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, decentralised¹ 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, standpoint.

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 (Remote Acquisition Units for 8 voltages and 16 Digitalis 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 quantities² 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)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Signals</th>
<th>Triggers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Analog</td>
<td>3U &amp; 3I, V₀</td>
<td>&gt;I, &lt;U, V₀</td>
<td>Line fault</td>
</tr>
<tr>
<td>Fast Dig.</td>
<td>Brkr pos, Prot. trip</td>
<td>Dig Edge or level</td>
<td></td>
</tr>
<tr>
<td>Slow Analog</td>
<td>P, Q, F, Urms</td>
<td>dP/dt, dQ/dt, dF/dt, Freq, &lt;U</td>
<td>System collapse, Swing, Power flow monitor.</td>
</tr>
<tr>
<td>Slow Dig.</td>
<td>Brkr pos, Prot. trip</td>
<td>Prot. trip</td>
<td></td>
</tr>
<tr>
<td>Continuous Recording</td>
<td>P, Q, Urms</td>
<td></td>
<td>Proof of service</td>
</tr>
</tbody>
</table>

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

The signals monitored are the same per feeder as the ones for a single feeder yet all Remote Acquisition Units can be connected to a single Control Unit through optical fibres.

- 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**

<table>
<thead>
<tr>
<th>Sags (Dips)</th>
<th>Swells</th>
<th>Long duration variations</th>
<th>Voltage distortion</th>
<th>Harmonics</th>
<th>Flicker</th>
<th>Frequency variations</th>
<th>Unbalance</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
</tr>
</tbody>
</table>

**Generator Monitoring**

- Triggers: Dig Edge or level
- Comments: Generator internal or induced fault, loss of sync.

**Analog Inputs**

<table>
<thead>
<tr>
<th>Volatages</th>
<th>5, 20, 140 &amp; 300 Vrms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currents</td>
<td>50, 200 Arms on 0.1Ω shunt (100A*1s std)</td>
</tr>
</tbody>
</table>

**General technical data**

- Bandwidth (±0.5dB): DC to 0.38 x Fs (Fs ≥ 10kHz)
- Cut-off frequency (-3dB): 0.49 x Fs (Fs ≥ 5 kHz)
- Attenuation: 90dB min above 0.5xFs
- Cross talk between channels: <84dB
- Insulation resistance: >100MQ
- Oscillatory waves (IEC61000-4-12): 2.5kV RMS
- Surge withstand capability (IEC 61000-4-5):
  - CM 4kV
  - DM 1kV
- Fast transient capability (IEC 61000-4-4): CM 4kV
  - DM 1kV

**Digital Inputs**

<table>
<thead>
<tr>
<th>Vnom</th>
<th>Vil min</th>
<th>Vil max</th>
<th>Vih min</th>
<th>Vih max</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-36</td>
<td>-70 V</td>
<td>5 V</td>
<td>-17 V</td>
<td>70 V</td>
</tr>
<tr>
<td>48-60</td>
<td>-80 V</td>
<td>10 V</td>
<td>-34 V</td>
<td>80 V</td>
</tr>
<tr>
<td>110-130</td>
<td>-160 V</td>
<td>25 V</td>
<td>-80 V</td>
<td>160 V</td>
</tr>
<tr>
<td>220-250</td>
<td>-300 V</td>
<td>45 V</td>
<td>-160 V</td>
<td>300 V</td>
</tr>
</tbody>
</table>

**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

**Triggers and derived quantities (virtual channels)**

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

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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:
- 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)

<table>
<thead>
<tr>
<th>Input / outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>in Real time clock synchro</td>
</tr>
<tr>
<td>/o PC direct</td>
</tr>
<tr>
<td>/o Modem</td>
</tr>
<tr>
<td>/o Ethernet</td>
</tr>
<tr>
<td>out Printer</td>
</tr>
</tbody>
</table>

Isolation resistance: >100MQ
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, Twidht: 5ms min, Period: 1, 5 or 15 min, 1 or 24 h

<table>
<thead>
<tr>
<th>i/o Calibration</th>
<th>1 x EIA-232 per Acquisition controller.</th>
</tr>
</thead>
<tbody>
<tr>
<td>out Relays</td>
<td>8 potential free contacts (optional 8 additional)</td>
</tr>
</tbody>
</table>

Contacts rated (NO/NC): 250VRMS - 5A (resistive load), 110V – 0.5A DC
Delay from start bus: 15ms
Minimum alarm duration: 100ms
Isolation resistance: >100MQ
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

Electromagnetic emissions:
- Conducted disturbances (IEC61000-4-6): 10V/m
- Surges withstand capability (IEC61000-4-5): CM 4kV
- Fast transient capability (IEC61000-4-4): CM 4kV

Environment
- Operating: 5 to 55 degrees °C without disk
- Storage: 5 to 40 degrees °C with battery option

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. Channels</th>
<th>Extension slots</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEN6000 Standard</td>
<td>192 A / 384 D</td>
<td>6</td>
</tr>
<tr>
<td>BEN6000 Compact</td>
<td>64 A / 128 D</td>
<td>1</td>
</tr>
</tbody>
</table>

Data Acquisition Units
Depending on the type of Control Unit, up to 8 or 24 Data Acquisition Units can be assembled in the configuration. The AU’s exists in the following versions:
- All Voltage Acquisition Unit (AVAU)
- Current Acquisition Unit (CAU)
- All Digital Acquisition Unit (ADAU)
- Remote Acquisition Unit (RAU)

Hardware
- Example for a RAU

<table>
<thead>
<tr>
<th>RAU Power Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU[153.5m] Rack</td>
</tr>
<tr>
<td>10B Bracket</td>
</tr>
<tr>
<td>Analog isolation board</td>
</tr>
<tr>
<td>Acquisition Controller &amp; Digital isolation boards</td>
</tr>
</tbody>
</table>

Example for a RAU
8A (2I – 6U) 16 D
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:

www.qualitrolcorp.com