The BE1-11g Generator Protection System is a multifunction numeric relay designed with many features to address reliability issues that arise due to the over complexity of programming. Reliability studies have shown that the majority of relay misoperations are caused by incorrect settings, logic or design errors. Correctly setting a numeric relay has never been easier than with the BE1-11 family of relays. With BESTspace™ files, multiple BESTLogicPlus pre-programmed logic schemes and associated application notes, you can be confident your relay is set correctly. The BE1-11g is a complete generator protection system providing protection, control, monitoring and metering for applications including utility power plants, backup generation, portable power and distributed on-site generation.

ADVANTAGES

- Intuitive BESTCOMSPlus® and BESTLogicPlus user interfaces with high-speed, front panel USB feature multiple customizable pre-designed templates.
- Optional second set of CTs for generator differential applications.
- Twenty-four industry standard timing curves, four custom table curves and one user-programmable curve provide flexibility to meet specific protection applications.
- Each overcurrent element can be individually set for forward, reverse, or nondirectional control. Voltage control and restraint are included within the phase overcurrent elements to provide maximum functional flexibility for the application.
- Sensitive earth fault protection available.
- Large, high-contrast programmable 128x64 LCD display provides a menu tree with progress bars that make the front panel navigation intuitive.
- Includes frequency tracking for backup and cogeneration applications.
- Provides separate ground current input for those applications where required.
- High-speed BESTCOMSPlus user interface via front panel USB.
- Selectable protocols support integration with SCADA and distributed control systems.
- Copper or fiber Ethernet communications and RS-485 for BESTCOMSPlus, BESTNETPlus, Modbus™, DNP3, and BEST61850 protocols.
- 10/100Mbit copper or 100Mbit fiber Ethernet with IEC 61850.
- Web page and user-selectable email triggers for remote alarm reporting.
- Real-time clock with 8-hour ride through and 5-year battery backup.
- Optional Remote RTD modules provide a choice of RTD types, as well as analog input and output channels.
- Optional enhanced HMI with user-customizable labels and virtual select and operate switches.
- Available in fully drawout half-rack case in a rack mount or panel mount configuration, or in a non-drawout S1 sized case that fits in an S1 case opening.

WINDOWS® SOFTWARE

Interface for setting and communicating with Basler protection products
Request BESTCOMSPlus for BE1-11

ADDITIONAL INFORMATION

INSTRUCTION MANUAL
Request publication 9424200994
MODBUS™ INSTRUCTION MANUAL
Request publication 9424200991
DNP3 INSTRUCTION MANUAL
Request publication 9424200992
IEC 61850 INSTRUCTION MANUAL
Request publication 9424200892

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FEATURES

PROTECTION

• 6 instantaneous overcurrent (50) elements provide selection of single- (IA, IB, IC) or three-phase (3PH), residual (3IO), ground (IG), positive sequence (I1), negative sequence (I2) or unbalance current measurement. Directional and non-directional operation is selectable. Definite time delay is available.

• 7 inverse time overcurrent (51) elements provide selection of single- (IA, IB, IC) or three-phase (3PH), residual (3IO), ground (IG), positive sequence (I1), negative sequence (I2) or unbalance current measurement. Directional and non-directional operation is selectable. Voltage control or restraint (51V) characteristics are selectable. The reset characteristic may be instantaneous or inverse.

• Each overcurrent element can have directional control (67, 67N). Directional control is by positive, negative, zero sequence voltage and zero sequence current polarization.

• Negative sequence and unbalance: 46

• 24 industry standard timing curves are available, as well as a user-programmable curve, and up to 4 user-defined tabular curves for use by any of the time overcurrent elements.

• Minimal transient overreach and overtravel is incorporated into the design of the overcurrent elements.

• An independent ground current input provides zero sequence current polarization and/or ground overcurrent protection.

• Breaker failure protection function: 50BF

• Optional percent differential or flux balance type phase differential (87) element.

• Optional neutral differential/restricted earth fault (87N) element.

• 5 phase undervoltage (27P) and 4 phase overvoltage (59P) elements use a 1 of 3, 2 of 3, or 3 of 3 logic and monitor phase-to-phase or phase-to-neutral voltage. Sensed voltage may be single- or three-phase. Undervoltage elements include an undervoltage inhibit setting to prevent erroneous operation.

• 4 auxiliary undervoltage (27X) and 4 auxiliary overvoltage (59X) elements monitor either fundamental or third harmonic on the fourth VT input, phase residual 3V0, 3V1 or 3V2. These undervoltage elements include an undervoltage inhibiting setting to prevent erroneous operation.

• 100% stator ground protection (64G) using auxiliary voltage input to detect fundamental overvoltage (59X) and third harmonic undervoltage (27X).

• All voltage elements have a choice of definite or inverse time characteristics.

• Negative sequence overvoltage element: 47

• Vector jump (78V) element for anti-islanding/loss of mains protection.

• Overexcitation, volts-per-hertz (24) element provides a selection for definite or inverse time characteristics.

• Sync check (25) with line and bus voltage monitoring logic (25VM).

• 2 directional power (32) elements measure single or three phase power, in the forward or reverse direction, and compare the measurement to an over or under power user setting.

• A choice of loss of excitation functional elements is provided. An offset var flow algorithm (40Q) provides underexcitation protection. A dual offset mho characteristic (40Z) with voltage suppression provides complete protection for a loss of excitation.

• Fuse loss detection protects against false tripping due to the loss of a sensing voltage (60FL).

• Distance impedance (21) elements provide backup protection for relays tied through a step-up transformer to transmission.

• Out-of-Step (78OOS) element provides pole slip protection when synchronism is lost.

• 8 frequency (81) elements may be set individually for over, under or rate of change frequency. The rate of change can be set for positive, negative or either. Each element can be assigned to either the three-phase or single-phase (Vx) voltage input. Each element includes an undervoltage inhibit setting.

• Up to 24 resistive temperature detector (49RTD) inputs provide thermal protection with optional Remote RTD modules.

• Up to 8 analog inputs with level detection included with optional Remote RTD modules.

• 4 protection setting groups with external or automatic switching selection modes.

• User-programmable and preprogrammed logic using BESTLogicPlus.

CONTROL

• Optional autosynchronizer (25A) function using either phased loop or anticipatory mode of operation.

• 5 virtual selector switches (43) are controllable from both the HMI and communications ports.

• 8 general purpose logic timers (62) and additional logic elements provide added functionality in the user designed BESTLogicPlus schemes.

• 2 virtual lockout (86) latches. Status is stored in EEPROM.

• Virtual breaker control switch (101) is controllable from both the HMI and communication ports.

• Communication port control in the virtual switches provides SCADA control of the BE1-11 and circuit breaker.

INSTRUMENTATION

• Phase (A, B, C) current, voltage, frequency, calculated neutral current, negative and zero sequence current, and voltage with magnitude and angle.

• Per phase and three-phase watts, vars and power factor.

• Third harmonic voltage metering on any input with magnitude and angle.

• Demand currents, watts, and vars.

• Primary and secondary metering.

• Actual RTD temperatures with optional Remote RTD module.

• 8 analog inputs and 8 analog outputs with 2 optional Remote RTD modules.

REPORTS

• All relay settings and logic can be saved in a file for printing or uploading to other BE1-11g relays.

• Current demands for phase, residual, ground and negative sequence currents, and forward and reverse watts and vars. Magnitudes and time stamps are recorded for today’s peak, yesterday’s peak and peak since last reset.

• 4000 point load profile log of demand readings.

• kWh and kVarh, forward and reverse.

• Breaker operations counter and contact interruption duty monitoring.
FEATURES, continued

FAULT RECORDING
• Oscillography and sequential event records can be retrieved from a relay, viewed and printed.
• 1028 event sequence-of-events report with I/O and alarm sub-reports.
• Fault Reporting - 1 or 2 oscillographic records per fault record.
• 255 fault summary reports; all fault summary records saved to non-volatile memory.
• Total number of oscillography records settable from 4 to 32.
• Oscillographic memory will store up to 512 cycles of data @ 32 samples/cycle or up to 2048 cycles of data @ 8 samples/cycle.
• Oscillographic records are in the COMTRADE format.
• Load compensated distance to fault.

HARDWARE FEATURES
• Case configuration - H: half-rack, P: half-rack panel mount or J: vertical (S1 size).
• Active CT technology for low burden and increased dynamic range.
• Flash Memory for upgrading embedded programming.
• Real-time Clock with 8 hour capacitor ride through and battery backup.
• Integral HMI with 128x64 character display.
• Wide range ac/dc power supply options provide long holdup time to ride through dips on ac power source: 100 ms with 4 output relays energized, upon complete loss of source.
• 7 additional front panel, programmable LEDs (J-case).

COMMUNICATIONS PORTS
• Three independent general purpose communication ports and available protocols:
  - Front USB-B: BESTCOMSPlus, BEST61850.
  - Rear Ethernet (copper or fiber optic): BESTNetPlus, BESTCOMSPlus, Modbus, DNP3 and BEST61850 protocols.
• IRIG-B time sync (unmodulated).

SELF-TEST and ALARM FUNCTIONS
• Relay fail, major alarm, and minor alarm LEDs, and fail-safe alarm output contact (open or closed)
  See style chart, page 16, for ordering information.
• Extensive internal diagnostics monitor all internal functions of the relay.
• More than 75 additional alarm points, user-programmable for major or minor priority. Including:
  - Phase current, forward and reverse Watt and var demand alarm.
  - Neutral and negative sequence unbalance demand.
  - Three breaker alarm points programmable for slow trip, interruption duty threshold, or operations counter.
  - Trip circuit voltage and continuity monitor.
  - Close circuit monitor via BESTLogicPlus.

PROGRAMMABLE I/O
• 4 programmable inputs (H- or P-case).
• 7 programmable inputs (J-case).
• 5 programmable outputs and 1 dedicated programmable alarm output (H- or P-case).
• 8 programmable outputs and 1 dedicated programmable alarm output (J-case).
• 12 programmable RTDs with each remote module.*
• 4 programmable inputs with each remote module.*
• 4 programmable outputs with each remote module.*

*Up to 2 Remote RTD modules may be used with one BE1-11g
APPLICATIONS

The BE1-11g is a complete generator protection system providing protection, control, monitoring and metering for generator applications. Protection features available include time and instantaneous overcurrent, differential, overvoltage, undervoltage, directional power, synchronism check, vector jump, overexcitation, loss of excitation, distance, out of step, frequency, synchronizer, and RTD and analog I/O functions. The easy programming capabilities of the BE1-11g system make it ideally suited for the following applications:

Applications that benefit from:
• A flexible logic library with the following logic schemes: Basic Low Impedance Grounded Generator Protection, Basic High Impedance Grounded Generator Protection, Low Impedance Grounded Generator Protection with Sequential Trip, High Impedance Grounded Generator Protection with Sequential Trip, Low Impedance Grounded Generator Protection with Sequential Trip and Sync Check, High Impedance Grounded Generator Protection with Sequential Trip J-Case Relay.
• The flexibility provided by wide setting ranges, a large number of elements, multiple settings groups, multiple coordination curves and the versatility of visual programmable logic in a single package.
• An economical digital multifunction relay in a space-conscious package. One unit that can provide all of the protection, control, instrumentation, modern communications and protocol support functions desired for sophisticated applications.
• High speed Ethernet communications, copper or fiber-optic.
• IEC 61850 functionality.
• Sensitive earth fault detection of low ground current levels.
• Drawout construction.
• Isolation between the RTDs and relay due to the distance between the relay package and the Remote RTD module.

Applications where:
• A small sized relay is needed due to limited behind panel space to make modernizing an existing installation possible.

FUNCTIONAL DESCRIPTION

The BE1-11g is a multifunction, numeric relay that provides a comprehensive mix of protective functions to detect generator faults and abnormal operating conditions, along with control and metering function in an integrated system. Features available in this relay, such as phase differential (ง7), neutral differential/restricted earth fault (ง7N), synchronizer (ง25A), distance (ง21), out of step/pole slip (ง78OOS), vector jump/loss of mains (ง78V), sync check (ง25), 100% stator ground (ง64G), loss of field (ง40Q, ง40Z), overexcitation/volts-per-hertz (ง24) and RTD monitoring (ง49RTD), make this system ideal for generator applications and many utility/cogeneration facility intertie applications.

32 samples-per-cycle digital signal processing with frequency compensation extracts the fundamental component for high accuracy with distorted waveforms and at off-nominal frequency operation.

The unit has one set of three-phase current inputs (a second set of current inputs is optionally available), one set of three-phase voltage inputs, and one auxiliary voltage input to provide all common protective functions for generator applications. The voltage sensing circuits can be configured for single-phase, three-phase three-wire, or three-phase four-wire VT circuits.

The BE1-11g also includes an independent ground current input, typically used for applications with a separate ground CT such as a flux balancing window CT, or to provide ground backup protection for the generator step up transformer.

A fourth auxiliary voltage (Vx) input also is available. This voltage input can be connected to line side potential for sync check (ง25) and dead line (ง25VM) closing supervision, or to a ground sensing VT connection for ground fault protection on the delta side of a cogeneration intertie transformer.

All overcurrent elements can be independently set for forward, reverse or nondirectional control. Directional control is obtained by positive, negative and zero sequence directional elements. The zero sequence current polarized element uses the optional independent ground input for its polarization signal. The zero sequence voltage polarized element requires that the VT connection be 4W. The positive sequence directional element has memory voltage to provide reliable directional control for close in balanced three phase faults.

Tripping by voltage dependent functions ง24, ง25, ง27, ง59, ง32, ง40Q, ง78V and ง51V will be blocked if a sensed (PT) voltage is lost (ง60FL).

The target reporting function in the BE1-11g automatically adapts the targets as appropriate. For example, if both the ง50-2 and the ง51-1 are set for directional control and trip for a fault involving a phase, they post targets for an A phase fault as "ง50-2 67 A" for the directional instantaneous trip or "ง51-1 67 A" for the directional time trip.
FUNCTIONAL DESCRIPTION, continued

Three independent communications ports are available in the unit. The front panel USB 2.0 port provides for BESTCOMSPlus and BEST61850 communications with the relay. The rear panel RS-485 and optional Ethernet ports provide support for BESTCOMSPlus, BESTNetPlus, Modbus, DNP3 and BEST61850 protocols. Either a Remote RTD module, Modbus or DNP3 are supported through the RS-485 port. The Ethernet port will support concurrent Modbus and DNP3 sessions. The BE1-11 will concurrently support Modbus over RS-485 and DNP3 over Ethernet, or DNP3 over RS-485 and Modbus over Ethernet. Modbus can concurrently be supported through the Ethernet and RS-485 ports. The Ethernet port will support concurrent Modbus and DNP3 or two concurrent sessions of DNP3. The Ethernet port may be defined at the time of order to be either a copper (RJ45) or multi-mode fiber optic connection.

A standard IRIG-B port provides time synchronization for the relay from an external GPS clock.

Real-time metering provides watt, watthour, var, varhour, voltage, amp, and unbalance loading telemetry for the protected equipment. Contact sensing inputs and alarm monitoring functions provide real-time status information. Extensive power quality metering is built-in. Remote control is provided by virtual control and selector switches with select-before-operate control of programmable outputs.

Figure 3 shows alternate external connections for Vx and IG. Figure 4 illustrates typical sensing connections for sync check and ground differential protection. Figure 6 illustrates the functionality contained within this device, and Figures 8 and 9 show rear panel connections.
BESTLogicPlus

BESTLogicPlus programmable logic provides the user with high flexibility in configuring a protection and control system.

Each of the protection and control functions in the BE1-11g is implemented as an independent function block that is equivalent to its single function, discrete device counterpart. Each independent function block has all the inputs and outputs that the discrete component counterpart might have. Figure 7 shows a sample BESTLogicPlus screen available in the BE1-11g. Programming BESTLogicPlus is equivalent to choosing the functional devices required by your protection and control scheme and drawing schematic diagrams to connect the inputs and outputs to obtain the desired operational logic.

The BE1-11g relay can store, as user settings, one user-programmable, custom logic scheme. To save time, several preprogrammed logic schemes also are provided. Any of the preprogrammed schemes may be copied into the logic settings without making any additional BESTLogicPlus settings.

BESTLogicPlus provides the protection engineer with the flexibility to set up this powerful multifunction system with the same freedom that was once enjoyed with single-function, discrete devices. It is no longer necessary to compromise your standard protection and operating practices to deal with the limitations in programmability of previous multifunction devices. In addition, these advanced logic features have been added: edge triggers, all Boolean operations including XOR and XNOR gates, logic timers, counters and latches.
FUNCTIONAL DESCRIPTION, continued

The BE1-11g can be ordered with either an optional copper or optional fiber-optic Ethernet port. Figure 8 shows the optional copper Ethernet port. Figure 9 shows the optional fiber-optic Ethernet port.

Figure 8 - BE1-11g H- and P-Case Style Rear Panel Connections

Figure 9 - BE1-11g J-Case Style Rear Panel Connections

GENERAL SPECIFICATIONS

5 Amp CURRENT INPUTS
- Continuous rating: 20 A
- One second rating: 400 A
- Saturation limit: 150 A
- Burden: <10 milliohms

1 Amp CURRENT INPUTS
- Continuous rating: 4 A
- One second rating: 80 A
- Saturation limit: 30 A
- Burden: <10 milliohms

SEF
- Continuous rating: 4 A
- One second rating: 80 A
- Begins to clip (saturate): 7.5 A
- Burden: <22 milliohms

PHASE AC VOLTAGE INPUTS
- Continuous: 300 V, Line to Line
- One second rating: 600 V, Line to Neutral
- Burden: Less than 1 VA @ 300Vac
GENERAL SPECIFICATIONS, continued

AUXILIARY AC VOLTAGE INPUT (Vx)
Continuous: 150 V
One second rating: 600 V
Burden: Less than 1 VA @ 150Vac

A/D CONVERTER
Sampling rate: 32s/cycle, adjusted to input frequency 10-75 Hz

POWER SUPPLY
Option 1: 48/125Vac/dc dc range 35-150 V ac range 55-135 V
Option 2: 125/250Vac/dc dc range 90 - 300 V ac range 90 - 270 V
Option 3: 24Vdc dc range 17 - 32 V (down to 8 V for momentary dips)
Burden: 10 watts continuous, 12 watts maximum with all outputs energized

TRIP CONTACTS
Make and carry: 30 A (0.2 s)
Continuous: 7 A
Break: 0.3 A DC (L/R=0.04)

CONTROL INPUTS
Wetting voltage range:

<table>
<thead>
<tr>
<th>Power Supply Option</th>
<th>Low Range</th>
<th>High Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turn-on Voltage Range</td>
<td>Burden</td>
</tr>
<tr>
<td>1) 48/125 Vac/Vdc</td>
<td>26-38 Vac/dc</td>
<td>23k ohms</td>
</tr>
<tr>
<td>2) 125/250 Vac/Vdc</td>
<td>69-100 Vac/dc</td>
<td>66k ohms</td>
</tr>
<tr>
<td>3) 24 Vdc</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Control inputs recognize both dc and ac voltages.

COMMUNICATION PORTS
Bandwidth: 10/100Mbit Copper or 100Mbit Fiber Ethernet
Response time: <100 ms for metering and control functions
RS-485 Baud rate: Up to 115,200 bps

ELECTRICAL ENVIRONMENT
- IEC 60255-4 Single Input Energizing Quantity Measuring Relays with Dependent Specified Time
- IEC 60255-5 Electrical Insulation Tests for Electrical Relays. Dielectric Test and Impulse Test
- IEC 60255-6 Electrical Relays, Measuring Relays and Protection Equipment
- IEEE C37.90.1 Surge Withstand Capability Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE C37.90.2 Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE C37.90.3 Electrostatic Discharge Tests for Protective Relays

MECHANICAL ENVIRONMENT
- Operating temperature range: -40°C to 70°C* (-40°F to 158°F) *LCD display contrast may be impaired at temperatures below -20°C.
- Storage temperature range: -40°C to 70°C (-40°F to 158°F)
- IEC 60068-2-38 Composite Temperature/Humidity Cyclic Test
- IEC 60255-21-1 Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 1) and IEC 60255-21-2, Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 2)
- IEC 60068-1 Environmental Testing Part 1: General and Guidance. Temperature Test
- IEC 60068-2-1 Basic Environmental Testing Procedures, Part 2: Tests - Test Ad: Cold (Type Test)
- IEC 60068-2-2 Basic Environmental Testing Procedures, Part 2: Tests - Test Bd: Dry Heat (Type Test)

CERTIFICATIONS
- UL recognized per Standard UL 508 for use in the United States and to Standard CAN/CSA C22.2 No. 14 for use in Canada, UL File Number E97033
- CSA certified per Standard CAN/CSA-C22-2-14
- DNP3-2009, V2.6 compliant
- KEMA certified per IEC 61850 Level A
- Gost R certified per relevant standards of Gosstandart of Russia
- CE qualified - meets or exceeds standards for distribution in the European Community

PHYSICAL
Weight:
- H1 Rack Mount (H-case style)- 5.9 lbs (2.6 kg)
- H1 Panel Mount (P-case style)- 6.2 lbs (2.8 kg)
- Vertical Case (J-case style)- 5.1 lbs (2.3 kg)
IP class: IP50
Case size:
- H- and P-case:
  10.50"W x 3.49"H x 9.17"D with mounting flanges (266.7mm x 88.65mm x 232.92mm)
  8.64"W x 3.49"H x 7.92"D behind panel (219.46mm x 88.65mm x 201.17mm)
- J-case:
  7.00"W x 9.12"H x 7.91"D with mounting flanges (177.8mm x 231.65mm x 200.91mm)
  5.33"W x 8.41"H x 7.29"D behind panel (135.38mm x 213.61mm x 185.17mm)

WARRANTY 7 years
PERFORMANCE SPECIFICATIONS

OVER/UNDER TEMPERATURE PROTECTION (49RTD)
Setting range: 0-250°C (32-482°F)
Accuracy: ±2% or ±2°C, whichever is greater
Rest/pickup: 105%/95% ±1% or 5°C minimum

Definite Timing
Setting range: 0-600,000 ms in 1 second increments
Accuracy: ±1 second

INSTANTANEOUS OVERCURRENT WITH SETTABLE DELAY (50)
Pickup:
- 5 A CT 0.5 - 150.0 A
- 1 A CT 0.1 - 30.0 A
- SEF 0.01 - 7.5 A
Unbalanced 5 to 50%
PU time with TD = 0.00 s
2 cyc for P, N & G @ 5 x PU
3 cyc for Q @ 5 x PU
Delay time: 0.00 - 60 s
Time accuracy: ±0.5% or ±½ cyc for P and N
±0.5% or ±1 cyc for Q

TIME OVERCURRENT (51)
Pickup:
- 5 A CT 0.5 - 16.0 A
- 1 A CT 0.1 - 3.20 A
- SEF 0.01 - 0.8 A
Unbalanced 5 - 50%
Time dial:
- TD=K=0 - 99 for 46 curve
- TD=0.0 - 9.9 for all other curves

Time-Current Characteristics:
The following expression describes the inverse time current characteristic for each curve:

\[ T_f = \frac{AD}{M^n-C} + BD + K = \text{Time to trip} \]
\[ TR = \frac{RD}{M^p-1} = \text{Time for decaying reset} \]

where D = Time dial, M = Multiple of PU and A, B, C, N, K and R are constants that govern the shape of each curve. The protection engineer can set the constants for the P (programmable) curve to achieve virtually any characteristic.

### Curve Types and Constants

<table>
<thead>
<tr>
<th>Curve Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>N</th>
<th>K</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>0.2663</td>
<td>0.03393</td>
<td>1.000</td>
<td>1.2969</td>
<td>0.028</td>
<td>0.5000</td>
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<tr>
<td>S2</td>
<td>0.0286</td>
<td>0.02080</td>
<td>1.000</td>
<td>0.9844</td>
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<td>29.0000</td>
</tr>
<tr>
<td>F</td>
<td>0.0000</td>
<td>1.00000</td>
<td>0.000</td>
<td>0.0000</td>
<td>0.028</td>
<td>1.0000</td>
</tr>
<tr>
<td>46</td>
<td>*</td>
<td>0.00000</td>
<td>0.000</td>
<td>2.0000</td>
<td>0.028</td>
<td>100.0000</td>
</tr>
<tr>
<td>A1</td>
<td>0.1400</td>
<td>0.00000</td>
<td>1.000</td>
<td>0.0200</td>
<td>0.028</td>
<td>2.0000</td>
</tr>
<tr>
<td>B1</td>
<td>13.5000</td>
<td>0.00000</td>
<td>1.000</td>
<td>1.0000</td>
<td>0.028</td>
<td>3.2500</td>
</tr>
<tr>
<td>C1</td>
<td>80.0000</td>
<td>0.00000</td>
<td>1.000</td>
<td>2.0000</td>
<td>0.028</td>
<td>8.0000</td>
</tr>
<tr>
<td>D1</td>
<td>0.0515</td>
<td>0.11400</td>
<td>1.000</td>
<td>0.0200</td>
<td>0.028</td>
<td>4.8500</td>
</tr>
<tr>
<td>E3</td>
<td>19.6100</td>
<td>0.49100</td>
<td>1.000</td>
<td>2.0000</td>
<td>0.028</td>
<td>21.6000</td>
</tr>
<tr>
<td>F1</td>
<td>28.2000</td>
<td>0.12170</td>
<td>1.000</td>
<td>2.0000</td>
<td>0.028</td>
<td>29.1000</td>
</tr>
<tr>
<td>P</td>
<td>0 to 600</td>
<td>0 to 25</td>
<td>0 to 1</td>
<td>0.5 to 2.5</td>
<td>0.028</td>
<td>0 to 30</td>
</tr>
<tr>
<td>T</td>
<td>User defined currents and time delays.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Constant A is variable for the 46 curve and is determined as necessary based on system full load current setting, minimum pickup, and K factor settings.

** Tabular curve definition may include up to 40 points for each of 4 user-defined curves.

VOLTAGE RESTRAINT/VOLTAGE CONTROL (51V)
Control/restraint range: 30 - 250V
Accuracy: ±2% or ±1V, whichever is greater
PERFORMANCE SPECIFICATIONS, continued

DIRECTIONAL CONTROL (67) (ALL OVERCURRENT)

Mode: Forward, Reverse, Nondirectional
67P polarization: Positive Sequence with Memory or Negative Sequence
67Q polarization: Negative Sequence
67N polarization: Selectable any combination
Zero Sequence Voltage (Requires 4W VT)
Zero Sequence Current (Requires IG)
Negative Sequence Current

NEGATIVE SEQUENCE OVERCURRENT (46)
Included as modes of 50 and 51 elements. Refer to 50 and 51 description in Performance Specifications section.

CURRENT PICKUP ACCURACY (All 50 and 51)

Phase and ground: 5 A 2% or 50 mA
1 A 2% or 10 mA
SEF ± 2.5% or ± 2.5 mA, whichever is greater
Positive, neutral, negative sequence and unbalanced: 5 A 3% or 75 mA
1 A 3% or 75 mA

CURRENT DIFFERENTIAL (87)

Percent Differential
Tap: 5A CT 2.0 - 20 Amps
1A CT 0.4 - 4.0 Amps
Minimum PU: 0.10 - 1.00 times tap
Second slope PU: 0.1 - 20.0 per unit
Pickup accuracy:
5A CT ±4% or ±75 mA, whichever is greater
1A CT ±4% or ±25 mA, whichever is greater
Restraint method: Maximum, Average
Restraint slope: 15-60%
Response time: <2 cycles @ 5x pickup
<3 cycles @ 1.5x pickup
Time delay: 0 to 60,000 ms
Time delay accuracy: 0.5% or ±1/2 cycle, whichever is greater, plus trip time for instantaneous response (0.0 setting)

Flux Balance
Pickup: 5 A CT 0.1 - 5 Amps
1 A CT 0.01 - 1.0 Amp
Pickup accuracy:
5A CT ±2% or ±50 mA
1A CT ±2% or ±10 mA
Time delay: 0 to 60,000 ms
Time delay accuracy: 0.5% or ±1/2 cycle, whichever is greater, plus trip time for instantaneous response (0.0 setting)

NEUTRAL DIFFERENTIAL (87N)

Iop Minimum (A)
Setting range: 5A CT 0 or 0.1 to 5A
1A CT 0 or 0.02 to 1A
Time Delay (ms)
Setting range: 0 to 60,000 ms
Overcorrection Coefficient
Setting range: 1 to 1.3

BREAKER FAILURE (BF)

Time: 50 - 999 ms
Fault detect pickup range:
5 A CT 0.25 - 10 A
1 A CT 0.05 - 2.0 A
SEF 0.01 - 0.5 A
Time accuracy: ±0.5% or +1¼ cyc / - ½ cyc
PERFORMANCE SPECIFICATIONS, continued

OVEREXCITATION-VOLTS/HZ (24)

Pickup: 0.5 - 6 V/Hz
Delay Time: Inverse Squared Curve

\[ DT = (M-1)^2 \]
\[ TR = DR \times FST \times 100 \]

TT = Time to Trip
TR = Time to Reset
DT = Time Dial, Trip
DR = Time Dial, Reset
Actual V/Hz
M = Pickup V/Hz
ET = Elapsed Time
FST = Full Scale Trip Time (TT)

SYNC CHECK (25)

Voltage Difference (%)
Setting range: 0 or 1 to 50% of nominal
Accuracy: ±2% or ±1V, whichever is greater

Slip Angle (Degrees)
Setting range: 1° - 99°
Accuracy: ±1°

Slip Frequency (Hz)
Setting range: 0.01 - 0.5 Hz
Accuracy: ±0.01 Hz

Sensing Angle Compensation (Degrees)
Setting range: 0° - 359.9°

SYNC CHECK, VOLTAGE MONITOR (25VM)

Live/Dead Voltage (%)
Setting range: 0 or 10 to 90%
Accuracy: ±2%

Drop Out Delay (ms)
Setting range: 0 or 50 to 60,000 ms
Accuracy: ±0.5% or ±2 cycles, whichever is greater

Logic
Dead Phase/Dead Aux
Dead Phase/Live Aux
Live Phase/Dead Aux

SYNCHRONIZER (25A)

Voltage Difference (%)
Setting range: 0 or 2 to 15%
Accuracy: ±2% or ±1V, whichever is greater

Slip Frequency (Hz)
Setting range: 0 - 0.5 Hz
Accuracy: ±0.01 Hz

Min/Max Slip (Hz)
Setting range: 0 - 2 Hz

Breaker Close Angle (Degrees)
Setting range: 0 or 3 to 20°
Accuracy: ±1°

Breaker Close Time (s)
Setting range: 0 to 800 s
Accuracy: ±1% or ±3 cycles, whichever is greater

Breaker Close Attempts
Setting range: 0 to 5

Sync Fail Activation Delay (s)
Setting range: 0 or 0.1 to 600 s

Volt Pulse Width (s)
Setting range: 0 or 0.1 to 5 s
Accuracy: ±1% or ±3 cycles, whichever is greater

Volt Pulse Interval (s)
Setting range: 0 or 0.2 to 10 s
Accuracy: ±1% or ±3 cycles, whichever is greater

Frequency Pulse Width (s)
Setting range: 0 to 99.9 s
Accuracy: ±1% or ±3 cycles, whichever is greater

Frequency Pulse Interval (s)
Setting range: 0 to 99.9 s
Accuracy: ±1% or ±3 cycles, whichever is greater

Sensing Angle Compensation (Degrees)
Setting range: 0 to 359.9°

Live/Dead Voltage (%)
Setting range: 0 or 10 to 90%
Accuracy: ±2%

Drop Out Delay (ms)
Setting range: 0 or 50 to 60,000 ms
Accuracy: ±0.5% or ±2 cycles, whichever is greater

Logic
Dead Line/Dead Aux
Dead Line/Live Aux
Live Line/Dead Aux
PERFORMANCE SPECIFICATIONS, continued

PHASE OVER/UNDERVOLTAGE (27P, 59P)
- **Mode:** 1 of 3; 2 of 3; 3 of 3
- **Pickup:** 10.0-300 V
- **Delay time:** 0.05 - 600 s
- **Inverse delay equations:**
  - For overvoltage protection: \( t(G) = \frac{TD}{(G / G_s)^{-1}} \)
  - For undervoltage protection: \( t(G) = \frac{TD}{(G / G_s)^{-1}} \)
  - Where:
    - \( t(G) \) = operating time with constant value of \( G \) (seconds)
    - \( TD \) = time multiplier setting
    - \( G \) = measured value of the characteristic quantity
    - \( G_s \) = setting (pickup) value of the characteristic quantity

AUXILIARY OVER/UNDERVOLTAGE 3V0 (27X, 59X)
- **Mode:** Fundamental VX, 3 phase Residual (3V0), 3rd Harmonic VX
- **Pickup:** 1.0 - 150 V
- **Delay time:** 0.05 - 600 s
- **Inverse delay:** ±5% or 2 cycles

VOLTAGE PICKUP ACCURACY (All 27, 47 and 59)
- **Phase (V_L or V_LN):** ±2% or ±0.5 V
- **Phase 3V0 and V2:** ±2% or ±0.5 V

DEFINITE TIME ACCURACY (All 27, 47 and 59)
- **Definite time accuracy:** ±0.5% or ±1 cyc

NEGATIVE SEQUENCE OVERVOLTAGE (47)
Included as modes of 27X and 59X elements. Refer to 27X and 59X description in Performance Specifications section.

100% STATOR GROUND (64G)
Included as modes of 27X and 59X elements. Refer to 27X and 59X description in Performance Specifications section. Uses auxiliary voltage input to detect fundamental overvoltage (59X) and third harmonic undervoltage (27X).

VECTOR JUMP (78V)
- **Pickup:** 0 or 2 to 90°
- **Pickup accuracy:** ±1°

POWER (32)
- **Mode:** Forward, Reverse
- **Pickup:** 5 A: 1.0 - 6000 W, 3 ph
  1 A: 1.0 - 1200 W, 3 ph
- **Pickup accuracy:** ±3%
- **Delay time:** 0.05 - 600 s

UNDEREXCITATION (40Q)
- **Pickup:** 5 A: 1.0 - 6000 vars, 3 ph
  1 A: 1.0 - 1200 vars, 3 ph
- **Pickup accuracy:** ±3%
- **Delay time:** 0.05 - 600 s

LOSS OF EXCITATION (40Z) Dual element
- **Offset:** 0 - 110 Ohms, 5 Amp
  0 - 550 Ohms, 1 Amp
- **Diameter:** 0.1 - 100 Ohms, 5 Amp
  0.5 - 500 Ohms, 1 Amp
- **Accuracy:** ±3%
- **Time delays:** 0.0 - 60 s

DISTANCE (21)
- **Diameter (Secondary Ohm)**
  - Setting range: 0 - 500 Ohms
  - Accuracy: ±5% or ±0.2 ohms, whichever is greater
- **Time Delay (ms)**
  - Setting range: 0 - 300,000 ms
  - Accuracy: ±0.5% or ±2 cycles, whichever is greater
- **Torque Angle (Degrees)**
  - Setting range: 0 - 90°
  - Accuracy: ±1°
- **Offset (Secondary Ohm)**
  - Setting range: -500 - 500 Ohms
  - Accuracy: ±5% or ±0.2 ohms, whichever is greater

OUT OF STEP (78OOS)
- **Reverse/Forward Reach (Secondary Ohm)**
  - Setting range: 0 - 500 Ohms
  - Accuracy: ±5% or ±0.2 ohms, whichever is greater
- **Blinder A/Blinder B Offset (Secondary Ohm)**
  - Setting range: 0 - 500 Ohms
  - Accuracy: ±2% or ±0.1 ohms, whichever is greater
- **Blinder Angle (Degrees)**
  - Setting range: 1 - 90°
  - Accuracy: ±1°
- **Blinder Traverse Time Delay (ms)**
  - Setting range: 0 - 10,000 ms
  - Accuracy: ±0.5% or ±2 cycles, whichever is greater
- **Trip Delay (ms)**
  - Setting range: 0 - 5,000 ms
  - Accuracy: ±0.5% or ±2 cycles, whichever is greater
- **Min I1 (%)**
  - Setting range: 5 - 600%
  - Accuracy: ±2%
- **I2/I1 (%)**
  - Setting range: 10 - 200%
  - Accuracy: ±1%
PERFORMANCE SPECIFICATIONS, continued

**FREQUENCY (81)**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Over, Under</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup</td>
<td>20.00 - 70.00 Hz</td>
</tr>
<tr>
<td>Delay time</td>
<td>0.00 - 600 s</td>
</tr>
<tr>
<td>Time accuracy</td>
<td>±0.5% or +1 cyc / -0 cyc</td>
</tr>
<tr>
<td>(Min. trip time affected by min. 3 cycle security count)</td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>Rate of Change (ROC)</td>
</tr>
<tr>
<td>Pickup</td>
<td>0.2-20 Hz/s</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.1 Hz/s or 2%</td>
</tr>
</tbody>
</table>

**GENERAL PURPOSE LOGIC TIMERS (62)**

<table>
<thead>
<tr>
<th>Mode</th>
<th>PU/DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shot, Non-Retrig.</td>
<td></td>
</tr>
<tr>
<td>1 Shot, Retrig.</td>
<td></td>
</tr>
<tr>
<td>Integrating</td>
<td></td>
</tr>
<tr>
<td>Latch</td>
<td></td>
</tr>
<tr>
<td>T1 and T2 delay time</td>
<td>0.00 - 9999 s</td>
</tr>
<tr>
<td>Time accuracy</td>
<td>±0.5% or ±¾ cyc</td>
</tr>
</tbody>
</table>

**SETTING GROUPS**

| Setting groups        | 4                               |
| Control modes         | Automatic: cold-load pickup,    |
|                       | dynamic load or unbalance       |
| External: Discrete input logic or |
| Binary input logic    |                                 |

**METERING**

<table>
<thead>
<tr>
<th>Current range</th>
<th>5 A 0.5 to 15.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A 0.1 to 3.0</td>
<td></td>
</tr>
<tr>
<td>SEF 0.01 to 3.0</td>
<td></td>
</tr>
<tr>
<td>Current accuracy</td>
<td>±1%</td>
</tr>
<tr>
<td>Phase voltage range</td>
<td>3 W 0 - 300 V&lt;sub&gt;L&lt;/sub&gt;L</td>
</tr>
<tr>
<td>4 W 0 - 300 V&lt;sub&gt;L&lt;/sub&gt;L</td>
<td></td>
</tr>
<tr>
<td>Phase voltage accuracy</td>
<td>±0.5% for 50</td>
</tr>
<tr>
<td>Watt/Var</td>
<td>5 A 0 to ±7500</td>
</tr>
<tr>
<td>1 A 0 to ±1500</td>
<td></td>
</tr>
<tr>
<td>Watt accuracy</td>
<td>1% @ Unity PF</td>
</tr>
<tr>
<td>var accuracy</td>
<td>1% @ Zero PF</td>
</tr>
<tr>
<td>Energy</td>
<td>0 to ±1.0E12</td>
</tr>
<tr>
<td>(F/R registers)</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>10 - 75 Hz</td>
</tr>
<tr>
<td>Frequency accuracy</td>
<td>0.01 Hz</td>
</tr>
</tbody>
</table>

**DEMANDS (IA, IB, IC, IN, IQ, Fwd Watts, Rvs Watts, Fwd VARs, Rvs vars)**

| Demand interval       | 1 - 60 min.                     |

**BREAKER MONITORING**

<table>
<thead>
<tr>
<th>Duty mode</th>
<th>I or I&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty alarm range</td>
<td>0 - to 100%</td>
</tr>
<tr>
<td>Op counter alarm range</td>
<td>0 - 99999</td>
</tr>
<tr>
<td>Trip time alarm range</td>
<td>20 - 1000 ms</td>
</tr>
</tbody>
</table>

**REMOTE RTD MODULE**

The Remote RTD module provides up to 12 Remote RTD inputs, 4 remote analog inputs, and 4 remote analog outputs for the BE1-11<sup>g</sup> Generator Protection System. The Remote RTD module communicates with the BE1-11<sup>g</sup> through either a RS-485 connection, a copper Ethernet connection, or an optional fiber Ethernet connection.

Each of the 12 RTD inputs may be connected to a 3-wire type RTD. The characteristic of these is user selectable from standard 100 ohm Platinum, 100 ohm Nickel, 120 ohm Nickel, or 10 ohm Copper materials. A selection of RTD elements may be defined and utilized in the thermal model for the protection of the generator. The measured temperature associated with each RTD element may be displayed through the metering functions within BESTCOMS<sup>Plus</sup> and on the relay front panel.

The module monitors each input for the status of the connected RTD and communicates this to the BE1-11<sup>g</sup> for alarm if necessary.

Each analog input is user-selectable for 4 to 20 mAdc, or 0 to 10 Vdc. BESTCOMS<sup>Plus</sup> provides the user with level, inhibit, time delay, and over or under comparison settings for the specific parameter and allows the user to incorporate these inputs into the BESTLogic<sup>Plus</sup> as desired.

Each analog output is user-selectable for 4 to 20 mAdc, or 0 to 10 Vdc. These outputs display a selected parameter on an external analog meter and provide other functions. Many selectable parameters include the measured and calculated currents and voltages, or the temperature of any of the monitored RTDs.

Two models of the Remote RTD modules are available. Both models (9444100100 and 9444100101) are the same functionally except for the addition of the Fiber Ethernet port to 9444100101.

Two Remote RTD modules may be connected to a single BE1-11<sup>g</sup> Generator Protection System for complete thermal condition monitoring and to provide process control monitoring and display capabilities.
FUNCTIONAL DESCRIPTION, RTD MODULE

12 RTD Inputs
- Selectable RTD types
  - 3 wire RTDs with the following characteristics:
    - 100 ohm Platinum (DIN43760)
    - 100 ohm and 120 ohm Nickel
    - 10 ohm Copper
  - Range: -50 to 250°C (-58 to 482°F)
  - Accuracy: ±2°C (3.6°F)
  - Maximum Lead Length: 150 ft. (45.72m) with 22awg wire
  - Sensing current level is 2.5 mA
  - Isolation: 35V P-P

4 Analog Inputs
- BESTCOMSPLUS setting selects either a 4 to 20 mA or a 0 to 10 Vdc input range
- Accuracy: ±1% of full scale

4 Analog Outputs
- BESTCOMSPLUS setting selects either a 4 to 20 mA or a 0 to 10 Vdc output range
- Accuracy: ±1% of full scale
- Output capability:
  - 4 to 20 mA into a maximum 500 ohm load
  - 0 to 10 Vdc across a minimum 800 ohm load

Programmable fail safe alarm
- Form C
- Alarms for programmable selection of:
  - Analog Failure
  - Calibration Error
  - Defaults loaded due to file system operational error
  - Flash Memory Failure
  - Non Volatile Memory Handler errors

Communications
- RS-485 (19,200 baud)
- Copper Ethernet Connection - 10BASE-T/100BASE-TX RJ45 type connection port for CAT 5 copper wire
- Optional Fiber Optic Ethernet Connection - 100BASE-FX ST type connection port for multimode fiber (9444100101)
- Password Security

Real-Time Status of RTD Module is indicated by:
- A green LED on the Module
  - Slow flashing - Communications established
  - Steady on - Power applied
  - Quick flashing - Communications lost
- Communications will report to the BE1-11g
  - RTD status (Open, shorted, or missing)
  - Analog Input Status

Reporting Functions
- Version information
- Each RTD type
- Communications settings
- Module ID

GENERAL SPECIFICATIONS, REMOTE RTD MODULE

POWER SUPPLY
- 125/250 Vac/dc
- dc range 90-300 V
- ac range 90-270 V
- Burden: 8 Watts continuous
- 9 Watts maximum

ALARM CONTACT
- Form C
- Make and carry: 30A (0.2 s)
- Continuous: 7A
- Break: 0.3A dc (L/R-0.04)

ELECTRICAL ENVIRONMENT
- IEC 60255-4: Single Input Energizing Quantity Measuring Relays with Dependent Specified Time
- IEC 60255-5: Electrical Insulation Tests for Electrical Relays, Dielectric Test and Impulse Test
- IEC 60255-6: Electrical Relays - Measuring Relays and Protection Equipment
- IEEE C37.90.2: Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

CERTIFICATIONS
- UL recognized per Standard 508, UL File Number E97035
- CSA certified to Standard CAN/CSA-C22.2 Number 14-M91
- CE qualified
CASE SIZE
6.38"W x 8.38"H x 2.23"D
(162.05mm x 212.85mm x 56.64mm)
For surface mounting behind the panel

MECHANICAL ENVIRONMENT
• Operating temperature range: -40 to 70°C (-40 to 158°F)
• Storage temperature range: -40 to 70°C (-40 to 158°F)
• IEC 60068-1: Environmental Testing Part 1: General and Guidance, Temperature Test
• IEC 60068-2-1: Basic Environmental Testing Procedures, Part 2: Tests - Test Ad: Cold (Type Test)
• IEC 60068-2-2: Basic Environmental Testing Procedures, Part 2: Tests - Test Bd: Dry Heat (Type Test)
• IEC 60068-2-38: Composite Temperature/Humidity Cyclic Test
  • IEC 60255-21-1: Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 1 - Vibration Test - Sinusoidal). Class 1
  • IEC 60255-21-2: Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 2 - Shock and Bump Test - Sinusoidal). Class 1
  • IEC IP rating of IP50.

SHIPPING WEIGHT  Approx. 2.15 pounds (0.975 kg)

WARRANTY  7 years

ORDERING, REMOTE RTD MODULE

9444100100  Remote RTD module with 12 user definable RTD inputs, 4 analog inputs, 4 analog outputs. For use with 90-300Vdc / 90-270Vac power source, and includes RS-485 and RJ45 type copper Ethernet ports.

9444100101  Remote RTD module with 12 user definable RTD inputs, 4 analog inputs, 4 analog outputs. For use with 90-300Vdc / 90-270Vac power source, and includes RS-485, RJ45 copper and multimode ST type fiber optic Ethernet ports.

Figure 10 - Mounting Dimensions, Remote RTD Module
ORDERING

SAMPLE STYLE NUMBER
The style number identification chart defines the electrical characteristics and operation features included in BE1-11 relays. For example, if the style number is BE1-11 G5A1M2H2N1E000, the device has the following:

- **G** - Generator Application
- **S** - 5 Amp Phase Nominal Current
- **A** - 5 Amp Ground Nominal Current
- **1** - 48/125 Vac/Vdc Power Supply
- **M** - Modbus Protocol
- **2** - Modbus/TCP with BESTNetPlus
- **H** - Half-Rack Case
- **2** - Normally Closed Alarm
- **N** - None
- **1** - Fiber Optic Ethernet
- **E** - English Language
- **0** - None
- **00** - Latest Release Of Firmware

STANDARD ACCESSORIES
- 9289900016 Escutcheon plate to panel mount two dovetailed H1 relays.
- 9289924100 Adapter bracket to mount single H1 case in 19" rack.
- 9289929100 Adapter bracket with cutout for ABB FT test switch, to mount a single H1 case in a 19" rack.
- 9424200073 Multilin 750/760 retrofit mounting plate.
- 9424226100 Test terminal block assembly kit for J-case relays.