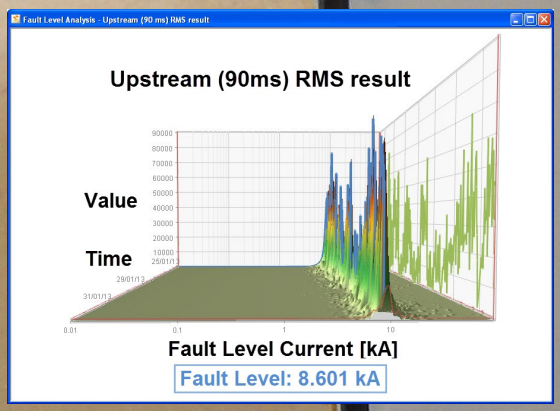
Analysing Network Power Intelligently with The Ranger PM7000 Fault Level Monitor

Use real Fault Level results to give you better visibility of your network.

- Predict the actual Fault Level on your network.
- Verify your Fault Level safety margin.
- Make sure your breakers are rated highly enough.
- Observe changing Fault Level due to Distributed Generation.

The PM7000 FLM can determine the Fault Level on radialised networks at any voltage level by passively measuring natural disturbances.



WINNER beea 2012 british engineering excellence awards

11/10/2018

Outram Power Master 7000 FLM (PM7000 FLM)

Three Phase, High Speed Fault Level Monitor with Flicker and Harmonics

Validated by UK Distribution Network Operators

Trials carried out with SP Energy Networks have verified better than 3% accuracy.
Get real time fault level values, composite results over selectable time periods and trends over time. Confidence weightings on each result generated give you reassurance in your Fault Level Values.

Determine the Peak and RMS Fault Level on your network

Validate your existing fault level values or generate new values for areas where it's been too difficult or costly in the past.

Wireless Communication

Use behind closed doors. Bluetooth, **PMGateway** and Ethernet enable remote communications including data download to your inbox, visibility of live results and remote control of your PM7000FLM.

Simultaneous Power Quality Recordings

Record >470 channels of PQ data automatically every recording.
Record 32 detailed troubleshooting channels down to a single cycle using Single Cycle Adaptive Store.
Record Waveforms on all inputs using our intelligent Auto-Ranking Waveform Capture technique.

Fast Download

Download data automatically to the unit or a Memory Stick (no max. size) or via the USB port. Optional Ethernet allows remote communication, both for unit control and data download, via your network.

Solid and Weatherproof to IP65

Feel confident that your PM7000 FLM can be left in a windy/damp substation for years with no adverse effects from the weather.

Colour Coded Inputs

Each unit is colour coded to help you, taking the confusion out of hooking up your unit.
Different colour combinations available for EU, USA and Asian / Australasian customers.

Completely passive, portable and easily deployable

Simply hook up for a single or 3 phase measurement on a Radial or Interconnected network with radialised sections as you would a PQ analyser.

Ranger PRODUCTS

designed and manufactured in the UK by

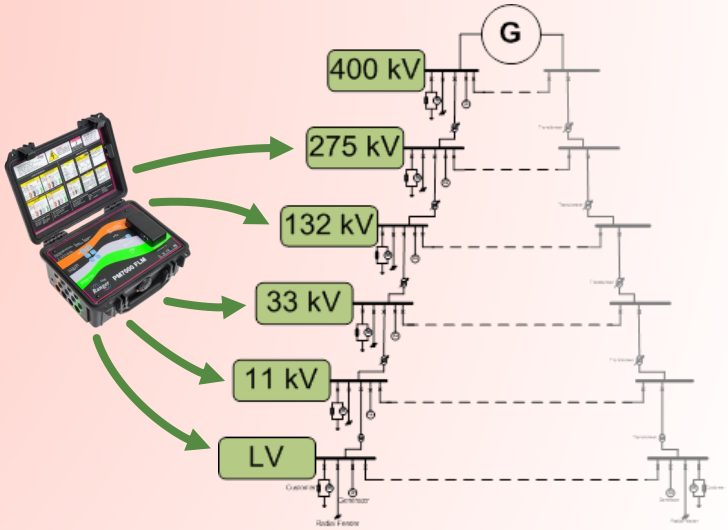
Technical help: support@outramresearch.co.uk - +44 (0)1243 573050
Sales enquiries: sales@outramresearch.co.uk - +44 (0)1243 573050

The Ranger PM7000 Fault Level Monitor

Operational Uses

- **Validate your existing models:** Confirm all sources of fault current are included in your predictions to make sure breaker ratings are adequate.
- **Give un-modelled areas a value:** Obtain fault level values for areas of the network where models don't exist or it's difficult to obtain them, e.g. sections of the 11kV or Low Voltage network.
- **Establish local fault level:** Measure the fault level at the point of common coupling (PCC) to enable accurate assessment of the impact of harmonic emissions for Engineering Recommendations such as G5/4 and G59/2.

Use the PM7000 FLM to predict the fault level from Low Voltage supplies up to 275kV networks.



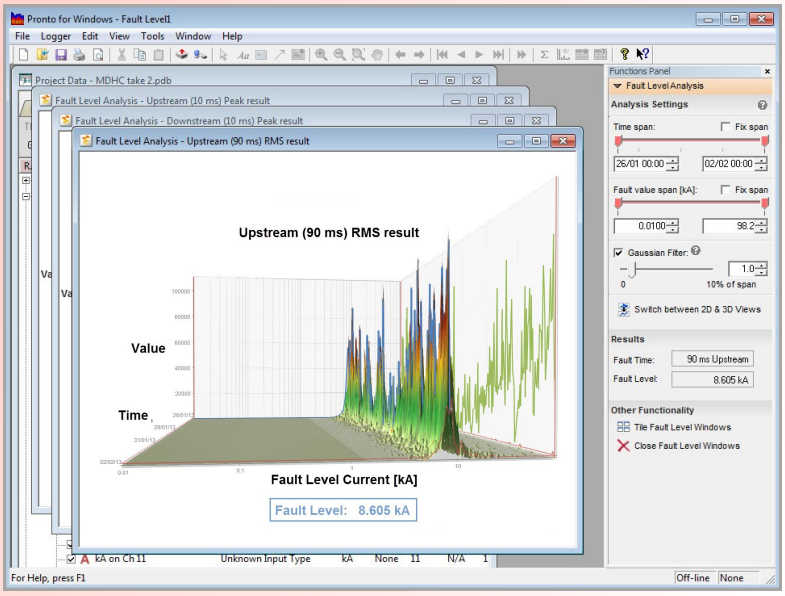
Immediate Benefits

- **Be alerted to underrated breakers.**
- **Optimise management of network interconnections:** Find out if it's possible to make connections where previously thought to be restricted.
- **Plan for additional load with more certainty:** Better predict the effect of harmonic emissions e.g. with respect to G5/4.
- **Save money through improved regulatory performance:** Use accurate monitoring to plan maintenance more effectively and remove perceived fault level issues.
- **Let your equipment work longer:** Help the environment and save money by not performing unnecessary fault level upgrades.
- **Increase renewable generation connection:** Measure the real impact on fault level enabling faster connection.

3D Data Analysis: Pronto

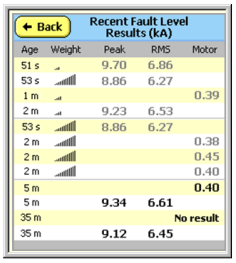
- **Predictions:**
  - Peak Fault Level at ½ cycle (10ms at 50Hz, 8.33ms @ 60Hz))
  - RMS Fault Level at some later time, typically 90ms (selectable)
  - Motor contribution at 10ms (8.33ms).
- **Live Results:**
  - Composite Fault Level results
  - Real Time Fault Level results
  - Fault Level Trend over time

N.B. Performance of the PM7000 FLM is based on the strength and the type of disturbances observed on the network, therefore if no or only very small disturbances are observed (< 0.15% on voltage) then no results can be generated.



Fault Level Prediction & Power Quality in one

- Predicts Fault Level on Radial and Interconnected Networks (must be in radialised sections).
- Generates Peak (10ms) and RMS (selectable, typically 90ms) Upstream and Downstream motor contribution (10ms) measurements

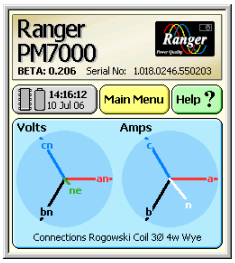


- Real time Fault Level and Power Quality results can be viewed wirelessly on Android Tablet or Mobile phone or via your internal network (Ethernet).
- In addition to Fault Level data recorded, the PM7000FLM records 32 channels simultaneously with single cycle resolution on disturbances due to our exclusive, patented Single Cycle Adaptive Store™. Records for up to a year at this rate.
- Records > 470 channels of general parameters in 10 minute (or user specified) increments.
- Auto-ranking Waveform Capture means time taken to analyse data is greatly reduced.

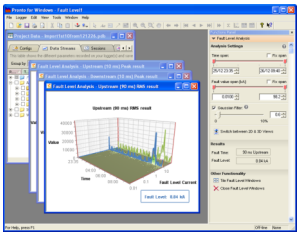
Fault Level, routine power quality measurements, troubleshooting & waveform capture all recorded simultaneously.

- Waveforms recorded include transients, sags, surges, notches, rings, THD and TH current.
- Extended Waveform Capture can record disturbance waveforms for up to 60 secs.
- Gives unprecedented detail due to superior sampling speeds.
- Reports to the Standards.
- G5/4 Harmonics surveys automatically generated in companion Software, Pronto.

- Virtually unlimited memory and zero download time! The unit can automatically download data after each recording session to USB stick. Record for weeks at a time.
- The first analyser to include the required Instantaneous Flicker Sensation output. Provides authoritative Flicker measurements to IEC61000-4-15.
- Harmonic Direction shows if Harmonics are upstream or downstream of the point of measurement. Also measures individual Harmonics and THD to the 50th. Interharmonics and individual harmonics to the 127th are optional.
- Over 200 MB of on-board data storage plus USB Flash.
- Comes with 12 pre-stored configurations. Just choose one using your portable device or PC, or program your own with the included software, PMScreen.
- Stores up to 200 configurations on board. Eliminates the need to program on site. Just choose a configuration, press Load and Start.
- Phasor Diagram Display ensures correct hook up and shows the phase relationship of individual harmonics, NOT just the fundamental.



- On-screen HELP guides users through configuration and hook up.
- Memory Expansion Port, unlimited size.
- Sampling rate: 384 samples / cycle @ 50 Hz
- Records automatically at 50 or 60Hz.
- The Cat IV 600V Phase A powered unit comes with our comprehensive, straight forward, analysis software, Pronto for Windows, at no extra cost.



Tablet or mobile phone included with every unit, showing via PMScreen:

- Analyser status,
- Live screens for waveforms,
- Harmonics,
- Interharmonics,
- Trends,
- Disturbance Incidents
  - 3D Bar Graph,
  - ITIC (CBEMA),
  - Severity Duration v Time,
- Phasor diagrams & many more.

PM7000 FLM Kit

- Ranger PM7000 Fault Level Monitor
- Four 24" 6000 Amp Flexible Current Clamps (max conductor size 8"), braided
- Four Low current CT O-10AMPS (0 to 10Amps equals 0 to 1Volt)
- Five Voltage Probes 600V Cat IV (1000V Cat III), braided
- Five Voltage Extension Leads
- Three Neutral Common Leads
- Mains Lead & USB Lead
- Pronto for Windows Analysis Software
- Customer CD with Operation Manual
- Android Tablet /Mobile Phone
- Customised Bag with Tool Roll (solid case in picture optional)

Single Cycle Adaptive Store™

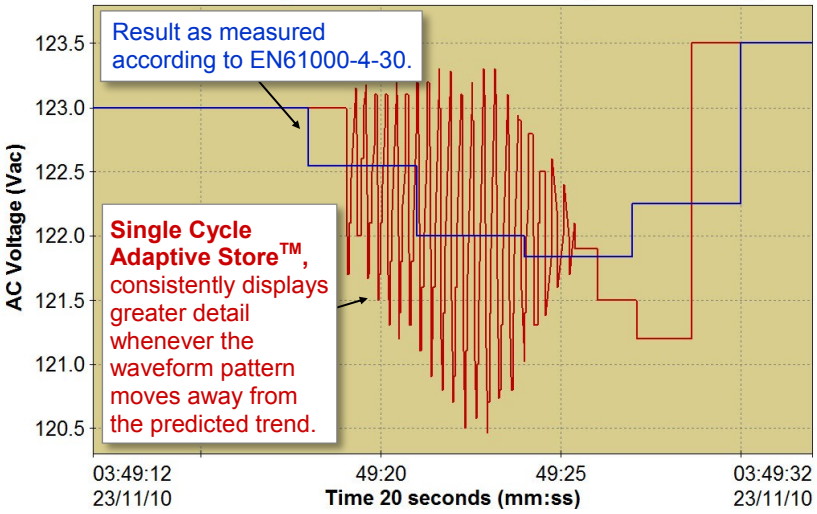
Adaptive Store is our patented compression technology available in all PM Series Analysers. It automatically records the chosen parameters in great detail and at high sampling rates when anomalies and deviations from the predicted trend occur.

Adaptive Store is designed to make the best use of available memory, whilst meeting two conflicting requirements:

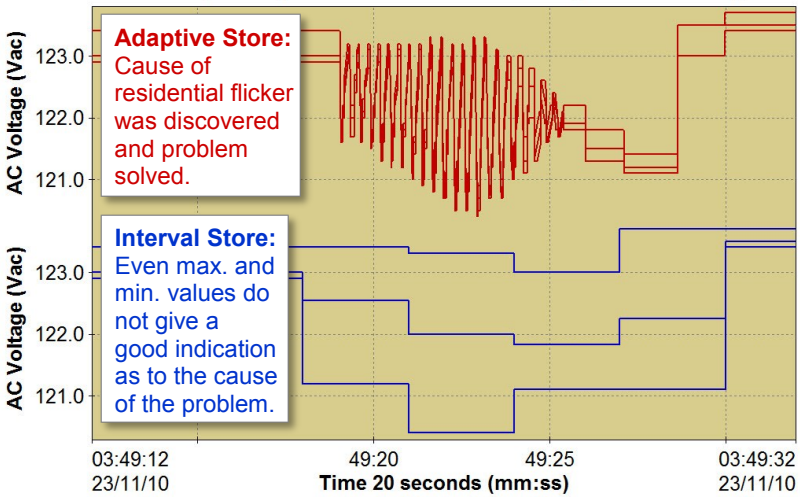
- to provide long-term trend data, observing the worst extremes of max and min values, and;
- to provide detail where new activity occurs, i.e., detecting and capturing sudden changes.

Adaptive Store assesses signal conditions in real time without having to set thresholds. The only required user parameter is the total time of the recording.

Outram's Adaptive Store vs. Interval Store (3 sec averages) of Van



Max, Min and Average of Van: Adaptive Store vs. Interval Store



Adaptive Store recognises the unpredictability of future signal activity

This unique method of *anticipating* the possible signal path has many advantages. For example:

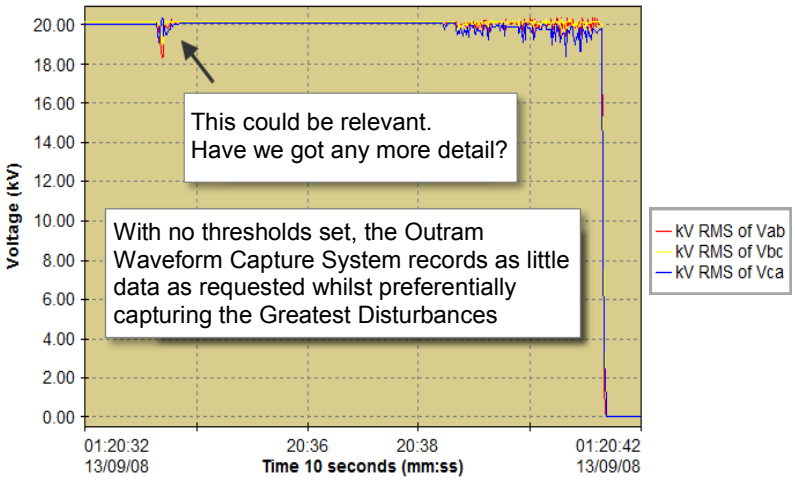
- it allows for immediate reaction to transients capturing the entire duration of the disturbance, and;
- it works with extremely long recording periods.

By automatically adjusting the thresholds distinguishing the anomalies from the trend as signal dynamics change or the available memory becomes full, Adaptive Store ensures that less significant phenomena can be summarised and greater detail recorded for abnormal behaviour.

The Single Cycle Adaptive Store™ recording mode is the most powerful automatic data compression system available in any data logger on the market.

Auto-Ranking Waveform Capture

Voltage transient occurs 8 secs before voltage collapse



Outram's Autoranking Waveform Capture is designed to manage any waveform data measured by the PM7000 FLM.

It tracks and ranks multiple categories of sub-cycle transient and other problem event types, such as sags, surges, notches and rings. It then discards smaller events when larger ones occur.

This automatic real time data management process has these advantages:

• It fills the allocated memory at the start of a recording with anything the analyser sees, then discards the least interesting disturbances, as more 'exciting' ones come along.

• It captures the best, most revealing events without any prior knowledge of what might happen. **Setting thresholds is not necessary** (though the option is present).

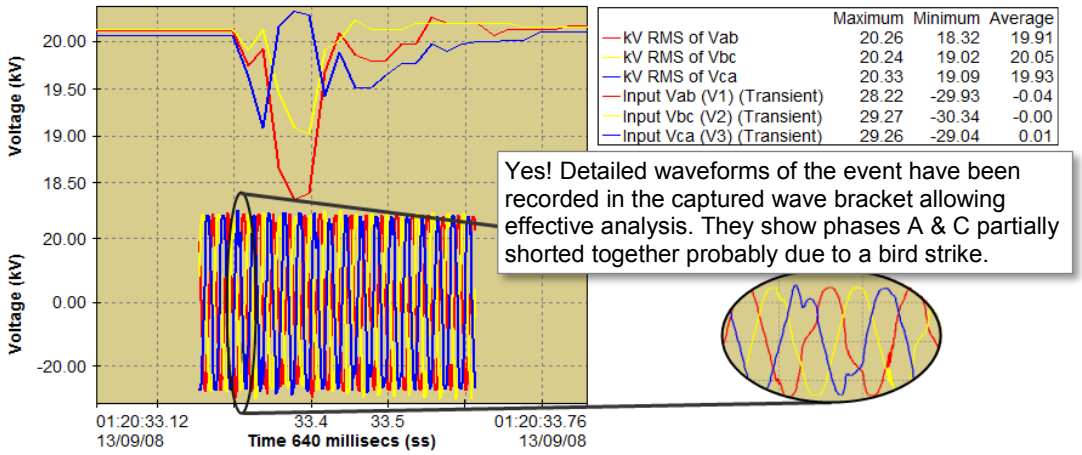
• It increases the quality of data at the same time as reducing volume, consequently speeding up download time as well as making data review easier.

• It works equally well over short and long recording periods.

• It is continuously re-triggerable and does not require re-arming.

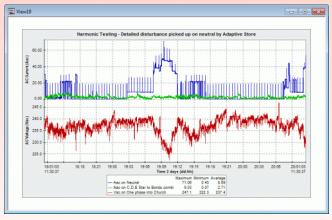
The waveforms captured are normally up to 2 cycles before the event and up to 5 cycles after. However, captures may be extended up to 60 seconds after the event with different extensions for individual triggers.

Voltage transient occurs 8 secs before voltage collapse



STANDARD REPORTS

Generate automatic G5/4 Harmonics reports & graphs/ tables suitable for EN50160 reports.



Sample Graphical Data of Voltage & Current

UPSTREAM OR DOWNSTREAM?

Our Adaptive Store recording regime can deliver enough detail to indicate whether a disturbance is coming from upstream or downstream from the measurement point. Work it out from the relationship between the voltage and current data streams.

COMPARE LIKE WITH LIKE?

From your own recorded data in Pronto you can load the same configuration back into the analyser to record the same measurements again and again.

TECHNICAL SUPPORT

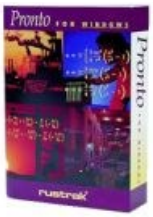
Technical support is available from those who either designed the unit or have over 25 yrs experience with the Ranger and PM series.

Who better to instruct you on how to make the most of your analyser?

Exclusive Software, Pronto for Windows

How to make the most of all your recorded data:

Use our **Pronto for Windows Software**, the best graphing software on the market for use with all PM Analysers



INTERACTIVE

All Fault Level prediction data can be viewed on an 3D graph showing Fault Level against Time and Result Weighting (Value). Move the graph to get the best view. Adjust the recording time bracket in Pronto to identify different fault level populations.

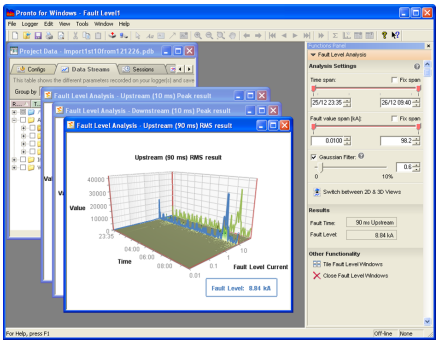
EASY TO COMPARE

Relate results to voltage and current activity. Is this really the worst case scenario? Is all machinery that could contribute to fault level running at the time of the recording?

REAL TIME DATA

Observe real time peak, RMS and Motor Contribution Fault Level results, waveforms, harmonic spectrums and up to 32 parameters of power quality data using wireless Bluetooth, connection to your PC or over your local network using Ethernet.

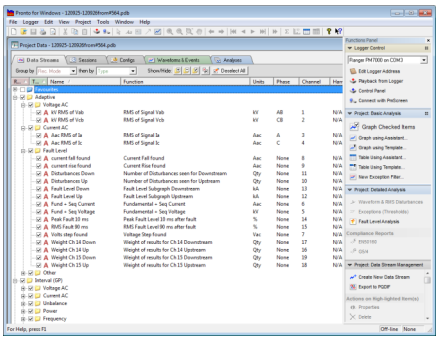
Pronto for Windows is a full-featured, Windows based program designed to extract data from the Power Master series and present it either graphically or in tables for straightforward analysis.



Sample 3-D Graphical Representation of Fault Level Data

Pronto for Windows is the only program you will need to communicate, analyse, report, and manage your Fault Level or Power Quality data (as well as configure the analyser itself).

Through the use of easy to follow 'assistants' and pre-loaded templates, create graphs and tables for emails and hard copy reports simply and quickly. Manage and save your favourites to create the same graphs recording after recording.



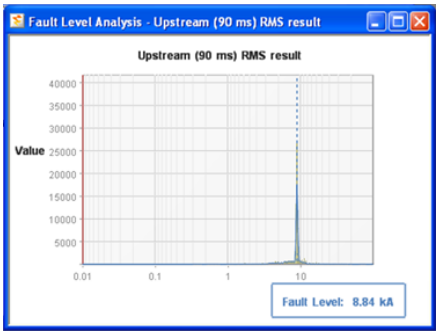
Pronto for Windows Project Browser

The selection of icons on the toolbar makes all commonly used instructions such as zooming, statistical analysis, annotation, downloading, and printing as easy as pointing and clicking the mouse.

Simply 'copy & paste' graphs into any word processing program and export tables straight to Excel or PQDIF for further analysis.

Pronto Features unique to the FLM:

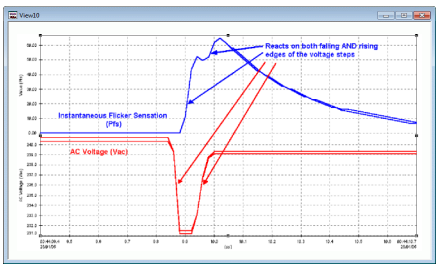
- Interactive 3D graph for data analysis
- Perform a Gaussian Filter on your results
- Adjust the time span for result prediction
- Switch between 2D and 3D views



Sample 2-D Graphical Representation of Fault Level Data

More General Pronto Features:

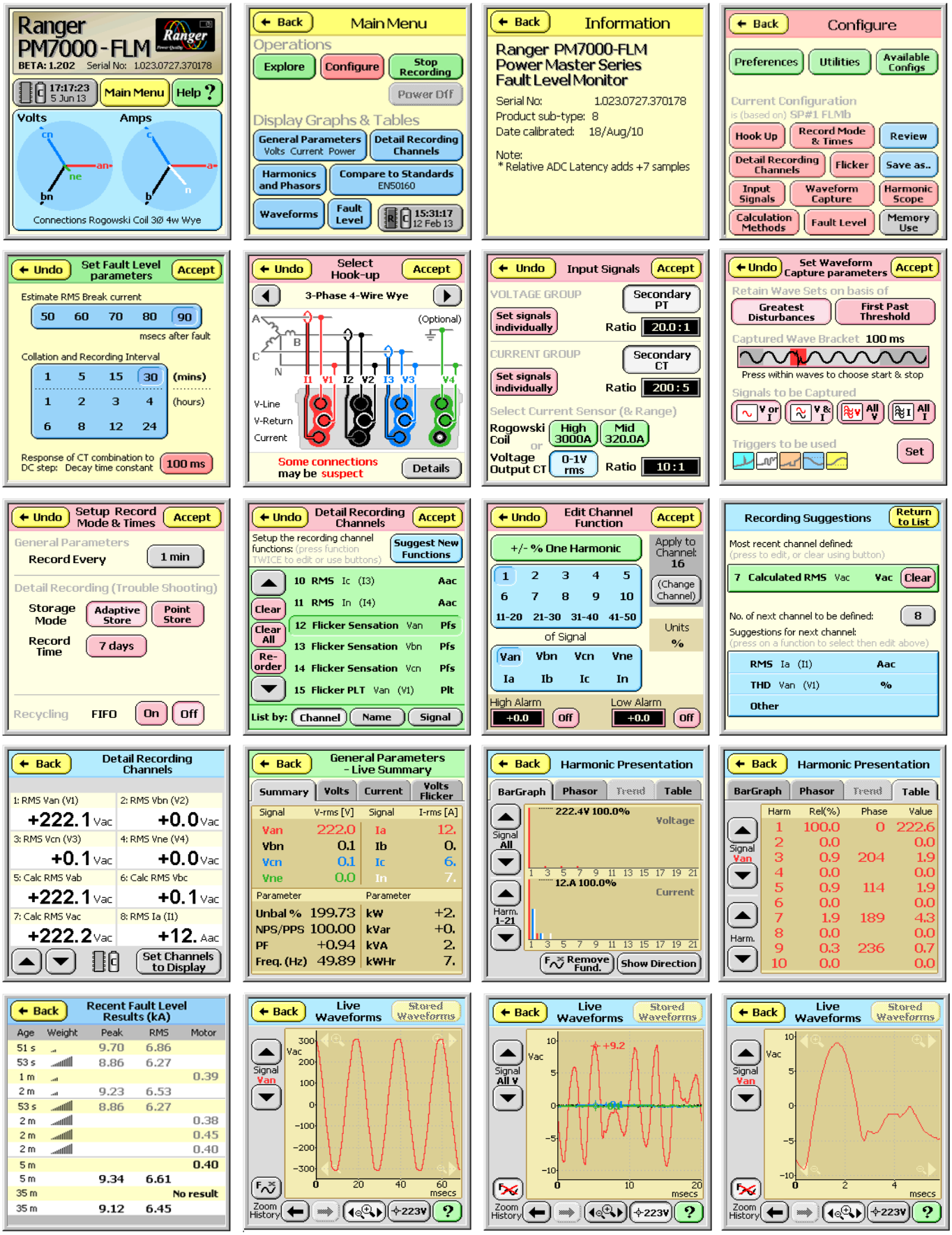
- Analyser configuration is saved with data for retrieval any time
- Easy file management tools
- Watch our video tutorials on-line
- Reporting Tools:
  - Automatically generated G5/4 Harmonics Survey reports
  - Exceedence reports
  - Summary statistics
  - Tabular listings
  - Custom reports saved as templates
- Unlimited traces on a screen
- Arrange traces on any axis, full freedom of editing on all aspects of a graph
- A comprehensive, context-sensitive help system.



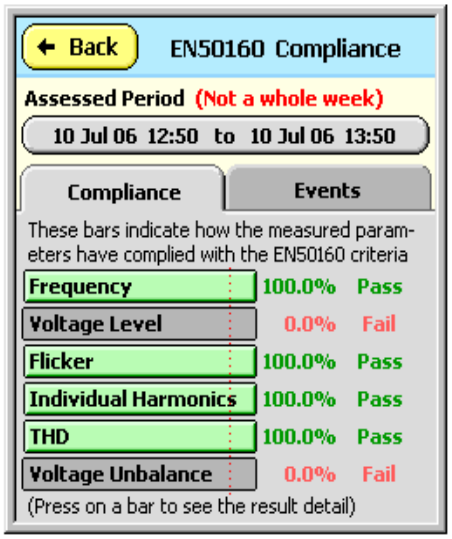
Analyse detailed data that Single Cycle Adaptive Store™ has captured automatically

Sales enquiries: sales@outramresearch.co.uk +44 (0)1243 573050
Technical help: support@outramresearch.co.uk +44 (0)1243 573050

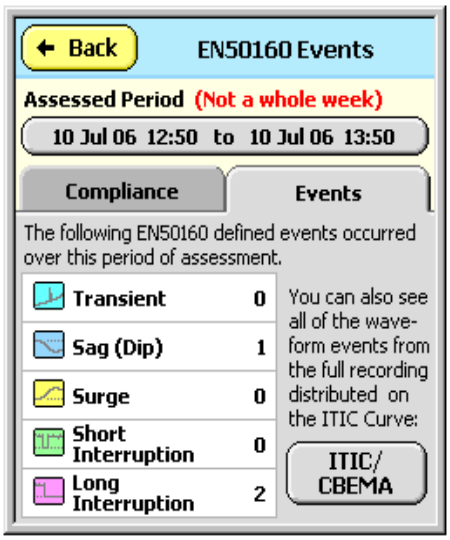
Example Screens of the PM7000 FLM



PMScreen example screens cont.



Screen a)



Screen b)

Compare vs. the standards

Recorded results may be compared against various standards, for example EN50160, the European Public Voltage Supply Characteristic.

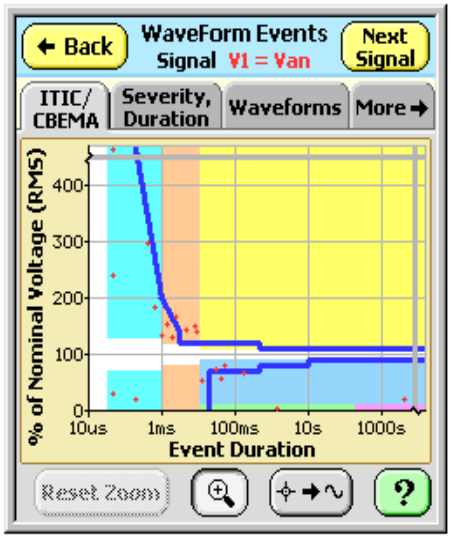
The screens here show examples of Screen a) the summaries for compliance of the supply during the assessed period, and Screen b) the number of specific events.

For both of these screens the assessment period can be adjusted.

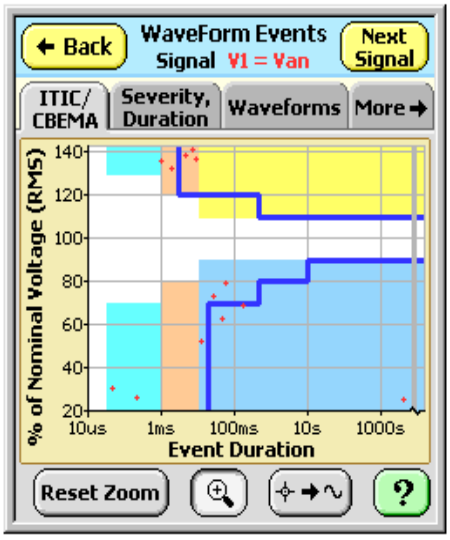
View data in multiple forms

ITIC (CBEMA) Curve

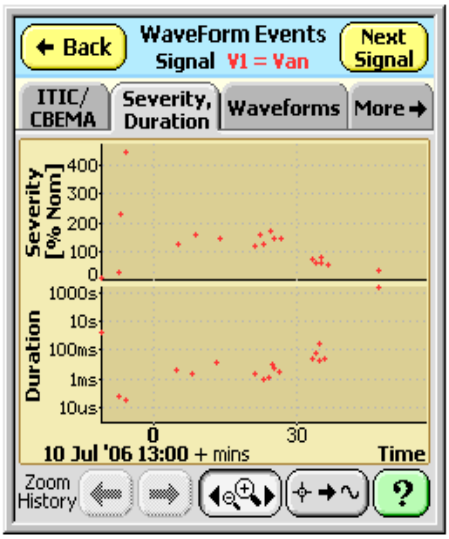
The screens to the right and below show different ways of presenting recorded event data, Screen c) is the conventional ITIC (CBEMA) presentation. This graph can be zoomed (d) to distinguish elements of a cluster, then the relevant waveform can be displayed.



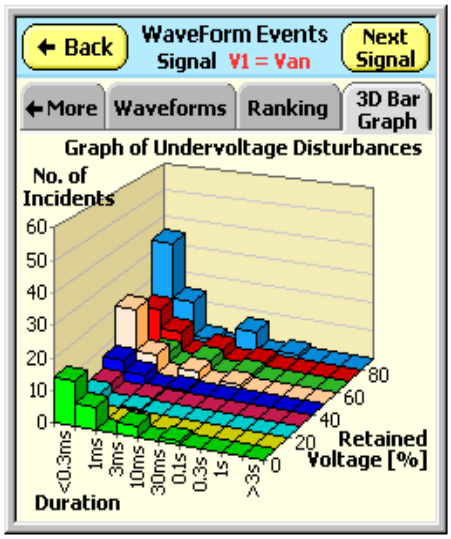
Screen c)



Screen d)



Screen e)



Screen f)

Severity / Duration Curve

Screen e) shows event severity and duration against time for the recording. This too can be zoomed in.

3D Undervoltage Disturbance Graph

Screen f), the 3D Undervoltage Disturbance Graph, shows how serious the supply disruptions have been in terms of an industrial process being disturbed.

Remember that sags/dips may effect processes more seriously than complete outages.

Ranger PM7000 FLM Specification

Input Voltage: 4 input channels. 0-600Vac or 0-1000Vac (if internal AC power supply disconnected). Sensors: In-line shrouded 4mm banana sockets. Fused voltage leads, crocodile clip.

Input Current: 4 input channels. Sensors: Two ranges on two types. Menu Selectable Rogowski coil 0-6000A, 0-400A, or Voltage Type 0-1 Vac. Safety BNC Socket. Phase reversal in software.

Recording Regimes - Fault Level Measurement

Fault level estimation: Obtained from disturbances seen by the normal measurement process. Results presented as probability distributions in Pronto, and as aged, weighted results in real time via Display device.

Hook-up: Operates on 3 phase or single phase hook-ups (not 3 phase hook-ups where assumptions are made e.g. 3 phase 2.5 element).

Disturbance types exploited: Natural or artificial, symmetrical or asymmetrical. System can exploit disturbances as little as 0.15% voltage variation and down to less than ½ cycle in length. Must be downstream (e.g. load changes) for Source Fault Level estimation, and Upstream (e.g. Tap changes) for Motor Contribution estimation.

Parameters recorded and reporting times:
Peak "Make" current: Reporting time after fault fixed at ½ cycle.
RMS "Break" current: Reporting time after fault selectable from 50 to 90ms.
Motor contribution current: Reporting time after fault fixed at ½ cycle.

Result collation interval: selectable 1 minute to 1 day. Up to 4096 interval data sets can be recorded (> 3 months at 30 minutes/interval).

Accuracy: Not specified. Depends on quality and quantity of disturbances seen. Typically better than 3% given numerous, abrupt voltage disturbances of >0.5% on a stable network.
Current resolution 0.01kA in real time display. (Finer resolution available in Pronto)

Fault level also available as a Power figure (MVA) in Pronto.

Recording Regimes: Power Quality

Four distinct simultaneous recording systems:
Waveform capture: Sampling at 19.2k samples per second on all inputs.
Troubleshooting/Trends: Utilising the patented single cycle Adaptive Store™ to capture comprehensive detail over long recording periods on up to 32 selected parameters.
General Parameter Analysis / Trends: > 470 parameters recorded automatically and simultaneously enabling reporting to recognised Standards.
RMS Event Database: Monitoring for 'official' power quality events such as sags/surges/ interruptions.

Configurations: Space for over 200 files. These may be used for configuration or recording sessions.

Accuracy: 0.2%. 0.1% in reference range 20-30°C (excluding sensors). +/-2LSB.

Resolution: Programmable to 0.1 Vac and 0.1 Aac, 0.01V high resolution mode.

General Parameter measurement: Records automatically. Fixed functions recorded on (selected) intervals. (1 sec to 2 hours). Voltage & Current RMS (Max, Min, Avg). THD / Harmonic Value (8 inputs), Flicker (3 Voltage inputs). Power (kW, VAR, AP, PF), Individual Harmonics 2-50 (8*50 signals on Volts and Current) or optional choice of 2-100 (4*100 on Volts or Current). Unbalance.

Troubleshooting maths functions:
***AC Single Phase Installation*:** RMS, Stray Voltage RMS Hi Res < 35V, (line-neutral, line-line where appropriate). Real power W, Reactive Power VARS, Apparent Power VA, Power Factor PF, Displacement Power Factor, Phase Angle, Frequency, Instantaneous Flicker Sensation, Short Term & Long Term Perceptibility, Flicker Flag, Distortion Power.
AC 2 (split) Phase Installation: Real Power, Reactive Power VARS, Apparent Power, Power Factor.
***AC 3 Phase Installation (Delta, Wye and variants)*:** Real Power, Reactive Power VARS, Apparent Power, Power Factor, Voltage Unbalance, (Conventional & Sequential Components), Current Unbalance. Distortion Power, Positive Sequence Fundamental Real & Reactive Power (IEEE1459).
***Harmonics*:** Odds, Evens, Triplens, Individual Harmonics value and % and Harmonic Direction to the 50th, K Factor, % Total Harmonic Distortion, Total Harmonic Value.
Symmetrical Components: Positive, negative, zero sequence: NPS, NPS/PPS (Voltage and Current), ZPS, ZPS/PPS (Voltage).
Other Maths Options: Channel X * Constant, Channel X / Channel Y, Filtered Channel X, Internal Temperature, On Charge, Battery Volts.

Waveform Capture: Sample rate - 19.2ks/s (~ 384 samples/cycle at 50 Hz) on 8 channels. Events examined, Ranked & stored in real time.

Ranger PM7000 FLM Specification cont.

Selectable waveform parameters:
Wave Retention Basis: Greatest disturbances (automatic ranking and low rank discard) and first past a threshold.
Capture wave bracket: Wave Sets: from 20ms up to 60secs. Can be contiguous; no re-arming.
Signals to be captured: offending wave / complementary current or voltage, All Voltages, All Currents.
Triggers to be used: Transient, Ring, Notch, Sag, Surge, THD Volts, THD Current.
Wave Allocation: Waves allocated across trigger functions.

Sampling:
PM7000S (Standard) 19.2k Samples per sec (Automatic tracking 45 to 65Hz).

Memory: 128MB Flash memory for all files. 32MB RAM for high speed waveform capture data, 64MB working RAM. Expansion with USB Memory Device.
Firmware (program memory) - Flash upgradeable 2MB
User Preferences - Stored in non-volatile Flash Memory.

Portable Device Requirements for PMScreen and PMGateway: Android or Windows compatible.

Data Retention: During recording sequential data is saved to Flash memory. Waveform capture data is held in RAM and transferred to Flash memory when recording ends. Configurations etc. stored in Flash memory.

User Interface via remote screen: PC via Bluetooth or USB running PMScreen, or tablet/mobile phone/ netbook (provided) via Bluetooth running PMScreen. Setup/Configuration and Data Review via remote screen. Data analysis using Pronto for Windows. Automatic download to USB stick.

Displays On PMScreen: Power & Energy, Waveforms, Harmonics, Phasors, Harmonic Phasors, Trends, Statistics, List of Channels. Comparison to Standards. Interharmonics (optional).

Communications:
Bluetooth: Wireless interface (isolated).
PMGateway App.: Enables Android mobile phone to act as a Gateway. Send data files to your inbox or dropbox, start and stop recordings.
USB: Memory module interface (non-isolated).
USB: Serial interface to PC (isolated > 2.5kV) download to PC & control through Pronto for Windows.
Protocol: MODBUS ASCII.

Power: Requires 100-600 VRMS, 15 W Max from Phase A voltage measurement (40 - 64Hz Rated power consumption 11Watts) or separate power supply @12Vdc, 6 W.
Burden: Normally <10 VA from Phase A. If a charger is used the Power Supply is automatically disconnected from Phase A (input impedance per phase 32MOhms).

Battery Capacity: 2100mAhrs (5 HI-Temp NiMH batteries).
Battery Ride Through: Ten minutes at a time.

Charge Method: From V1 input or from 12V Wall Charger (auto switching).

A/D Converters: 24 bit at 19.2 kSps, top 16 bits used normally for harmonics, power & energy, flicker.

Measurement & Reporting Standards:
IEC 61000-4-15, IEC 61000-4-7, IEC 61000-4-30, IEEE1453 (Flicker), IEEE1459, IEEE100.
Report to EN50160, G5/4.

Safety Standards: IEC 61010, (600v Cat. IV, pollution level 2, 1000V CAT III if PSU fuses removed), CE Fused voltage leads (lead fuses 500mA, 700V, 50kA rupture current), IEC 61326 (EMC).

Internal fusing: PSU (x2), Charger input, Battery stack, Internal Thermal Switch (x2).

Computer Requirements for Pronto Software:
Windows 2000, XP, Vista, 7, 8, 10; 250MB hard drive space.

Case: Pelican 1150 Guard Box: Dimensions. 22.9 x 19.1 x 11.0cm.

Weight: 3.5 kg. without leads and clamps.

Operating Temp: -20ºC (-4º F) to 60ºC (140º F).

Environmental: **IP65.** Main unit will tolerate momentary emersion when lid sealed. Leads and their connections are not watertight and for safety reasons we strongly recommend that the operator does not connect and disconnect the unit in wet environments.

Applicable Patents: 6424277, 0230712, 4910692. Further patents pending on Fault Level Measurement.

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Outram also make Power Quality Analysers specifically designed to troubleshoot power quality issues.

Download datasheets for the PM7000, PM7500, PM3000 and PM1000 from www.outramresearch.co.uk

Fault Level Prediction

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