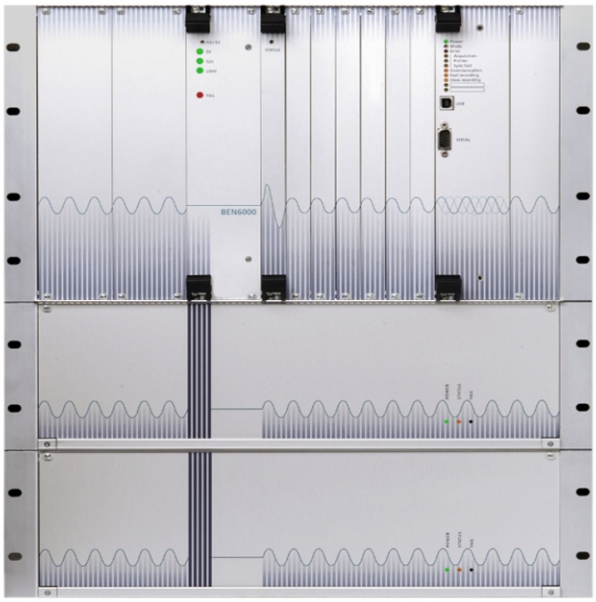
Multi-function Intelligent Electronic Device
BEN6000

Ultimate in the field of high voltage monitoring, the **BEN6000** can easily spread its measurement points throughout your high voltage universe. Grouped into one structure, it shines by its accuracy, and the variety of measurements and sizes one can configure it for.

- **Multi-Function (DFR, DSM, Cont. Rec, PQM)**
- **16-bit data acquisition at 10 or 12 kHz**
- **Triggered (2 speeds) + continuous recordings**
- **Centralised, decentralised[1] architecture**
- **Standardised IEC 61850 communications**
- **Up to 192 Analog inputs and 384 Digital inputs**
- **Up to 200 Derived quantities (virtual channels)**



General

Measuring System

Revolving around a powerful multi-tasks and real time operating system embedded in its core, the easily distributed architecture allows the complete overview of a high voltage environment from a single, extremely dependable and accurate, stand point.

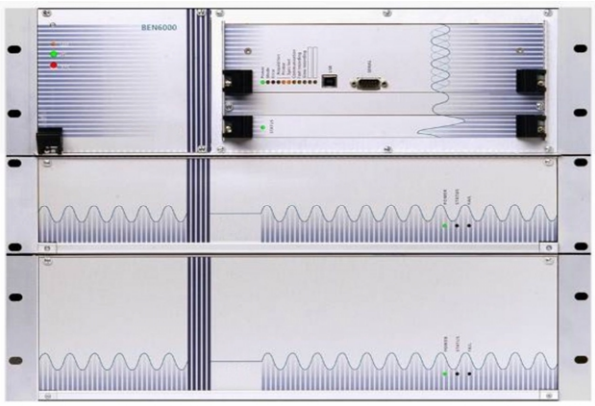
A distributed **Digital Fault Recorder** with state-of-the-art resolution (16bits) and accuracy (0.1%) can be deployed with minimal intrusion and maximum communication into the protection panels (**R**emote **A**cquisition **U**nits for 8 voltages and 16 Digitals are as small as 89mm (3.5”) high). The system channel capacity allows the monitoring of the widest applications.

A compact **Dynamic Swing Monitor** allows the combination of any inputs to create derived quantities[2] to trigger long duration records for system stability or power flow analysis or generator monitoring.

A **Continuous Recorder** providing more than one month worth of recording independently from eventual triggering conditions.

A comprehensive **Power Quality Monitor** elaborating and compiling the Power Quality profile of the connected signals and offering them for restitution in a standardised fashion. The BEN cross triggering capability allows fast (DFR) and/or slow (DSM) signals recordings to happen upon a PQ event, significantly easing identification of its origin.

Application examples



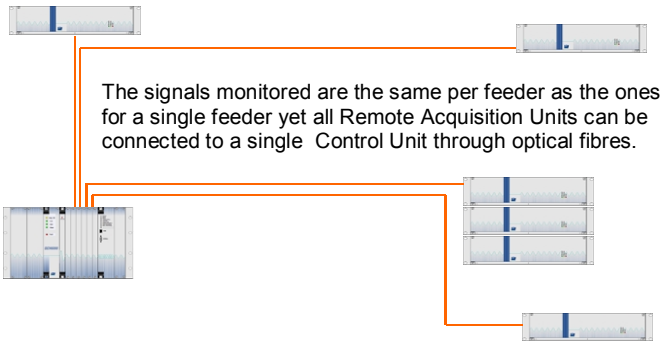
- **Single feeder monitoring (BEN6000)**

Speed	Signals	Triggers	Comments
Fast Analog	3U & 3I, V_0	>I, <U, V_0,	Line fault
Fast Dig.	Brkr pos, Prot. trip	Dig Edge or level	
Slow Analog	P, Q, F, Urms	dP/dt, dQ/dt, dF/dt, Freq, <U	System collapse, Swing, Power flow monitor.
Slow Dig.	Bkr pos. Prot. trip	Prot. trip	
Continuous Recording	P, Q, Urms		Proof of service

[1] Up to maximum 3 km
[2] Derived quantities may be recorded by the fast **DFR** and/or slow **DSM** and/or **Continuous Recording** functions

QUALITROL COMPANY LLC

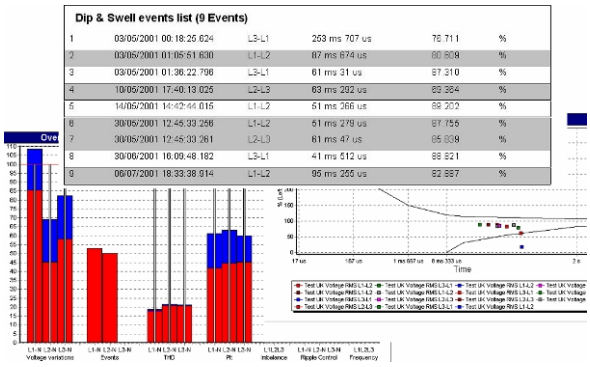
- **Complete substation or multiple feeders monitoring (multiple RAU's)**



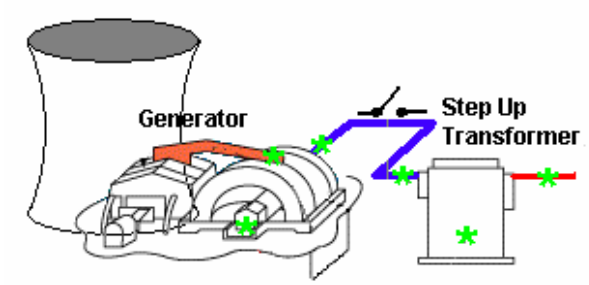
- **Power Quality Monitor**

Detection, capture and restitution of PQ events and trends in a standardized fashion. PQ profiling at an interface between distribution and load, or between utilities at the transmission level.

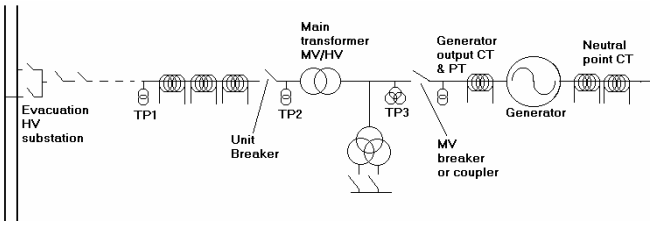
Type of Event	
Sags (Dips)	✓
Swells	✓
Long duration variations	✓
Voltage distortion	✓
Harmonics	✓
Flicker	✓
Frequency variations	✓
Unbalance	✓



Generator Monitoring



Speed	Signals	Triggers	Comments
Fast Analog	Generator 3U & 3I, V_0, Step-up Xfo V_0, Bus U, Auxil.V, Gen Excit., Gen Flux	>I, <U, V_0, Step-up Xfo V_0, Bus <V	Generator internal or induced fault, loss of sync.
Fast Digital	HV, coupler and excitation, Bkr pos, Auxil. Bkr pos., Prot. trip	Dig Edge or level	
Slow Analog	Generator In, Vrms, P, Q, Freq., Excit. I, Gen. Speed, and valves pos.	dP/dt, dQ/dt, Swing, Freq, <U	Generator star-up, fault or swing, loss of sync
Slow Digital	Bkr pos. Prot. Trip, turbine trip, stop valves	Prot. Trip	
Continuous Recording	*Same as slow*		



General technical datas

Analog Inputs

Voltages	5, 20, 140 & 300 Vrms
Currents	50, 200 Arms on 0.1Ω shunt [3] (100A*1s std) (special 4-20mA range)

The current shunts may be internal to the CAU or external to a AVAU.

Bandwidth (±0.5dB):	DC to 0.38 x Fs (Fs ≥ 10kHz) DC to 0.3 x Fs (Fs = 5 or 6 kHz)
Cut-off frequency (-3dB):	0.49 x Fs (Fs ≥ 10kHz) 0.32 x Fs (Fs=5or 6 kHz)
Attenuation:	90dB min above 0.54xFs
Common mode rejection:	74dB min (140V range)
Signal/Noise ratio:	82dB min
Time skew between channels:	5µs max
Cross talk between channels:	<-84dB
Insulation resistance:	>100MΩ
Common mode isolation (IEC255-5):	2.5kV RMS
Oscillatory waves (IEC61000-4-12) [4]:	2.5kV
Surge withstand capability (IEC 61000-4-5) [4]:	CM 4kV DM 1kV
Fast transient capability (IEC 61000-4-4) [4]:	CM 4kV DM 2kV

Digital Inputs

Vnom	Vil min	Vil max	Vih min	Vih max
24-36	-70 V	5 V	17V	70 V
48-60	-80 V	10 V	34 V	80 V
110-130	-160 V	25 V	80 V	160 V
220-250	-300 V	45 V	160 V	300 V

Time skew between channels:	25µs max
Insulation resistance:	>100MΩ
Common mode isolation (IEC255-5):	2.5kV RMS
Oscillatory waves (IEC61000-4-12) [4]:	2.5kV
Surges withstand capability (IEC 61000-4-5) [4]:	CM 4kV DM 1kV
Fast transient capability (IEC 61000-4-4) [4]:	CM 2.5kV DM 1kV

Acquisition characteristics

Sampling speed	Fast: 1-12kHz, Slow:1-120Hz
Accuracy	0.1% on V — 0.2% on I
Resolution	16 bits optimised per input ranges
Memory Capacity	Std. 64Mb per 64 channels. Partitioned for Fast and Slow recording (128 Mb optional)
Mass storage (optional)	Hard Disk: 8 GB or FlashDisk of specified capacity
Time resolution	Records tagged to 0.1 ms
Skew between different BEN's	<20µs with IRIG-B/J+1pps pulse
Absolute time precision	<50µs with IRIG-B/J+1pps pulse or 5 ms (typical) if external pulse or IRIG-B only.
Absolute time drift	10 ppm. max without external synchro.

Triggers and derived quantities (virtual channels)

Physical analog channels	Level, Rate Of Change, Swing, Adaptive Rate Of Change
Virtual (derived) quantities: RMS, P, Q, F, Angle, Sequence components, Unbalance	
Digital channels	Edge

[3] Other shunt values available
[4] Performance criteria: A

- Threshold resolution: 0.1%
- Tpost 0.02 to 1300s (resolution: 10ms)
- Tmax 0.05 to 3000s (resolution: 10ms)
- Tinhibit 0 to 24h (resolution: 10ms)
- Rate of change Time window: 10 to 1000ms

RMS value:
Accuracy: see analog input,
Response time: 60ms typ
Frequency:
Range: ±8Hz around nominal value
Accuracy: 2mHz (±2Hz around nominal value)
Response time: 240ms min (adjustable)
Power (dP/dt, dQ/dt):
Accuracy: 0.4%
Response time: 40ms typ
Phase angle: (only in DSM mode)
Accuracy: 0.1°
Response time: 175ms typ
Zero-sequence:
Accuracy: 0.15% on voltage inputs, 0.25% on current inputs
Response time: 50ms typ
Positive/Negative sequence:
Accuracy: 0.2% on voltage inputs, 0.3% on current inputs
Response time: 60ms typ
Unbalance:
Accuracy: 0.25% on voltage inputs, 0.35% on current inputs
Response time: 60ms typ

Other triggers available with PQ Card (harmonics, …)

Continuous recording

Capture of a selection of virtual channels in ultra slow recording (hard or flash disk is mandatory for this option)

Input / outputs

in	Real time clock synchro	Modulated IRIG-B/J, pulse Serial IRIG-J + 1pps
		Synch pulse input
i/o	PC direct	EIA-232, USB
i/o	Modem	V 24
i/o	Ethernet	10Base-FL, 100Base-FX
out	Printer	Centronics

Isolation resistance: >100MΩ
Common mode isolation: 1kV RMS
Fast transient capability (IEC61000-4-4): CM 2kV
Ethernet: 10Base-FL or 100-BaseFX, Effective throughput: 100KB/s
Synch pulse input: Vih: 15 or 80V, Twidth: 5ms min, Period: 1, 5 or 15 min, 1 or 24 h

i/o	Calibration	1 x EIA-232 per Acquisition controller.
out	Relays	8 potential free contacts (optional 8 additional)

Contacts rated (NO/NC): 250VRMS - 5A (resistive load), 110V – 0.5A DC
Delay from start bus: 15ms
Minimum alarm duration: 100ms
Isolation resistance: >100MΩ
Common mode isolation (IEC 255-5): 2.5kV RMS
Oscillatory waves (IEC61000-4-12): 2.5kV
Surges withstand capability (IEC61000-4-5): CM 4kV
Fast transient capability (IEC61000-4-4): CM 2kV

Power supply

Model	Vin
SENS 941-04	48 – 60 VDC
SENS 941-01	110 – 220 VDC or 125 - 220 VAC

Tolerance on input voltage: ±20%
Isolation resistance: >100MΩ
Common mode isolation (IEC255-5): 2.5kV RMS
Oscillatory waves (IEC61000-4-12) [4]: 2.5kV
Conducted disturbances (IEC61000-4-6) [4]: 10V/m
Surges withstand capability (IEC61000-4-5) [4]: CM 4kV, DM 2kV
Fast transient capability (IEC61000-4-4) [4]: CM 4kV, DM 2kV
Electromagnetic emissions: EN 55011 class A

Environment

Operating: 5 to 55 degrees °C without disk, 5 to 45 degrees °C with disk, 5 to 40 degrees °C with battery option
Storage: -10 to 65 degrees °C
Humidity: 10 to 90% non-condensing
Vibration (IEC 68-2-6): 4.9m/s^2
Electrostatic discharge (IEC 61000-4-2) [4]: class 4
Radiated Electromagnetic field (IEC 61000-4-3): class 3

Hardware

Control Unit

Built on an industrial Compact PCI bus and one 250 MIPS CPU card. It exists in two versions:

Type	Max. Channels	Extension slots
BEN6000 Standard	192 A / 384 D	6
BEN6000 Compact	64 A / 128 D	1

Data Acquisition Units

Depending on the type of Control Unit, up to 8 or 24 Data **A**cquisition **U**nits can be assembled in the configuration. The AU's exists in the following versions:

- **A**ll **V**oltage **A**cquisition **U**nit (**AVAU**)

For 8 analog voltages and 16 digital inputs

- **C**urrent **A**cquisition **U**nit (**CAU**)

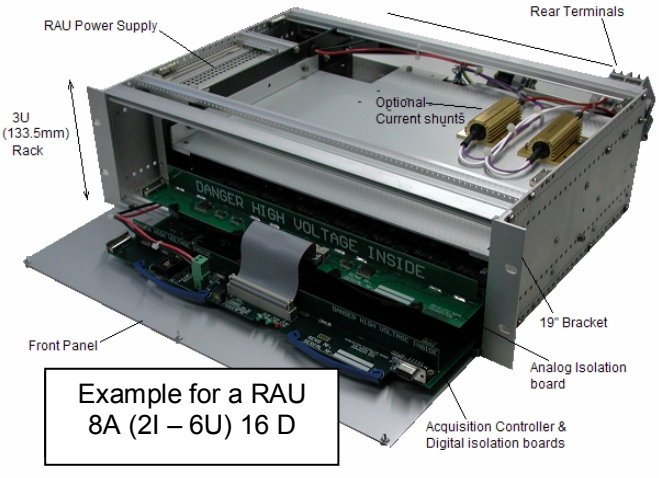
For up to 8 analog currents (the remaining channels are voltages) and 16 digital inputs

- **A**ll **D**igital **A**cquisition **U**nit (**ADAU**)

For 32 digital inputs

- **R**emote **A**cquisition **U**nit (**RAU**)

An assembly of AVAU's and/or CAU's and/or ADAU's remotely located from the Control Unit. It includes its own power supply and optical fibre interfaces for the connection to the Control Unit.

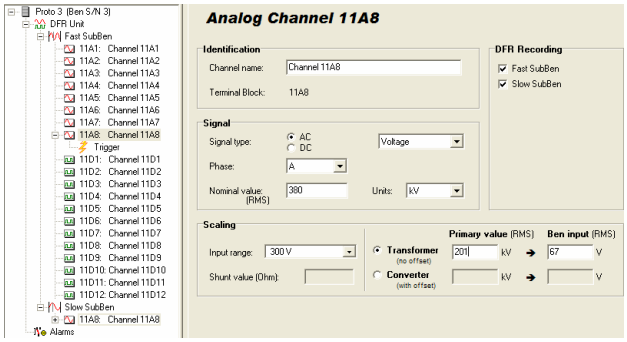


Example for a RAU 8A (2I – 6U) 16 D

[4] Performance criteria: A

Software

Configuration



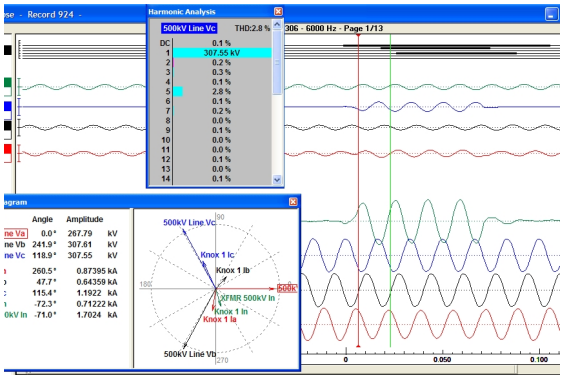
The CONFIGURATION software offers a comprehensive Windows™ environment for the definition and tuning of the **BEN6000** basic functionality and settings.

- identification of terminals
- scaling
- types of recording and triggers
- settings
- relay functions
- circuits and communications
- Diagnostic of the remote recorder to the board level

Analysis and communication

Thanks to the true multitasking capabilities of the Analysis Centre Software, all communication are performed in the background while the user works with analysis or other functions. The use of high transfer baud rates (up to 115200 Bps) and powerful data compression algorithms considerably reduces communication time.

Once retrieved, the records are then introduced in the analysis software database which allows file classification with user defined classes (and comments), record names, DFR serial number, triggering date and time, record weight,...File sharing on a LAN is also supported.



The BEN32 Master Station software allows the data collection by various means and a multi-facetted analysis for a complete power system event overview, analysis and reporting.

- 32 bit application for faster access to data
- Records Database
- Multitask software (doing communication, analysis, reporting simultaneously)
- Single software for analysing, communicating, updating of parameters, reporting, ...
- Windows™ 2000/XP operating systems
- Ethernet or serial communications
- Instant record opening
- Fast scrolling and zoom function
- Easy creation of user defined layout with drag and drop operation on record channels
- User's annotations superimposed on signal trace
- Amplitude modification with channel stretching handles
- Time and waveform amplitude delta measurement by means of two cursors
- Display the digital event information in a sequence of event recorder format
- COMTRADE import/exports
- Multiple analysis windows for parallel analysis of two records at the same time whether from the same BEN, from different BEN's or from any device providing COMTRADE compatible files
- In-screen annotations
- Extended printout capabilities allowing the user to print whole or partial records with the desired resolution
- Comprehensive on-line help

BEN 32 software remains fully downward compatible with any existing BEN recorder.

BENLOC: High Precision Fault Locator Software.

- Single ended fault locator
- Possibility to adjust the calculation at every step
- Calculation of the fault location for successive faults states within one record
- Identification of the most accurate location according to the fault states
- Comprehensive report
- High accuracy (typical <2%)

Scope of Delivery

Please contact your sales office for details as we offer complete systems on customer requirements.

Distributor:

QUALITROL COMPANY LLC

www.qualitrolcorp.com

Printed in EU
Technical modifications reserved
Publication A24302E

Qualitrol Company LLC
1385 Fairport Road
Fairport, NY 14450
USA
Phone: +1 (585) 586-1515
Fax orders: +1 (585) 377-0220
Fax quotes : +1 (585) 377-9613
E-mail: info@qualitrolcorp.com

Information Products Division
15 Wildflower Way
Belfast
Northern Ireland BT126TA
Phone: +44 (0)2890-225200

Information Products Division
Avenue Newton 8 **– Zoning Nord**
1300 Wavre
BELGIUM
Phone: +32 (0) 22 67 16
Fax: +32 (0) 22 69 98