatt	54.164	54.304	53.862	54.111	V
11	Ibatt (J551) 11kV trip/close	0.005	5.142	0.003	0.004	A
12	In	1.465	135.371	0.684	0.977	A
	Frequency	49.871	49.913	49.870	49.903	Hz

Contact Events

All changes of state of the input contacts detected during the event. Times are relative to the stated Start time.

State	Contact	ms
Alarm	LCM 366	98
Normal	LCM 366	4129
Alarm	LCM 366	4329
Alarm	LCM 366	4329
Normal	LCM 366	14326

Analogue Limits

Inputs exceeding the set operating limits during the event. Times are relative to the stated Start time.

State	Label	Limit type	ms
Alarm	1:T1 Vrn	Analogue RoC	104
Alarm	2:T1 Vyn	Analogue RoC	111
Normal	1:T1 Vrn	Analogue RoC	164
Normal	2:T1 Vyn	Analogue RoC	191
Alarm	2:T1 Vyn	Analogue RoC	4331
Alarm	1:T1 Vrn	Analogue RoC	4334
Normal	11:Ibatt (J551) 11kV trip/close	Analogue over	14327
Alarm	2:T1 Vyn	Analogue RoC	15112
Alarm	1:T1 Vrn	Analogue RoC	15116
Normal	1:T1 Vrn	Analogue RoC	15166

Fault location from Btown

Impedance to fault circuit model search.

Line	Location	Easting	Northing	UDB
836-06	0.140 km past Line 1764 Pole 58 08/2634/010/F-FUSE SPUR (towards Line 1764 Pole 63 08/2635/011/ -AW 08/607 DS Normally Open/End)	000530.66	004995.01	00002506
836-06	0.161 km past Line 12047 Pole 5 08/2634/003/P-PISTYLL	000027.950	004329.590	00000797
836-06	0.079 km past Line 1764 Pole 58 08/2634/010/F-FUSE SPUR (towards Line 12050 Pole 4 08/2635/005/P-T End)	000530.66	004995.01	00002506
836-06	0.079 km past Line 1764 Pole 58 08/2634/010/F-FUSE SPUR (towards Line 12051 Pole 3 08/2634/002/P-TE	000530.66	004995.01	00002506

Assets

Switchgear operations during the event.

68968F (Trip) 836-06 at 66.4 mS

Operate time	102.6 ms
Coil current	6.785 A
Pulse width	90.5 ms
Aux contact	122.81 ms
Battery Vm	53.735 V
Battery impedance	0.060 R

68968F (Close) 836-06 at 4131.9 mS

Operate time	38.5 ms
Coil current	3.984 A
Pulse width	25.4 ms
Aux contact	23.33 ms
Battery Vm	54.080 V
Battery impedance	0.029 R

68968F (Trip) 836-06 at 4299.1 mS

Operate time	47.1 ms
Coil current	6.612 A
Pulse width	33.4 ms
Aux contact	63.90 ms
Battery Vm	53.756 V
Battery impedance	0.062 R

68968F (Close) 836-06 at 14328.8 mS

Operate time	61.5 ms
Coil current	4.033 A
Pulse width	25.5 ms
Aux contact	23.48 ms
Battery Vm	53.974 V
Battery impedance	0.035 R

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How sub.net prioritises an event

event classification - - - - - - - - - -	internal (diagnostics) - - - - - - - - - - -
priority - - - -	priority - - - -
1 Station disconnected (Protection)	1 DEFAULTS button
1 Asset Fault	1 GPS sync off
	1 GPS sync on
2 Line fault - isolated locally (Protection)	1 Battery Power Low
2 Asset Warning	2 No Modem: cannot initialise
3 Line fault - downstream, partial loss of load (Protection)	3 No GPS
3 Line disconnected - no fault detected	4 various modem errors
4 Line fault - downstream (Protection)	5 Off Battery Power: Supply restored
4 Transient fault (Protection)	5 On Battery Power
5 Asset Maintenance	10 Meters reset by
5 Upstream fault - voltage dip (Power Quality)	
6 Unclassified	
7 Power/Frequency (Stability)	
7 Restoration of supply (Protection)	
7 Contact change (Protection)	
7 PQ limit excursion (Power Quality)	
10 Manual	

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Specification.

Inputs

Analogue inputs	12. Auto selected from VTs, CTs & transducers Monitor up to 3 individual circuits
VT input	150/300V RMS max. Phases isolated
VT burden	24mW (500kR)
VT isolation	2.5kV ac for one minute
CT input	via interposing CT (clamp, toroidal, etc.) Input voltage 1.4142V ac
CT range	Selectable interposing CT ratio Scaled for load or fault levels
Frequency response (-3dB)	30Hz – 3kHz (VT): DC – 3kHz (CT)
Sampling scheme	True synchronous sampling – converter per input
Quantising resolution	16 bits (65536 levels)
Accuracy	Better than 0.1% of full scale
Contact inputs	16. Two isolated banks of 8 inputs
Wetting voltage	24, 48, 110 or 220V dc. Polarity independent
Debounce time	1 – 10 ms

Recording

Waveform sampling rate	128 samples per cycle (6.4 or 7.68kHz)
Maximum recording time	60 cycles (up to 8 waveform files per event)
RMS/swing channels	Up to 84 (programmable)
RMS/swing sampling rate	50 or 60 samples per second
Maximum recording time	60 seconds
Trend log channels	~800 all recorded continuously
Trend log sampling rate	Max, min, avg values every 10 mins
Trend log duration	26 weeks rotating buffer
Continuous RMS channels	12
Continuous RMS sample rate	10 samples per second
Continuous recording time	14 days rotating buffer

Operating limits

Voltage	Max & min value with hysteresis, dip & surge level, ZPS, NPS, imbalance
Current	Rate of change
Frequency	Max & min value, Rate of change
Power	Rate of change

Real time clock

Crystal	Temperature compensated 32.768 kHz
Drift	Better than 4 ppm (~2 s per week)

Synchronisation	GPS (optional)
GPS 1PPS accuracy	500 ns

Communications

Modem baud rate	Up to 56,000 baud (V90)
Modem DTE rate	Up to 115,200 baud
Modem line isolation	3.0kV
Modem connector	RJ11
LAN data rate	10/100 Mbps
LAN protocol	TCP/IP
LAN connector	RJ45
Network services	HTTP, SMTP, Modbus, PMU

Data storage

Buffer storage	16Mbytes
Program and data storage	1024Mbytes flash memory

Status LEDs

Top panel	System OK (green) Battery OK (green) Event (green) Serial comms (orange) Disk access (orange) Comms error (red) Sync error (red) Attention (red)
Network connector	Rx packet (orange) Tx packet (green)

Interface functions

User interface (local or remote)	Web browser (Internet Explorer, etc.)
Event report delivery	Email, SMS or fax
Output data file format	COMTRADE (IEEE C37.111-1999)
SCADA protocol	Modbus (RS485 or TCP/IP)
Synchrophasor (PMU)	IEEE C.37.118 - 2005

Status relays

Outputs	4
Contact rating	400V dc, 1A continuous
Surge current	5A for 1 sec.
Isolation	3.75kV ac
Relay type	Solid state (IGBT)
Functions	System OK (N/C)

eMS

	Event detection (N/O)
	THD alarm (N/O)
	Attention (N/O)
Power Supply	
Standard Supply	110V & 230V ac 50/60 Hz
	125V & 250V dc
	24V or 48V dc (other options available)
DC Supply	3.0 kV ac
Isolation	External 12V gel cell
Battery back up (option)	2 Hrs (0.8Ah battery)
Battery support time	< 4W
Standard power consumption	
Enclosures	
DIN rail mounting	Symmetrical DIN rail
Main module size	225 x 110 x 75 mm (LXHXW)
Weight	0.65 kg
Input module size	45 x 110 x 75mm
Weight	0.63 kg (3VT&3CT)
	0.1 kg (6CT&1DC)
Wall mounted enclosure	Steel cabinet IP65
Size	380 X 380 X 174MM
Weight	11.5KG
Pole mounted enclosure	Aluminium AlMg3
Size	420 x 560 x 210
Portable enclosure	Yellow Pele 'suitcase'
Size	406 x 330 x 174 mm
Weight	5.2 kg
Environment	
Operating temperature	-5 to 60Deg C
Relative humidity	Up to 95% non-condensing
EMC	
Radiated immunity	EN61000-4-3 10V/m Criteria A
Radiated emissions	EN55011 Class A
Conducted immunity	En61000-4-6 10V/m Criteria A
Conducted emissions	En55011 Class A
EFT	EN61000-4-4
	Supply & contact input 2Kv Criteria A
	Voltage inputs 2Kv Criteria B
ESD	EN61000-4-2
	Contact discharge 4Kv
	Air charge 8Kv
NERC. Compliant	Meets cyber security requirements.
	(As detailed on website www.emsni.com)

Appendix 1

Recording modes

sub.net has four concurrent recording modes to provide data for its range of monitoring functions. The recording speeds and periods cover the range of variations that are found on the power network. The sampling rates are fixed and the durations and some recorded values may be adjusted to suit specific applications.
The waveform and RMS modes start recording when one of the inputs or derived quantities exceeds its defined operating limit value. Samples are recorded from a time before the limit was exceeded to sometime afterwards. A report is created for each event. This may include RMS and waveform plots as well as computed measurements.

Waveform recording

This mode records all the analogue and contact inputs at 128 samples per cycle. This is equivalent to 6.4kHz for a 50Hz supply and 7.68kHz for a 60Hz supply. All the inputs are sampled at the same time with no channel skew. The actual sampling rate is adjusted slightly to ensure that there are exactly 128 samples in every cycle and allows for the small variations in supply frequency. This maximises the accuracy of RMS, phasor and harmonic values derived from the waveform data.
The 12 analogue and 16 contact inputs are recorded in this mode. The maximum size of a waveform file is 60 cycles. These are used for high speed events like protection operations or power quality limit excursions. If there are multiple limit excursions there can be multiple waveform records in one event report.

RMS/Swing recording

A selection of up to 85 input and computed quantities are recorded at one sample per cycle (50 or 60 samples per second). These inputs are selected from the RMS inputs, phasors, frequency, power, power factor, sequence components and contact inputs. The data are used for longer events like recloser sequences and power and frequency oscillations. The maximum recording time for this mode is 60 seconds. The actual recording time is adjusted to cover the length of the event. Sub.net starts recording for a number of seconds before the first limit excursion and continues for some time after the last has returned within its normal range.

Trend log

The trend recording is a continuous log of over 800 measurements with the max, min and average saved every ten minutes. The inputs are the average values of the RMS inputs, harmonics, flicker, frequency, power, power factor and sequence components. The log contains the measurements from the previous 26 weeks. This is used for examining the load profiles and long term variations in power quality parameters. The ten minute interval is synchronised to the real time clock and is used to meet standards like EN50160, IEC61000-4-7, IEC61000-4-15, EN61000-4-30 & G5/4.

RMS log

This is a continuous recording of 12 key values at 10 samples per second. The input options are the same as those for the RMS recorder. The RMS log contains the measurements from the previous 14 days. This creates a large amount of data and small intervals may be examined for small measurement variations which were insufficient to create an RMS record.

eMS

Appendix 2

sub.net meets Smart Relays.

There are some fundamental differences between sub.net and a relay. A protection relay has one critical function to perform; to protect the network. Everything else is secondary to that. Relays have to operate very quickly whereas recorders can leave any analysis until an event is complete. One of the main reasons that fault recorders were created was to monitor the protection system. If there is a problem with a relay then it is critical that the event is recorded so that the problem can be analysed and rectified. If the recording function is inside the relay then there won't be any record of the event. Admittedly this is a very exceptional event but it does happen and is worth investing a small extra amount just to ensure that any relay failure is captured.

As you know one of the key features of sub.net is that it analyses, classifies and reports on its own events and sends formatted event reports via email directly to users. This functionality is entirely missing from the relay specification. Like almost all relays, PQ meters, recorders and other IEDs it just sends raw data back to some master station where users have to interrogate the system to uncover the information that they want.

The relay has a very limited recording function and non-volatile storage. It only offers waveform recording and the maximum recording time is 60 cycles for each event. The relay includes a 4 shot recloser function so a protection event could last over 40s which the relay would capture as 4 short events whereas sub.net will capture the whole event as one report with an RMS overview and 4 or more waveform graphs. Sub.net also includes the RMS log and trend recording modes which are both continuous and these are used for energy trending, power quality, stability events, etc. The relay has none of these functions.

The relay has a very limited PQ function which is limited to harmonics up to the 16^{th}. sub.net records harmonics up to the 50^{th} and can generate harmonic trend reports for up to 6 months against standard limit tables. Sub.net also records flicker (Pst and Plt) and analyses voltage dip events within the event reports. Voltage, current, power and frequency are also available in trend reports.

The relay has a very limited recording capability with none of the event analysis and reporting functions of sub.net. The relay is not a substation monitor and sub.net is not a relay. The two devices should be treated as complimentary where both are required to protect and monitor an electricity network.

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Appendix 3

Modbus, DNP3 and SCADA

The RS485 port on sub.net is used for connecting to a SCADA or RTU network using the Modbus / DNP3 protocols. An internal link may be fitted to insert a 120R termination resistor across the receive pair for the last connection on a bus.

Sub.net can provide real time measurements of over 800 measured quantities and indicators via the Modbus protocol. This is available on both the RS485 and the Ethernet ports. Sub.net supports both TCP and RTU over TCP. The serial baud rate, slave address and TCP/IP type are configured on the Modem, Modbus and DNP3 configuration page.

The available data include:-

- Present analogue and contact input values
- Phase voltages, currents, powers and accumulated energy per circuit
- Accumulated cleared current and I^2t values per phase for each circuit breaker
- Trip and close coil pulse measurement ranges
- Tripping battery voltage and source impedance ranges
- Most recent fault type, level and fault impedance with the circuit number.
- The Modbus register map is available on the eMS web site. www.emsni.com

This gives customer's SCADA systems full access to all of sub.nets attributes as well as our unique e-mail notification features.