TRACTION POWER PROTECTION AND CONTROL

WITH BE1-11 AND BE1-11D SYSTEMS
Basler Enters the Magnetic Components Market

1942

• In the beginning, Basler performed rewinding and repair of electrical equipment for the magnetic components market.
Generations of Family Leadership

1942

• Carl H. Basler began operations on Main and Olive Streets in Highland, Illinois in 1942. Products consisted of transformers, coils, reactors, and other magnetic components.
Generations of Family Leadership

1984

• William “Bill” Basler became Chairman of the Board and Chief Executive Officer after his father’s passing in 1984.
Generations of Family Leadership

2018

• Greg Basler joined the company full time in 1993. In 2018, he was promoted to Vice Chairman of the Board and Chief Executive Officer.
In 1969, Basler introduced the first ever solid-state protective relay. More reliable and requiring less maintenance than its predecessors, this innovation completely transformed the protective relay market.
In 1974, Basler introduced its first static excitation system. With no moving parts, it required less maintenance and provided more reliability. Basler excitation systems are now operating in more than 145 countries worldwide.
Basler Introduces its First BE1 Numeric Protection System

1997

• BE1 numeric systems allow Customers to replace multiple relays with one unit. The current version of Basler’s numeric relay is the BE1-11 family.
Complete excitation systems solutions for

- Synchronous generators and motors
- New or upgrades to existing applications
- Up to 10,000 Adc of excitation power

Manufactured in Highland, IL
Standard and custom solutions

- Excitation system cubicles
- Pan chassis systems
- “Front end” controls upgrades for legacy Basler products and other manufacturers
Excitation Systems

Control channel redundancy options

• Single control channel
• Dual control channels
• Dual control channels with supervision

Power stage redundancy options

• Single and multiple power bridge designs

Local and remote Interactive Display Panel provisions
Excitation Systems

Basler’s in-house capabilities

System design
- Electrical
- Mechanical
- Software

Complete manufacturing and machine shop
- Sheet metal fabrication
- Paint booths

Multiple factory test cells

System level design, installation, and turnkey services
E² Power Systems, LLC

E2PS, LLC is a wholly owned subsidiary of Basler Electric

Comprehensive customized services include:

• System design
• Evaluation and enhancement studies
• Power and electrical system studies
• Protective relay coordination studies
• NERC compliance testing
E² Power Systems, LLC

Comprehensive customized services include:

• System maintenance and testing
• Technical training
• Generating system upgrades
• Custom tailored turnkey installation services
• Task-specific solutions

Always Innovating. Always Evolving.
More than 55 years of industry leading experience in AVR design and application

Complete digital systems and analog designs provide perfect solutions for any application

2-20Adc of excitation current capabilities available

Manufactured in Highland, IL and Taylor, TX
Voltage Regulators

Reliable in the harshest applications
- Potted designs available to protect AVR against extreme environments
- Salt fog and humidity tested
- Shock and vibration tolerance among the highest in the industry

Leaders in innovation
- Autotuning feature available for simple, fast, and accurate setup
- Reactive load sharing via communications for system load sharing and response
Models available to meet the application, whether simple stand alone or complex paralleled systems

Flexible controls with PLC function, protection, load sharing

Simple configuration makes difficult applications easy (multiple gen or multiple gen/grid)

Manufactured in Highland, IL and Taylor, TX
Genset Controls

Designed for operations in the harshest environments
• HALT tested
• Potted construction
• EMC / RFI hardened

Designed to provide years of trouble free, reliable service
BESTCOMS™ / BESTCOMSPlus® / BESTCOMS™ Pro Graphical User Interface (GUI) Software

- Create and view settings files in an intuitive point-and-click environment.
- Create and edit settings files, upload them to the device, and download COMTRADE oscillography files.
- Create settings files without connection to the device. Export settings to storage media or e-mail to another user to set of devices in the field.
Software Interface

BESTCOMS™ / BESTCOMSPlus® / BESTCOMS™ Pro Graphical User Interface (GUI) Software

- Power programmable logic function
- Simplifies complicated logic schemes with error checking
- Easy to use but extremely powerful to adapt our products to virtually any application.
Custom Magnetic Components
• 5 VA through 2800 kVA three phase
• Agency approved standards through 100 VA
• Multiple UL-approved insulation systems

Value-Added Assemblies
• Customized manufacturing
• Simple wiring harnesses
• Complex build-to-print electromechanical assemblies

Manufacturing Facilities
• Highland, Illinois, USA
• Piedras Negras, Mexico
Custom Transformers

Class 2 transformers
- Standard and custom through 100 VA
- Wide range of input voltages
- Multiple mounting and termination schemes
- Flexible production schedules for customer demand
Custom Transformers

Intermediate power transformers
• Custom designed and manufactured
• Through 10 kVA
• Multiple core geometries
• Worldwide regulatory agency compliance available
Custom Transformers

Large dry-type transformers

• Custom designed and manufactured
• Through 2,500 kVA convection, 2,800 kVA forced-air cooled
• 15 kV class
• 100% copper conductors
• 110 kV BIL design capability
• Tightly regulated Potential Power and Power Current Transformers
Basler Plastics, LLC

Injection molding
- Engineered and commercial plastics
- Molding presses through 500 tons
- Product development
- Value-added assemblies
- Manufactured in San Marcos, Texas, USA
Basler Plastics, LLC

Product development support
• On-site engineering
• Mold design
• Secure FTP site file management
• In-house mold maintenance and repair
Value-added services

- Stamping
- Labeling
- Ultrasonic welding
- Over-molding
- Assembly and secondary services
- Insert molding
TRACTION POWER PROTECTION AND CONTROL

WITH BE1-11 AND BE1-11D SYSTEMS

PART 2
More than 45 years of providing superior protection equipment

We provide products that:

• Eliminate settings errors
• Are easy to configure and set
• Provide reliability

Wide range of protection solutions
Manufactured in Highland, IL and Taylor, TX
One Firmware, highly configurable for maximum flexibility

Common protection and control applications

• Feeder
• Generator
• Intertie
• Transformer

• Motor
• Bus
• Traction
• Auto Sync

Suitable for 25, 50, 60, 100Hz nominal via setting. DC via style number

Wide range of communication options to access settings, metering, and system analysis data
Protective Relaying

Complexity of systems has changed, but our approach keeps it simple.

- Preprogrammed logic files for many applications
- Intuitive, descriptive settings
- Graphs for many functions
- Logic that is easy to configure and understand
Protective Relaying

Simplify commissioning with built-in tools

- Error checking at time of setting
- Off-line simulator proves out logic, reducing costly errors at commissioning
- Setting summary screen displays system overview at a glance
# BE1-11 Protection System

<table>
<thead>
<tr>
<th>Feeder</th>
<th>Generator</th>
<th>Intertie</th>
<th>Motor</th>
<th>Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="BE1-11f.png" alt="Image" /></td>
<td><img src="BE1-11g.png" alt="Image" /></td>
<td><img src="BE1-11i.png" alt="Image" /></td>
<td><img src="BE1-11m.png" alt="Image" /></td>
<td><img src="BE1-11t.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Communications options shared by each application:
- IEC 61850
- Modbus®
- DNP3
- Ethernet

Elements shared by each application:

<table>
<thead>
<tr>
<th>BESTCOMSPlus®</th>
<th>27</th>
<th>43</th>
<th>46</th>
<th>47</th>
<th>49 RTD</th>
<th>50</th>
<th>51</th>
<th>59</th>
<th>60</th>
<th>62</th>
<th>81</th>
<th>86</th>
<th>101</th>
<th>BF</th>
<th>Analog I/O</th>
<th>SEF</th>
</tr>
</thead>
</table>

**BE1-11f** specific elements:
- 21
- 24
- 25
- 32
- 67
- 79

**BE1-11g** specific elements:
- 21
- 24
- 25
- 25A
- 32
- 40
- 64G
- 67
- 780CS

**BE1-11i** specific elements:
- 24
- 25
- 32
- 67
- 78V
- 79

**BE1-11m** specific elements:
- 32
- 37
- 48
- 49TC
- 55
- 66
- 87

**BE1-11t** specific elements:
- 21
- 24
- 25
- 51TF
- 67
- 79
- 87
- 87N

*Options available in J-case only.

**Only available in J-case.**

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Always Innovating. Always Evolving.
BE1-11d DC Power Protection System
Basler DC System Components

BE1-11d
• Based upon AC BE1-11
• CT/PT inputs modified to fiber

IT-D
• 2 channels per module for voltage or current
• Universal hardware accepts 100-2,000 Vdc for voltage measurement
• Or 25-100mV from the shunt for current measurement
Enhanced HMI with S1 case size:

- Operate virtual switches (43) using only Select and Operate buttons.
- Seven user-identified and configurable indicators
BE1-11 – Hardware
IT-D Module
RTD Module

- 12 RTD inputs: 3-wire or 2-wire
- Four analog inputs (0-10V, 4-20mA)
- Four analog outputs (0-10V, 4-20mA)
Traction Systems

**DC to train**
- AC Rectified at substation
  - Relays cannot see through rectifier
- BE1-11_f, BE1-11_t and BE1-11_d at substation

**AC to train**
- Rectified on train
- 25, 50, 60, 93.3, 100Hz
- BE1-11_f, BE1-11_t at substation
Traction Systems

Diesel Engine

• Power source onboard
• Does not require electrified network
• DECS-150, DGC-2020, BE1-11

• Basler Electric now offers solutions for any system
Typical DC System Configuration
Open BESTCOMSPlus

Protective Functions

- Multilevel reverse current or power -> Multiple 32 or 76
- Instantaneous Forward Overcurrent -> 76
- Low level Fault Forward Overcurrent -> 76
- Long Time Overcurrent -> 76
- Other overcurrents…
- Rate of Rise -> Rate of Rise
- Thermal -> 49
- Over/under voltage -> 27, 59

* BE1-11d includes 13 overcurrent elements (76) per setting group
System Requirements -> Basler solution

Control Functions

• Auto-reclose -> 82
• Transfer Trip -> I/O and/or IEC61850 Goose messaging
• Control Power Voltage monitor -> V3 – 27 and/or 59
• Disable/Enable functions -> Block/unblock any element in logic

Other Requirements

• Integration -> Ethernet and RS485, DNP/Modbus/IEC61850
• Event Records with Timestamp -> Sequence of Events, Fault Records, Security, IRIG and Clock setup
Familiar BE1-11f AC Relay

Similar BE1-11 AC System Elements
BE1-11 DC traction functions

Similar BE1-11 DC System Elements

27  32  43  49  59  62  76  82
86  101 ROR Ethernet Option
Modbus Option  DNP3 Option  IEC 61850 Option
Protection / Control Functions

Functionality:
- 76-Instantaneous overcurrent trip (bi-directional)
- 76-Low level fault trip (bi-directional)
- 76-Straight time overcurrent trip
- 76-Long time overcurrent trip
- 76-Timed (inverse) overcurrent trip (bi-directional)
- 76-Extreme inverse overcurrent trip
- RoR-Rate of rise trip (delta current)
- 82-DC bus breaker auto reclosing
- 59-Neutral ground relay
- 49-Thermal Overcurrent
Overcurrent

DC Overcurrent

76-1 Element
Mode
Enabled
Source
DC Current I1
Pickup
50.0 Shunt mV
500.0 System A
Direction
Forward
Timing Mode
Inverse Timing
Time Delay (ms)
0
Reset Delay (ms)
0
Time Dial
3.0
Curve
S1-CO Short Inverse
Reset Timing
Instantaneous

76-1 Pickup Curve
S1 at Time Dial=3.0

Time (Sec)

Multiple of Pick-Up (xPU)
Rate of Rise (RoR)

**RoR Functionality and Purpose:**

- Rate of rise protection can be used to protect trolley wires, third rails, feeder, and substations from remote overload conditions such as arcing faults, bolted faults, and severe overloads while allowing for normal train starts.

- Parallel algorithms
  - DDL+ΔI (Current Increment Detection) and DDL+ΔT (Time Delay Detection)
  - First to trip, trips RoR
  - No need to wait for both conditions
Rate of Rise (RoR)

**DDL+ΔI Detection**

Suitable for short-circuit faults at close distances

**DDL+ΔT Detection**

Suitable for remote short-circuit faults because of their low rise rate and long duration of time
82 Functionality and Purpose:

• The recloser (82) element automatically recloses the line DC circuit breaker (72L), which has been tripped by a protective relay or other device in DC power systems.

• A line test can be performed on line DC circuit breaker (72L) before closing to prevent the line DC circuit breaker closing onto an overload or a short-circuit condition.
Reclose with Line Test (82)

LM Contact

- The Line Measurement (LM) contact output is true when the Bypass input is false and the Enable input is true.
Thermal Overload (49)

49 Functionality and Purpose:

- The thermal overload (49) element models the thermal capacity in the cables and catenary system.
- Calculates overheat temperature by using load current and thermal time constants.
- Similar, but not identical, to the 49TC in the BE1-11m.
Thermal Overload (49)

49 Element
Mode: Enabled

Overload:
- 50.0 Shunt mV
- 500.0 System A

Trip Time Constant (min):
- 1.0

Reset Time Constant (min):
- 1.0

Minimum Reset Time (min):
- 0.0

Alarm Level (%):
- 90

49 IEC Pickup Curve

Time (in minutes) vs. Multiple of Pick-Up (xPU)
DC Traction Protection - This logic scheme provides protection functions common in DC traction applications. Included elements are time and instantaneous overcurrent, undervoltage, overvoltage, rate of rise, thermal overcurrent, and reclosing with line measurement test.

Functions such as breaker failure, virtual breaker control and thermal features are not enabled in this scheme. However, these features may be activated through BESTLogicPlus.
Secure Communications

Protocols
• Modbus over RS485 or Ethernet
• DNP over RS485 or Ethernet
• IEC61850 with Goose messaging over Ethernet

Security
• 6 access levels
  ◦ Each port and protocol independently secured
• Up to 26 accounts
  ◦ With maximum access level and expiration time
• Complex passwords
• Security Log
• Login Failure Alarm and Lockout
Event Recording

Sequence of Events
• Automatically records 1000+ most recent events

High Speed Waveform Capture (Oscillography)
• Records all Current, Voltage and I/O channels
• 2000 samples/second per channel
  ◦ 32 samples per cycle at 60Hz
• Fault Summary Report
• Open protocol Comtrade Format
Oscillographic Records
BESTwave™
Live Metering

**Primary Voltage (BE1-11)**

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>124.4 V</td>
<td>0.0°</td>
</tr>
<tr>
<td>124.9 V</td>
<td>120.6°</td>
</tr>
<tr>
<td>123.9 V</td>
<td>240.4°</td>
</tr>
</tbody>
</table>

**Phase to Phase Voltages**

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>216.5 V</td>
<td>330.2°</td>
</tr>
<tr>
<td>215.3 V</td>
<td>90.6°</td>
</tr>
<tr>
<td>214.6 V</td>
<td>210.1°</td>
</tr>
</tbody>
</table>

**Sequence Voltages**

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.648 V</td>
<td>---</td>
</tr>
<tr>
<td>124.4 V</td>
<td>0.3°</td>
</tr>
<tr>
<td>0.396 V</td>
<td>---</td>
</tr>
</tbody>
</table>

**Phasor Diagram (BE1-11)**

- VA
- VB
- VC
- VAB
- VBC
- VCA
- V1
- V2
- 3V0
Basler Solution

Designed, Manufactured, Supported in the USA

Provides a 2-3 component solution
• (1) low voltage cabinet mounted BE1-11d relay
• (1 or 2) IT-D high voltage cabinet mounted modules

Advanced Secure Communications options

High Accuracy (±1% of reading or ±0.15% of full range)

High Isolation between High Voltage IT-D and User Interface BE1-11d via fiber optic communications
THANK YOU

WWW.BASLER.COM