Application Note

BESTCOMS*Plus*® Series – BE1-11 Step-By-Step Guide to Using BESTCOMS*Plus*®, BESTspace™, and Preprogrammed Logic Schemes: *Feeder Protection with Interlock*

Setting up a numeric relay has never been easier than with BESTCOMS*Plus* BESTspace tool. A recent national study on electrical reliability has shown that the majority of numeric relay misoperations are caused by incorrect settings/design error. BESTspace combats the issue by clearly identifying relevant settings and adapting to your specific application - minimizing errors and time spent creating settings files. Although BESTspace files can be created and customized, the purpose of this guide is to assist you in using Basler Electric preconfigured BESTspace and preprogrammed logic files.

Feeder Protection with Interlock

This guide is a walkthrough of the *Feeder Protection with Interlock* BESTspace and logic scheme. The logic scheme provides protection for the system represented by the one line diagram shown in Figure 1. These two items are intended for use on feeder breakers to provide overcurrent protection, breaker failure protection, reclosing, and control functions required for typical feeders in nondirectional overcurrent protection applications. The logic scheme provides time and both high-set and low-set instantaneous overcurrent elements for phase, neutral and negative-sequence protection. Automatic reclosing is included and is initiated (RI) by a protective trip. The breaker may be manually opened or closed via the virtual breaker control switch (101). Protective voltage features are not enabled in this scheme; however, these features may be activated through BESTlogic™*Plus*. Interlock logic allows for bus overcurrent backup of feeder relays and allows for fast bus overcurrent protection. When used with other programmable relays using the *Primary Bus Overcurrent Protection* and *Backup Bus Overcurrent Protection* logic schemes, the *Feeder Protection with Interlock* logic provides protection when the feeder relay is out of service (test mode). Unneeded elements can be disabled without changing the logic.

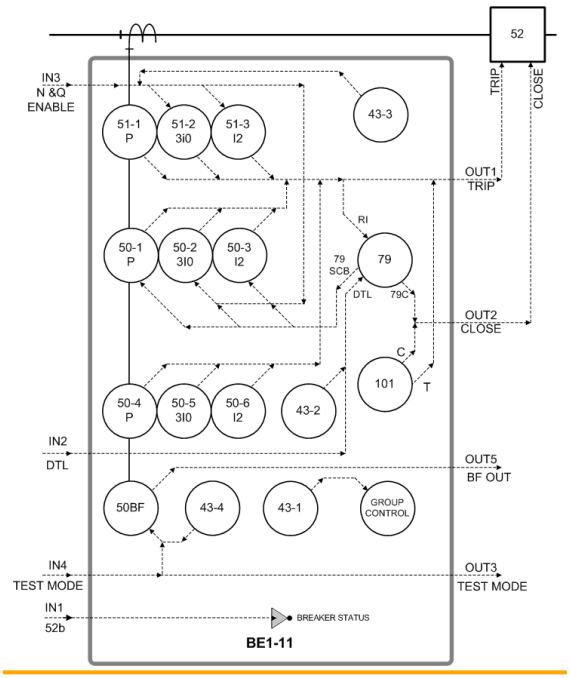

Figure 1 - One-Line Diagram of Feeder Protection with Interlock

Recently, the BESTspace feature was added to BESTCOMS*Plus*. Opening a BESTspace file automatically formats the BESTCOMS*Plus* environment to support specific activities. BESTspace files do not add or alter actual settings. The BESTspace discussed in this document is specially designed to work with the *Feeder Protection with Interlock* logic scheme developed by Basler.

Opening the BESTspace File

BESTCOMS*Plus* refers to the software suite used to program BE1-11 relays. The BESTspace featire is only compatible with BESTCOMS*Plus* v 2.11.01 or greater.

If not already installed on your computer, it is easy to download the latest version at www.basler.com. BESTCOMS*Plus* requires an activation key for use without an active BE1-11 connection. Please email request for activation to info@basler.com.

The BESTspace file can be downloaded from www.basler.com/Product/BE1-11-Logic-Schemes.

To begin, launch BESTCOMS*Plus* and click on the 'File' dropdown menu at the top left-hand corner of the window. Select to open a new BE1-11 file as shown in Figure 2.

BESTCOMS*Plus* will then open a default settings file. To open the BESTspace file, click on 'View' directly below 'File' and select to open a new BESTspace as shown in Figure 3.

Based on the screen capture in Figure 4, click 'Load' on the Load/Save Window BESTspace File window and browse for the BESTspace file 'FeederProtectionwithInterlock.bswx'. Click 'Apply' to open the BESTspace.

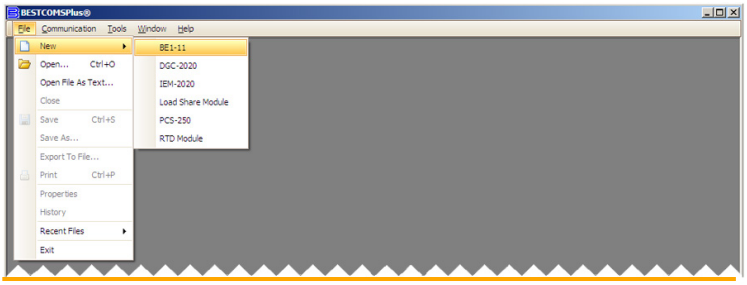

Figure 2 - Opening a File in BESTCOMS*Plus*

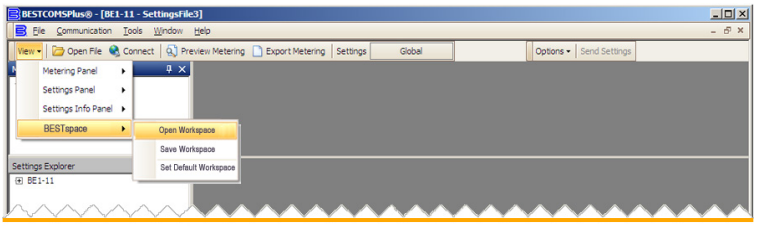

Figure 3 - Opening a New BESTspace in BESTCOMS*Plus*

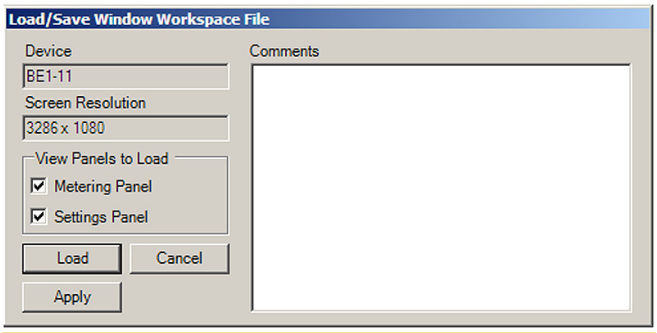

Figure 4 - Loading a BESTspace File

Establishing the Style Number

Figure 5 demonstrates how the BESTspace formats the working environment with the Style Number screen on top. The BESTspace formats the working environment with the Style Number screen on top. The environment is tab-based, with tabs aligned across the top of the screen. Check the relay front faceplate for the style number and enter it on the style number screen using the dropdown selection boxes. Note that any setting or menu shown as disabled or grayed out can be safely disregarded. The right-hand bottom portion of the viewable area contains settings information such as settings ranges and units. It can be closed at any time to increase viewing area. Tabs can be closed by clicking on the 'x' to the right of the right-most tab. Doing this will close the active tab. Close the style number screen when finished. Successive tabs should be closed once you are finished, except where noted.

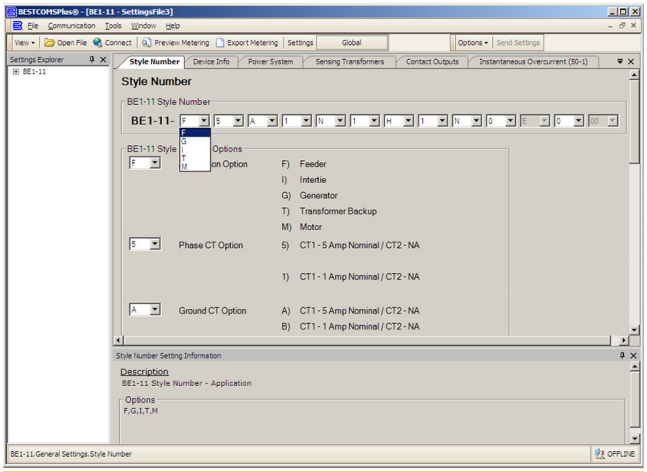

Figure 5 - The Style Number screen is on top when starting a BESTspace

Accessing Device Info

Closing the style number screen causes the next tab to the right, "Device Info", to activate. The Device Info screen contains information about the embedded software in the connected BE1-11 relay. If you are not connected to a relay, this should be mostly blank. It will populate information automatically when settings are downloaded from a relay. Device, station and user IDs also can be specified here.

Power System

The Power System screen contains information about your system that the relay uses to perform internal calculations. Starting under Nominal Settings, enter the system frequency, nominal secondary voltage in terms of PN quantities, and nominal secondary current (this is the secondary rating of your CT). For a basic overcurrent application, the auxiliary voltage input is not typically used, so this setting is left as-is. The phase rotation of the system is crucial. A reverse setting will cause the relay to calculate erroneous negative sequence current and possibly misoperate.

Although the power line parameters are useful, they are not necessary if the information is not available. MTA is necessary only if you plan to specify a directional overcurrent element. Additional details on the power line parameter and MTA settings can be found in the BE1-11 instruction manual.

Sensing Transformers

The Sensing Transformers screen contains settings used to calculate primary voltage and current from the sensed secondary values. These settings are important for accurate primary metering and pickup values set in terms of primary quantities. Enter the turns ratio for the phase and ground CTs. For example, if your CT is 1200:5, the setting would be 1200/5=240. If there is no ground CT in your system, this setting can be left unchanged.

Follow the same process for the phase VT setup, making sure to specify the type of transformer connection (4W-Y, 3W, PN, or PP). The auxiliary VT ratio and connection type is not necessary for a typical overcurrent application. When using a 4W-Y connection, the relay can operate on PN or PP sensed voltage for the 27 and 59 element. Since no voltage elements are to be used, this setting also can be left unchanged.

Contact Inputs and Outputs

Closing the previous screen will pull up two successive Contact Inputs and Outputs screen. These screens allow you to customize the physical alarms and contact I/O with a label and energized state labels. All customized labels will appear on the BE1-11 LCD screen.

Each input has a contact recognition and debounce setting. The default contact recognition and debounce settings enable their use on ac signals as well as dc signals. Since the *Feeder Protection with Interlock* scheme utilizes four contact inputs, label them here:

- Input #1 is designated as a 52b breaker status input.
- Input #2 is a manual input to drive the 79 to lockout.
- Input #3 is used to enable or disable neutral and negative-sequence overcurrent elements.
- Input #4 is used to enable or disable test mode.

The hold attribute serves several purposes for contact outputs. The main use for the BE1-11 is to prevent the relay contact from dropping out until the current has been interrupted by the 52a contacts in series with the trip coil. If the tripping contact opens before the dc current is interrupted, the contact might be damaged. Label the contact outputs:

- Output #1 is the designated trip output for protective elements. It is also tied logically to the virtual breaker 101 trip switch and the breaker failure retrip function.
- Output #2 closes the breaker through the virtual breaker 101 switch and is also the 79 reclose output.
- Output #3 is used to activate relays with the *Primary Bus Overcurrent Protection* logic scheme while the feeder relay is in test mode.
- Output #4 blocks all upstream devices when it is picked up, has not declared a breaker failure, and is not in test mode.
- Output #5 is a breaker failure trip to be fed to a main bus relay using the *Backup Bus Overcurrent Protection* logic scheme.

Labeling of the contact I/O is not required, but is a handy feature for analyzing relay operations and categorizing I/O.

Instantaneous Overcurrent (50-1, 50-2… 50-6)

The next six tabs contain settings for the Instantaneous Overcurrent elements. By default, all protection elements are disabled. Choosing a mode of operation enables them. There are several modes of operation for overcurrent elements on the BE1-11:

1. I_A, I_B, I_C operates only on the selected phase of current.
2. 3 Phase will monitor all three phases and operate on any one of them.
3. $3I_0$ operates on the calculated zero-sequence current (calculated 50G).
4. I_2 operates on the calculated negative-sequence current (46).
5. I_G operates on the ground CT input only (50G).
6. I_1 operates on the calculated positive-sequence current.
7. Unbalance operates on calculated unbalanced current.

The *Feeder Protection with Interlock* logic scheme utilizes a high and low set phase, neutral and negative-sequence instantaneous overcurrent elements. Any of the six 50 elements will trip OUT1. Low set elements are for detecting transient faults that may be cleared after reclosing the breaker. They initiate a reclose sequence for phase (50-1), neutral (50-2) and negative sequence (50-3) pickups. The other three high set elements detect severe bolted faults and drive the 79 to lockout. These elements are designated phase (50-4), neutral (50-5) and negative sequence (50-6). All protective overcurrent trips initiate the breaker failure element.

Enter the secondary current pickup and intentional time delay (if no intentional time delay is desired, leave at 0). Choose the directionality of the element "Non-Directional". If six instantaneous overcurrent elements are not needed, they can be left disabled as you continue to the next tab.

Breaker Fail (50BF)

The breaker failure screen shows the logical operation of the element, as well as all of the associated settings. If your application implements a breaker failure element, enable it under the 'Mode' setting. This logic scheme only uses the 50BFI input to initiate the element.

Upon sensing, the 50 initiate (50BFI) transitions from 0 to 1 state and a Control Timer seals in the 50BFI signal for the duration of the Control Timer setting. If the Control Timer expires and the 50BFI signal is still present, an alarm signal will occur. The Control Timer improves security by presenting a window of opportunity for the breaker failure element to operate. It improves dependability by sealing in the initiate to prevent the stop breaker failure timing if the tripping relay drops out prematurely. A Control Timer setting of zero will disable the control timer seal-in function, allowing the Control Timer to follow the 50BFI input.

Phase and neutral fault detectors monitor current in the three phases and the optional ground current input. At least one of these four fault detectors must pick up to start the breaker failure Delay Timer. The current detector logic is TRUE if the current has been interrupted and is used to stop the BF timer.

The I=0 algorithm looks at the sample data directly and does not rely upon the one cycle phasor estimation calculation. It rejects dc tail-off by looking for the characteristic exponential decay. Current will be declared to be interrupted when the current in all three phases is below 5% nominal or if the current is decaying exponentially. Only the three phase currents are monitored by this function.

When the 50BFI is asserted, the Control Timer has timed out and current is sensed on the phase or neutral inputs based on the pickup settings, the I=0 algorithm drops out, and the block input is '0' - the Delay Timer will start. When the Delay Timer has timed out, a breaker failure trip output will occur.

Inverse Overcurrent (51-1, 51-2, 51-3)

There are three inverse overcurrent elements for phase (51-1), neutral (51-2), and negative sequence (51-3) detection.

The element screen contains a setting for pickup, time dial, curve, direction, and reset timing. There are many curves to choose from; however, if these curves do not fit your needs, you can either program your own custom curve using the IEEE C37.112 equation or construct one of up to 40 custom points using a table curve. The table curve feature adds points to the curve and uses a point and click interface to move points around once they are inserted. Configuring a table curve is done on a separate screen under protection > current.

Be sure to set the directionality (non-directional) and reset type. An integrating reset mimics the behavior of an electromechanical reset. When used to provide high-speed overcurrent protection for the substation bus, it is recommended that all 51 function timing curves be set for instantaneous reset. Both the inverse timing curve and the reset time can be viewed by changing the selection below the graph.

Current/Protection/Control Setting Summary

The Current, Protection and Control summary screens allow you to view all elements that are enabled and the modes of operation. If elements are disabled when you believe they should be enabled, it will appear on these screens. Each element will have a status color to the right and the mode of operation to the left. Green status indicates that the element is enabled, yellow indicates the setting is disabled by a setting other than the mode (i.e. the element has an invalid setting such as a pickup of 0.000 amps), blue indicates the setting is disabled by only the mode setting, and gray indicates the element has both an invalid setting and disabled mode.

It is a good practice to leave these screens open and double check the protection elements you have set up once you are finished.

Recloser (79)

The reclosing function provides up to four reclosing attempts that can be initiated by a protective trip or by one of the contact sensing inputs. It can be enabled by selecting a mode of operation. The reclose times are settable between 100 and 600,000ms. To make additional attempts available, enter a valid time for Reclose Time 1. The logic scheme is designed to inhibit 50-1 (low set phase), 50-2 (low set neutral), and 50-3 (low set negative sequence) via Sequence Controlled Blocking (SCB). If you wish to inhibit these elements for any re-trip, enable SCB by checking the appropriate box. For more information on the SCB feature, please consult the BE1-11 manual.

The *Feeder Protection with Interlock* logic scheme can be modified so any of the four recloser shots can be used to select a different settings group when the appropriate shot is reached in a reclosing sequence. This change in settings groups allows changing protection coordination during the reclosing sequence.

For example, you could have a fast 51 curve on the first two trips in the reclosing sequence and then on the second reclose switch to a new group that uses a slow 51 curve. For more information on settings groups, please consult the BE1-11 manual.

The reset time is the amount of elapsed time required after a successful reclose for the 79 to reset. A maximum cycle timer keeps track of the entire reclose sequence, locking out the 79 when it is exceeded. The reclose fail time is the amount of acceptable time between a reclose output and the breaker state input.

Virtual Control Switches (43, 101)

The BE1-11 contains two types of virtual switches. The 43 is a general purpose virtual switch while the 101 is designated for breaker control. The four 43 switches in the *Feeder Protection with Interlock* logic scheme are not enabled by default.

- Switch 43-1 can be used to enable or disable automatic settings group selection.
- Switch 43-2 is a virtual drive-to-lockout input.
- Switch 43-3 is a virtual toggle switch to enable or disable the neutral and negative sequence elements low set instantaneous and time overcurrent elements.
- Switch 43-4 is a virtual toggle switch to enable or disable the breaker failure element.

The 43 tab allows labeling of the switch and on/off positions. Labeling is not required but is useful for determining switch function at a glance. If you plan to use the virtual breaker switch, enable it on the 101 tab.

BESTlogic™*Plus*

BESTlogic*Plus* is a powerful tool used to internally route trip signals and other virtual I/O based on system status to physical I/O. Elements can be conditionally enabled or disabled in the logic scheme, such as breaker position. Other important features contained in BESTlogic*Plus* are the ability to trigger oscillographic records and configure switchable settings groups.

Preprogrammed logic schemes make it easy to import a file for common applications. To download logic files, please visit www.basler.com/Product/BE1-11-Logic-Schemes and download the logic scheme 'Feeder with Interlock'. To import a logic file, click on the 'Logic Library' dropdown menu shown in Figure 6. Find and open 'FeederProtectionwith-Interlock.bslx' to import the file.

The BESTlogic*Plus* working environment is nested within BESTCOMS*Plus* and follows the same tabbed interface. Each tab is a new page to organize and build logic. To the left of the logic pages is a toolbox containing all status, physical I/O, logic gates, and elements. Items in the toolbox can be dragged and dropped onto any logic page. Logical I/O are conveyed among pages using custom labeled off-page inputs and outputs.

Preprogrammed logic is complete as downloaded. No changes are necessary to use it. Reviewing it is recommended. Below are the tabs that are available:

- *Input/Output* - You will find a brief description of the logic scheme on this page. Additionally you will find the physical output assignments with a description of their intended purpose.
- *Reclosing/Switches* - This tab shows the interconnection of the 43 and 101 switches plus the recloser and breaker failure elements. Elements such as the recloser are represented by blocks with logic inputs on the left side and outputs on the right. The 43 switches are disabled by having logic '0' tied to all of the inputs. For a full description of the elements on any tab, please consult the BE1-11 instruction manual.
- *Current* - Logic elements can be blocked by asserting logic 1 at the 'Block' input. The 'Current' tab utilizes this feature on the low set instantaneous overcurrent elements by tying the block inputs to other off page inputs. The 50-2, 50-3 elements can be blocked via SCB or IN3. Similarly, the inverse time overcurrent 51-1, 51-2, and 51-3 can be disabled via IN3. Logic elements such as the 50-1 generate 'Pickup' and 'Trip' signals used elsewhere in the logic scheme via off-page outputs to generate physical trips and oscillography.
- *Misc. Logic* - The Misc. Logic tab shows the consolidation of the element off-page outputs using OR gates and two more off- page outputs, 'Trip Bus' and 'Pickup Bus'. Also on this tab is the settings groups. The fault trigger oscillography element is also on this tab. It is useful to have a consolidated bit for performing other functions elsewhere in the logic scheme, for triggering oscillography and for having a single trip output.

To use the logic scheme, click on the 'Save' button, shown in Figure 7, so that it is saved to the settings file. Before saving, a functional logic scheme will have three indicators at the bottom right-hand corner of the window. A yellow and two greens indicate there are no errors in the scheme and it can be saved. Saving the logic will result in three green indicators.

To finish, save the entire settings file by clicking on 'File' at the top left-hand corner of the BESTCOMS*Plus* window and select 'Save' or 'Save As…'.

For More Information

To get more information on BESTCOMS*Plus* and the BE1-11 product line, including additional application notes, product bulletins, and instruction manuals, go to www.basler.com or contact Technical Support at 618-654-2341.

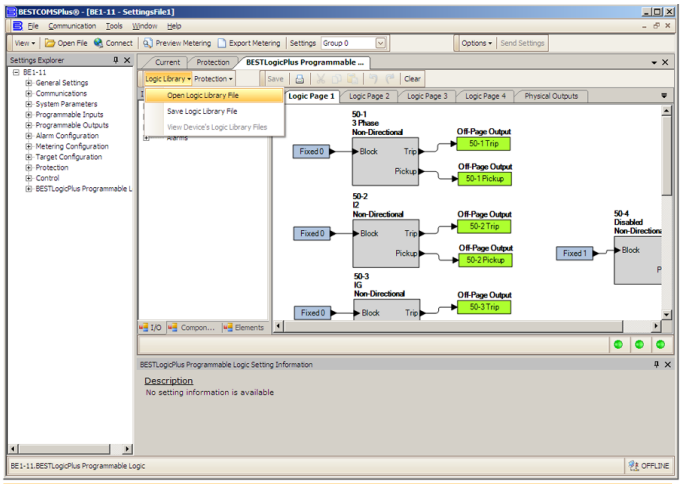

Figure 6 - Working with the Logic Library

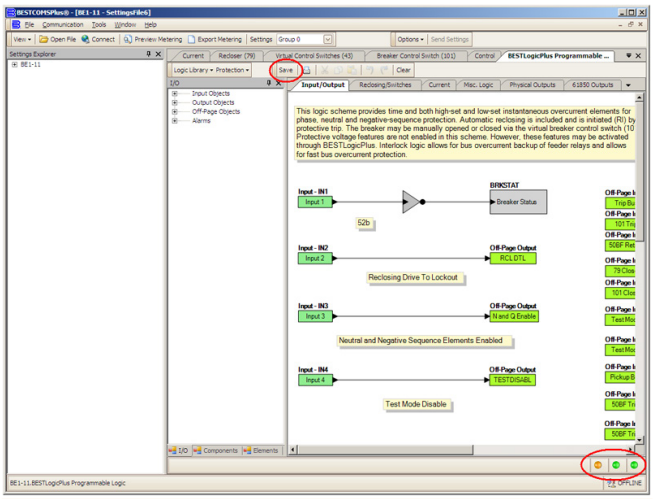

Figure 7 - Saving a Settings File with a Functional Logic Scheme

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