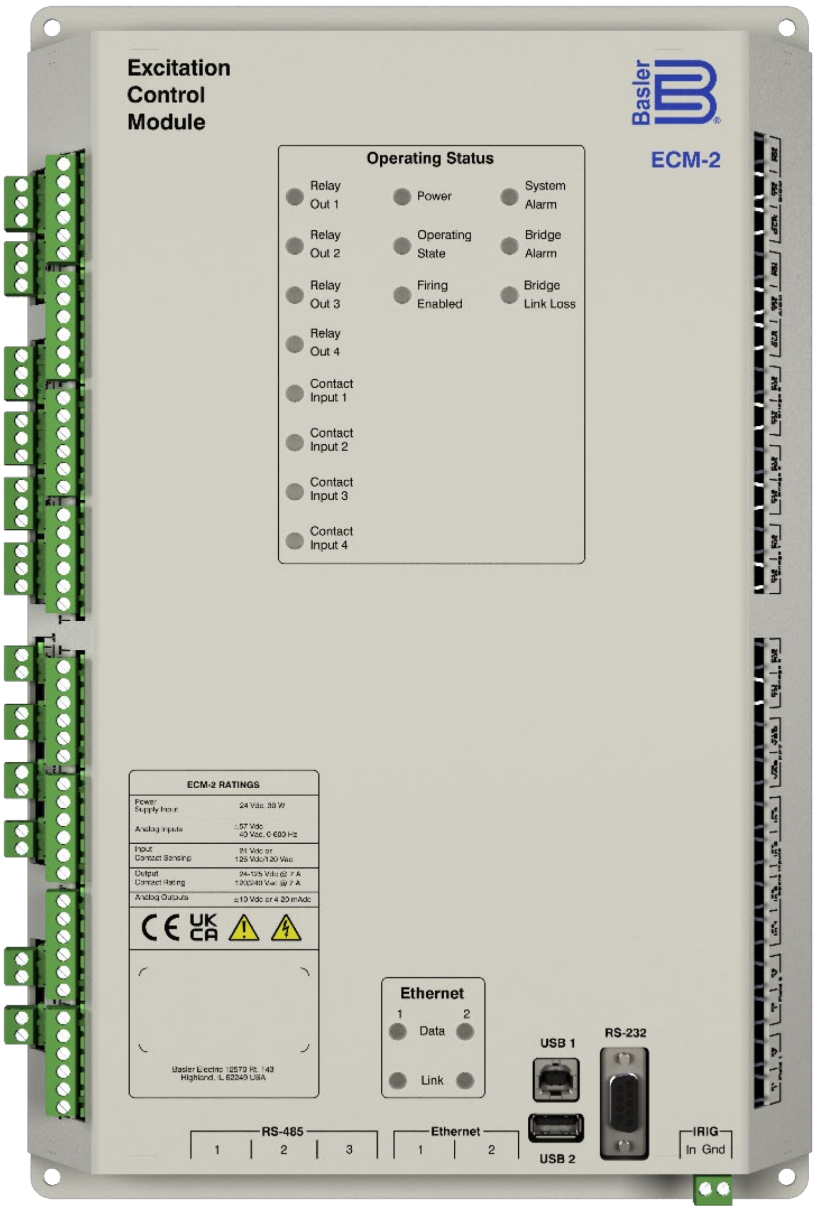
ECM-2

Excitation Control Module

Instruction Manual



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Preface

This instruction manual provides information about the installation and operation of the ECM-2 Excitation Control Module. To accomplish this, the following information is provided:

- General Information
- Indicators and Interfaces
- Functional Description
- Mounting
- Terminals and Connectors
- BESTCOMS™*Pro* Software
- Commissioning
- Modbus™ Protocol
- Maintenance
- Specifications

Warning!

To prevent personal injury or equipment damage, only qualified personnel should install, operate, or service this system.

Conventions Used in this Manual

Important safety and procedural information is emphasized and presented in this manual through Warning, Caution, and Note boxes. Each type is illustrated and defined as follows.

Warning!

Warning boxes call attention to conditions or actions that may cause personal injury or death.

Caution

Caution boxes call attention to operating conditions that may lead to equipment or property damage.

Note

Note boxes emphasize important information pertaining to installation or operation.

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Warning!
READ THIS MANUAL. Read this manual before installing, operating, or maintaining the ECM-2 Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

Revision History

A historical summary of the changes made to this instruction manual is provided below. Revisions are listed in reverse chronological order.

Refer to Basler publication 9410100899 (DECS-2100 and ECS2100 Revision History) for ECM-2 hardware and firmware revision history as well as BESTCOMS™*Pro* software revision history.

Instruction Manual Revision History

Manual Revision and Date	Change
F, Jun-25	• Added statement about RS-485 signaling • Added note about energizing aluminum electrolytic capacitors • Added FCC compliance statement • Removed altitude specification • Added section for troubleshooting BESTCOMS™*Pro* screen resolution • Removed firmware and software history • Updated figures to reflect new cover
E, Nov-24	• Removed references to CD-ROMs
D, Feb-17	• Added caution statement about nonvolatile memory • Corrected relay output contact specifications • Added procedure for manual installation of the USB driver • Updated the CE compliance statement • Added an NIIPT compliance statement
C, Mar-13	• Revised the minimum PC recommendations (Table 3) for BESTCOMS™*Pro* • Updated Figure 7, Figure 20, and Table 14 to reflect new BESTCOMS™*Pro* toolbar icon (close button) • Added caution box addressing the suitability of Auto Tuning PID values in the Commissioning chapter • In BESTCOMS™*Pro* chapter, Data Monitoring descriptions and illustrations were updated to reflect consolidation of settings into two screen views. • Replaced workspace material with discussion of BESTspace™ • Revised *Updating* BESTCOMS™*Pro* to cover manual and automatic updating of the software • Added bridge status screens and descriptions to BESTCOMS™*Pro* chapter • Updated "Monitor View" illustrations in BESTCOMS™*Pro*
B, Apr-12	• Moved Logic Blocks into separate manual (9411300991) • Converted manual to latest style • Minor text edits in *Introduction* • Replaced Figures 7, 8, and 9. (Added ™ to BESTCOMS™*Pro)*
A, Dec-11	• Initial release

Contents

1 • Introduction

The ECM-2 Excitation Control Module provides the core functions of regulation, input sensing, and thyristor firing control in a DECS-2100 Digital Excitation Control System. Functions previously provided by three separate circuit boards in ECS2100 systems are now provided by one compact module. The ECM-2 replaces the Sensor Input Module (SIM), Exciter Control Module (ECM), and Firing Control Interface Module (FCIM) previously used in ECS2100 systems. ECM-2 advantages include:

- Fully-enclosed package provides protection of key system circuitry
- Previously-required space for three, separate circuit boards is reduced to one compact module
- The proven reliability of the ECS2100 system design with added functionality:
  - Improved thyristor firing accuracy
  - Increased number of analog inputs from 12 to 24
  - Standard ECM-2 hardware configuration supports up to four power bridges via fiber optic communications. The expanded fiber optic version can accommodate up to 16 power bridges
  - Expanded event recording and data logging capability
  - Additional USB port accepts removable storage media for downloading events, data logs, and alarm logs without the use of a computer
  - Cross-current compensation between excitation systems through a built-in communication via RJ-45 port over Ethernet
  - IRIG-B and NTP time synchronization provides synchronized data recording.
  - Additional RJ-45, 10BASE-T/100BASE-TX Ethernet port for a dedicated control network protocol

2 • Indicators and Interfaces

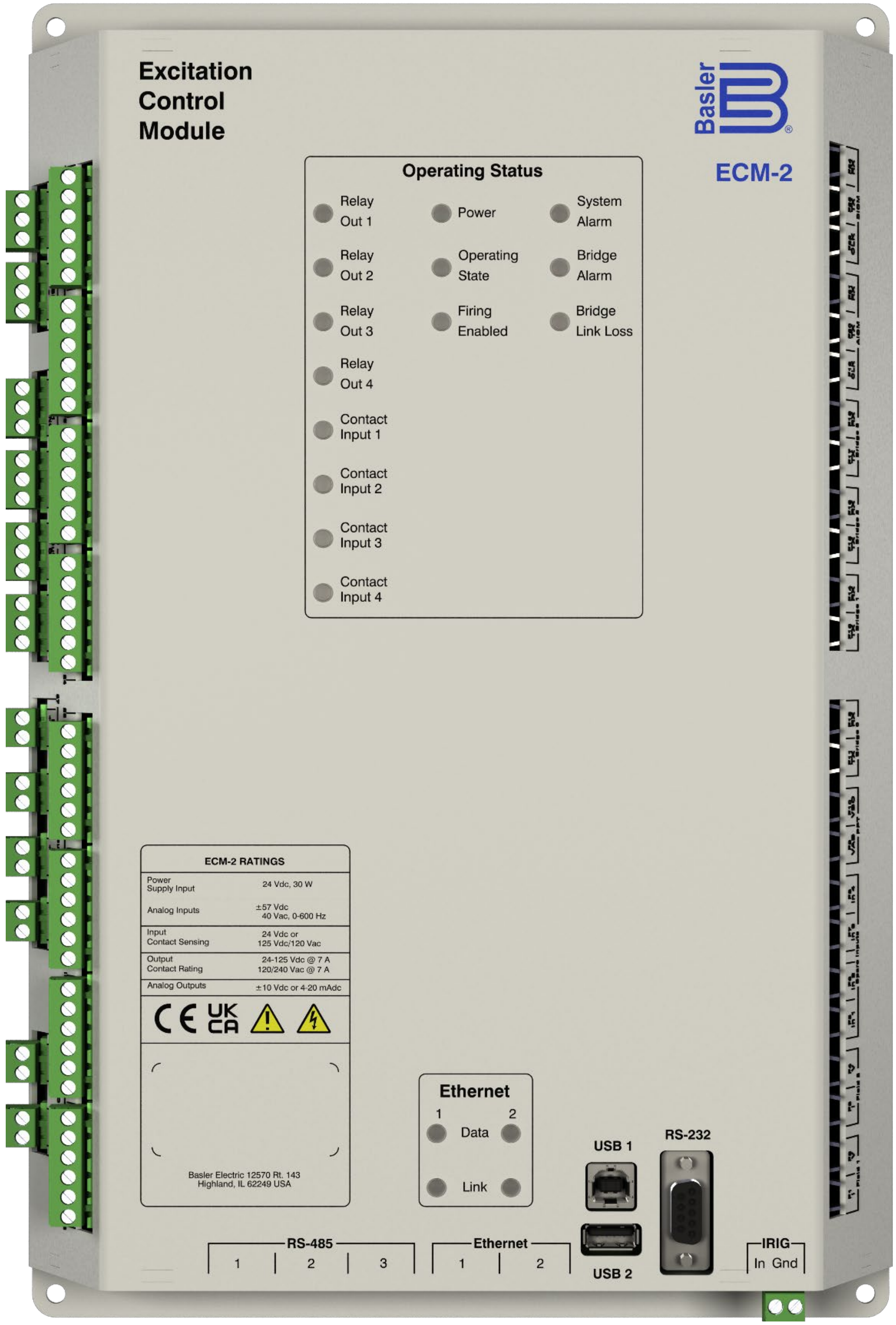

Figure 2-1. ECM-2 Indicators and Interfaces

Indicators

LED indicators, located on the front panel, provide the status of ECM-2 functions.

Power

This green indicator lights to indicate the presence of ECM-2 operating power at either of the ECM-2 power supply inputs (PS1 or PS2).

Operating State

This green indicator annunciates the three operating states of ECM-2 operating code.

When the function block logic within the user's application program is not being executed by the ECM-2 firmware, this indicator is unlit.

A flashing indicator annunciates that execution of the logic within the user's application program is occurring but the DECS-2100 system is offline (41A, breaker open).

Execution of application logic in an online (41A, breaker closed) DECS-2100 system is annunciated by a steadily-lit indicator.

Firing Enabled

This green indicator lights when the ECM-2 module is supplying power bridge SCR firing commands to the DECS-2100 system's Bridge Control Module (BCM).

System Alarm

This red indicator lights when a system alarm exists within the ECM-2 module.

Bridge Alarm

This red indicator lights when a power bridge problem or failure is detected by the Bridge Control Module (BCM) and communicated to the ECM-2 module.

Bridge Link Loss

This red indicator lights to indicate a loss of the fiber-optic signals between the ECM-2 module and the Bridge Control Module (BCM).

Relay Out 1, 2, 3, and 4

Four amber indicators annunciate the energized/de-energized status of the four programmable relay outputs. A lit indicator annunciates that the corresponding relay is energized.

Contact Input 1, 2, 3, and 4

Four amber indicators annunciate the open/closed status of the four externally-wetted programmable contact inputs.

Ethernet

Two sets of indicators show the status of the two Ethernet communication ports. The green Link indicators light to indicate that the corresponding Ethernet port connection is active/enabled. The amber Data indicators light when the ECM-2 module is transmitting or receiving data over an Ethernet network.

Interfaces

Interfaces provide communication between the ECM-2 and other system devices.

USB Connectors

Two USB connectors are located on the front panel. An A-type, USB connector, designated USB 2, connects with a USB flash drive for the downloading of DECS-2100 event records, data log, and alarm log. A B-type USB connector, designated USB 1, mates with a standard USB cable and is used for communication between the DECS-2100 system and a PC operating BESTCOMS™*Pro*.

RS-485 Connectors

Three eight-pin, RJ-45 jacks, located on the lower side of the ECM-2 module, enable communication with distributed control, SCADA systems, or other operator interface devices via Modbus™ RTU. The RS-485 connectors are identified with the numbers 1, 2, and 3.

In the ECM-2 design, RS-485 signaling is half-duplex where each RJ-45 connector has Pin 4 connected to the Inverting signal and Pin 5 connected to the Non-Inverting signal.

Ethernet Connectors

Two eight-pin, RJ-45 jacks, located on the lower side of the ECM-2 module, are intended for local area network (LAN) communication (10BASE-T/100BASE-TX). Typically, one jack is used for communication with the DECS-2100 display panel. In a typical DECS-2100 system, the user will not plug directly into these Ethernet ports. Instead, these Ethernet ports will be connected to an Ethernet switch which will accept any of the Ethernet connection required by the user. The Ethernet connectors are identified with the numbers 1 and 2 and have separate MAC addresses.

RS-232 Connector

A nine-pin, D-sub connector, located on the front panel, enables communication with the ECM-2 and Bridge Control Modules through a PC operating BESTCOMS*Pro* software.

3 • Functional Description

ECM-2 performs functions previously performed in ECS2100 systems by three, separate modules: Sensor Input Module (SIM), Exciter Control Module (ECM), and Firing Control Interface Module (FCIM). The functionality of these modules has been retained with some enhancements. ECM-2 functions are illustrated in the block diagram of Figure 3-1.

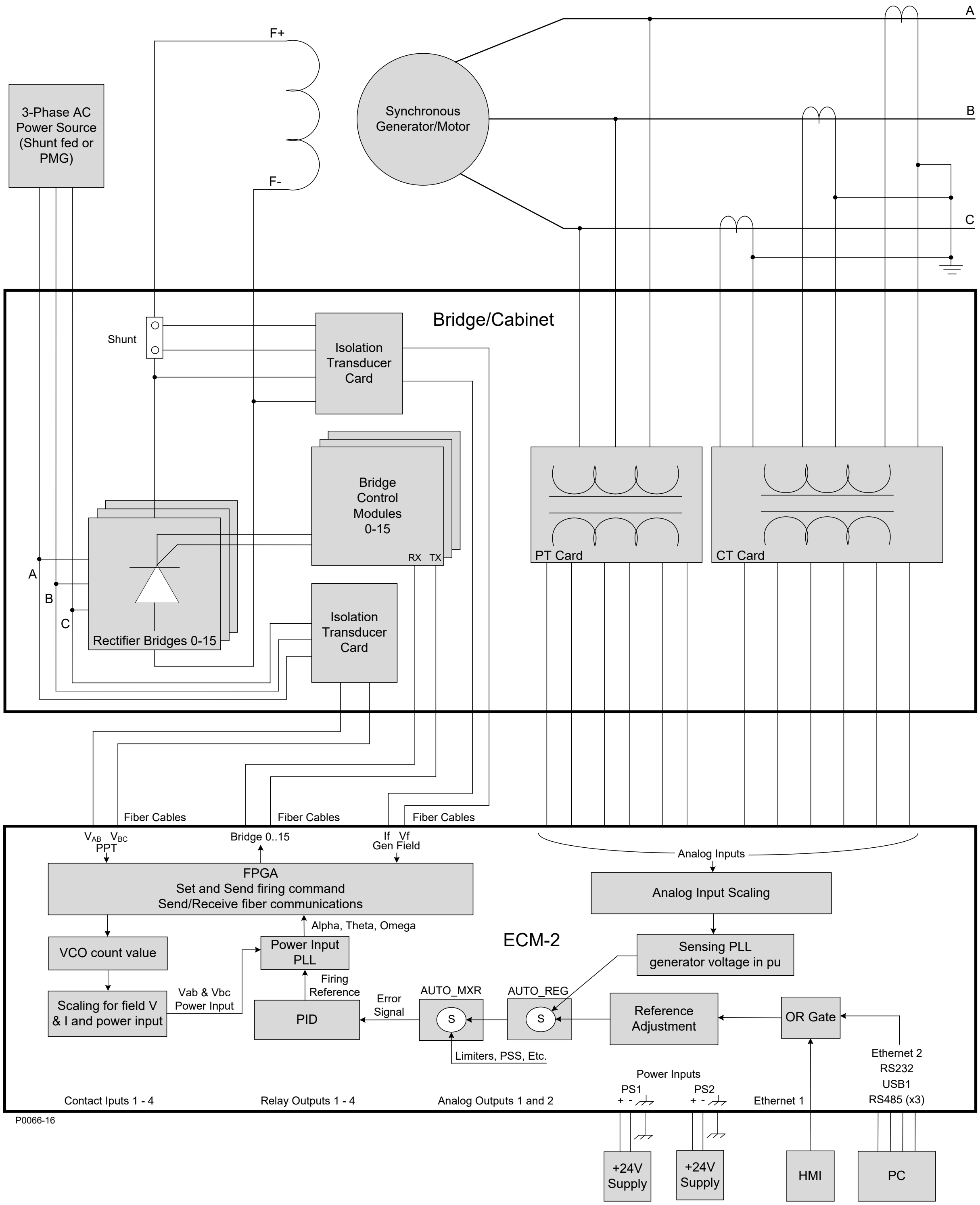

Figure 3-1. ECM-2 Function Blocks

Sensor Inputs

Twenty-four, high-speed analog inputs (channels) collect data (sensing values) from the generator PTs and CTs and other analog signal sources through hard-wired inputs. Fiber-optic connections receive digital signals supplied by the DECS-2100 system Digital I/O Modules. Analog and temperature signals supplied by the DECS-2100 system Analog I/O Modules are also received through fiber-optic connections on the isolation transducer card interface. Analog inputs are digitized and provided to the excitation circuitry for interpretation.

Excitation Control

The excitation control portion of the ECM-2 module provides the primary control for the DECS-2100 system and consists of logic for excitation control, limiting, protection, and communication.

Regulation

Regulation modes are described in the following paragraphs.

Manual Regulation

This function provides closed-loop regulation of field current (or during system testing, field voltage). Manual regulation mode is typically the default control mode used when the PT signal is lost.

When operating in manual regulation mode, the ECM-2 maintains the field current level to within ±0.5% of the setpoint throughout the entire load range of the generator. The field current regulation setpoint is adjustable over the range of 1 or 5% of no-load field current to 125% of rated load current.

Automatic Regulation

This function provides closed-loop regulation of the generator terminal voltage and is derived from the regulator PTs. In the event of a regulator PT failure, it can be derived from the metering PTs.

When operating in automatic regulation mode, the steady-state generator terminal voltage is held to within ±0.2% over the entire load range. The voltage adjustment range is 40 to 120% of the rated terminal voltage. Regulation occurs for generator frequencies over the range of 20 to 180 hertz.

Several types of generator current compensation can be provided as auxiliary signals to the automatic regulation function. Reactive droop and line drop compensation use a processed CT input to modify the operating point value based upon the magnitude of the reactive portion of the line current. Cross-current compensation uses an additional CT input from another generator or data exchanged via an Ethernet link to provide for reactive current sharing of paralleled generators.

Var Regulation/Control

This function compares the calculated var level of the generator output to an internal reference (var adjuster) value. The difference between the two values is multiplied by a gain and then used for var control or var regulation.

For var control, if a condition exists where the var error is outside the acceptable window for the duration of the preset time delay, the var controller acts to control the voltage regulator to keep the var level near the prescribed value. If a condition exists where the var error is outside the acceptable window for less than the duration of the preset time delay (such as, during transients), the system continues to function like a voltage regulator.

Var regulation is sometimes utilized in industrial applications where the generator is providing local power factor correction in addition to real power (watts). In this application the var error substitutes for the ac voltage error. Proper adjustment of parameters is critical for stable operation in this application.

A var adjuster function provides the means for varying the generator var output by varying the internal references applied to the digital var regulator error function.

Power Factor Regulation/Control

This function compares the calculated generator power factor value to an internal reference (PF adjuster). The difference between the two values is multiplied by a gain and then used for power factor control or power factor regulation.

Power factor control operates in a similar manner to var control.

Power factor regulation operates in a similar manner to var regulation. Power factor regulation, like var regulation, is sometimes utilized in industrial applications where the generator is providing local power factor correction in addition to real power (watts). In this application, the power factor error substitutes for the ac voltage error. Proper adjustment of parameters is critical for stable operation in this application. Note also that the power factor error is not nearly as sensitive to var output as the var error at unity power factor. At unity power factor a 1% bandwidth in power factor (0.99 lag to 0.99 lead) corresponds to a var bandwidth of 14% (±0.14 per unit of generator rating). The power factor to var relationship is also highly nonlinear. For this reason, power factor regulation is not normally a recommended mode of operation.

A power factor adjuster function provides the means for varying the generator power factor output by varying the internal references applied to the digital power factor regulator error function.

Limiters

Limiting functions are described in the following paragraphs. Dual setpoints/gain groups are available.

Minimum Excitation Limiter (MEL)

The MEL maintains machine excitation above a predetermined MVA characteristic and thus prevents the machine from reaching underexcited conditions that could endanger synchronism with the power system. The inputs to this limiter are taken from the CT and PT signals, and the resultant operating point is compared to an approximated steady-state stability limit curve. The MEL function sends an output that is proportional to the distance from the limiter curve and the operating point. The MEL output is auctioneered against the ac error signal to prevent excitation from decreasing below the desired level. This function operates in the same manner as traditional analog systems in that the limiter curve is based upon assuming it is a steady-state stability limit, and as such, is recalibrated based upon the square of the system voltage.

Underexcitation Limiter (UEL)

The UEL is nearly identical to the MEL (minimum excitation limiter). However, it is capable of recalibration of the limit curve based upon the stator temperature or the hydrogen cooling gas pressure. Thus, it is used for limiting of underexcited conditions based upon the generator capability. The inputs to this limiter are also taken from the CT and PT signals. The resultant operating point is compared to the limit curve. The UEL function sends an output that is proportional to the distance from the limiter curve and the operating point. The UEL output is auctioneered against the ac error signal to prevent excitation from decreasing below the desired level.

Overexcitation Limiter (OEL)

This function limits the magnitude and duration of excessive current and voltage applied to the exciter or machine field. The limiter returns excitation to a preset level after an adjustable time delay. The limiter operates on an inverse time characteristic, permitting lower values of overexcitation for longer time periods and cutting off higher values of overexcitation in shorter time intervals. The OEL function also has cool-down modeling that provides a “memory” of the heating effects of excessive overcurrent. The OEL function sends an output that is proportional to the distance from the limiter curve and the operating point. The OEL output is auctioneered against the ac error signal to prevent excitation from increasing above the desired level.

Volts per Hertz Limiter

This limiter protects the generator from excessive volts per hertz operating conditions. This could result from system frequency dropping below normal or from system conditions causing overvoltage at nominal frequency. Excessive volts per hertz can cause overheating of the machine and unit transformer. This limiter has an inverse time characteristic that can be reduced when offline to prevent excessive volts per hertz during coast-down of a unit for circumstances where the excitation system remains energized. The

Volts per Hertz Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Volts per Hertz Limiter output is auctioneered against the ac error signal to prevent volts per hertz increasing above the desired level.

Overvoltage Limiter

The overvoltage limiter protects the generator from sustained, high levels of terminal voltage. High terminal voltage can occur due to either full-load rejection (on a large hydro unit) or a failure within the excitation system. The Overvoltage Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Overvoltage Limiter output is auctioneered against the ac error signal to prevent voltage from increasing above the desired level.

Undervoltage Limiter

The undervoltage limiter protects the generator from sustained, low levels of terminal voltage. Low terminal voltage can occur due to a failure within the excitation system. The Undervoltage Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Undervoltage Limiter output is auctioneered against the ac error signal to prevent voltage from decreasing below the desired level.

Minimum Field Excitation Limiter (MFEL)

The MFEL maintains the generator field current or voltage at a user-adjustable level. The MFEL function sends an output that is proportional to the distance from the limiter curve and the operating point. The MFEL output is auctioneered against the ac error signal to prevent field excitation from decreasing below the desired level.

Instantaneous Overcurrent Limiter

This limiter prevents the excitation system from producing high output currents in excess of any useful level, such as could occur if a turn-to-turn short appears in the field. As the name implies, there is no intentional time delay in actuation of this limiting function. The Instantaneous Overcurrent Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Instantaneous Overcurrent Limiter output is auctioneered against the ac error signal to prevent current from increasing above the desired level.

Var Limiter

The var limiter protects the generator from sustained, high levels of vars. High var levels can occur due to a failure within the excitation system. A user-defined setpoint limits the maximum var flow. The Var Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Var Limiter output is auctioneered against the ac error signal to prevent the var level from increasing above the desired level.

Generator Line Current Limiter

The generator line current limiter lowers the field current during overexcitation and raises the field current during underexcitation. The limiter operates after the field current exceeds the user-defined pickup level. The Generator Line Current Limiter function sends an output that is proportional to the distance from the limiter curve and the operating point. The Generator Line Current Limiter output is auctioneered against the ac error signal to prevent generator line current from increasing above below the desired level.

Regulation Mode Selection (PID Controller)

This function provides the means to utilize proportional, integral, and derivative closed-loop control of the generator terminal voltage. Dual gain settings are available. Separate gain settings are available when operating in manual mode.

Excitation System Stabilizer ("Damping")

Damping compensates for the inherent, long time delay associated with the response of the generator and exciter fields of brushless or rotating exciter systems. The excitation control system is stabilized by applying a negative feedback to the ac error and limiter functions. This feedback signal is derived from either the generator or exciter field current (or voltage) rate of change and scaled by a gain factor.

Transient Gain Reduction (TGR)

TGR is usually applied only to static excitation control systems. It is normally used for improving system stability by providing separately defined time constants for the various limiters and error detectors.

Adjuster Followers (Setpoint Tracking)

The adjuster follower functions provide for a "bumpless" transfer of the digital regulator from ac voltage regulation to dc field current regulation and vice versa.

In field current regulation mode, the follower in the ac adjuster is enabled. It senses the ac error signal, changes the setpoint of the ac error signal, and changes the setpoint of the ac adjuster to keep the error within a preset bandwidth.

In the ac voltage regulation mode, the follower in the digital dc adjuster is enabled. It senses the dc error signal and changes the setpoint of the digital dc adjuster to keep the error within a preset bandwidth.

Balance Meter Driver

This driver provides a signal for a balance meter. Use of a balance meter helps the operator ensure that a transfer from manual to auto mode is bumpless.

Power System Stabilizer (PSS)

The optional PSS feature damps oscillations that may occur due to voltage regulators swinging against the balance of the power system. The PSS function may be configured to incorporate the IEEE dual-input model, which can accommodate both an instantaneous electrical power signal and either a frequency or speed input signal.

Protection Functions

The excitation control portion of the ECM-2 module can be programmed to provide the following protective functions:

- Over/Undervoltage
- Volts per Hertz
- Overexcitation
- Loss of Field Underexcitation
- Loss of Sensing
- Phase Unbalance
- Field Ground

The protection pickup setting in the ECM-2 must be coordinated with any additional, external backup protective relays that may be utilized.

Field Temperature Monitor

The exciter and/or generator field temperature can be accurately calculated and displayed with this function. Temperature is calculated based upon the known field resistance at a known temperature (usually 25°C). The measured resistance is obtained by dividing the measured field voltage by the measured field current. The temperature is then determined based upon the temperature coefficient of the winding material (usually copper).

Data Logger

A time- and date-stamped group of 12 user-selectable parameters also serves as a continuous data logger function. Up to 100,000 points (shared equally with up to 12 selected parameters can be recorded. ECM-2 data logger functions are configured in BESTCOMS™*Pro*.

Event Recorder

Four configurable event recorder blocks are capable of capturing up to eight input event records per recorder block. There are 100,000 points of data dedicated to each recorder block. Data point collection intervals can be as short as one millisecond. ECM-2 event recorder functions are configured in BESTCOMS*Pro*.

Sequence of Events Logging

A time- and date-stamped list of up to 16,000 internal and user-defined variables are logged. User-defined variables are selected in BESTCOMS*Pro*.

Power Bridge Firing Interface

This portion of the ECM-2 module provides SCR firing commands to the DECS-2100 system Bridge Control Modules. In turn, each Bridge Control Module controls the level of dc output power supplied by the corresponding power bridge. Power bridge output is determined by a control signal supplied from the excitation control circuitry to the firing control logic. To generate the SCR firing signals, the firing control circuitry creates timing signals that are time- and pattern-synchronized with the monitored, three-phase PPT voltage. (The PPT voltage is monitored by way of an Isolation Transducer connected to the ECM-2 module's PPT fiber-optic input.) The firing signals, interspersed with data signals, are transmitted to the DECS-2100 system Bridge Control Modules via fiber-optic connections.

In its standard configuration, the ECM-2 module can control from one to four sets of Bridge Control Modules and power bridges. In its optional configuration, up to 16 sets of Bridge Control Modules and power bridges can be controlled.

In addition to power bridge control, this circuitry processes power bridge alarms received from the Bridge Control Modules and provides the alarm data to the excitation control logic. Processed alarms include SCR loss, high power bridge temperature, and low power bridge temperature.

4 • Mounting

ECM-2 circuitry is housed in a metal enclosure with a footprint of 14 by 9 inches (36 by 23 centimeters). Enclosure dimensions are illustrated in Figure 4-1.

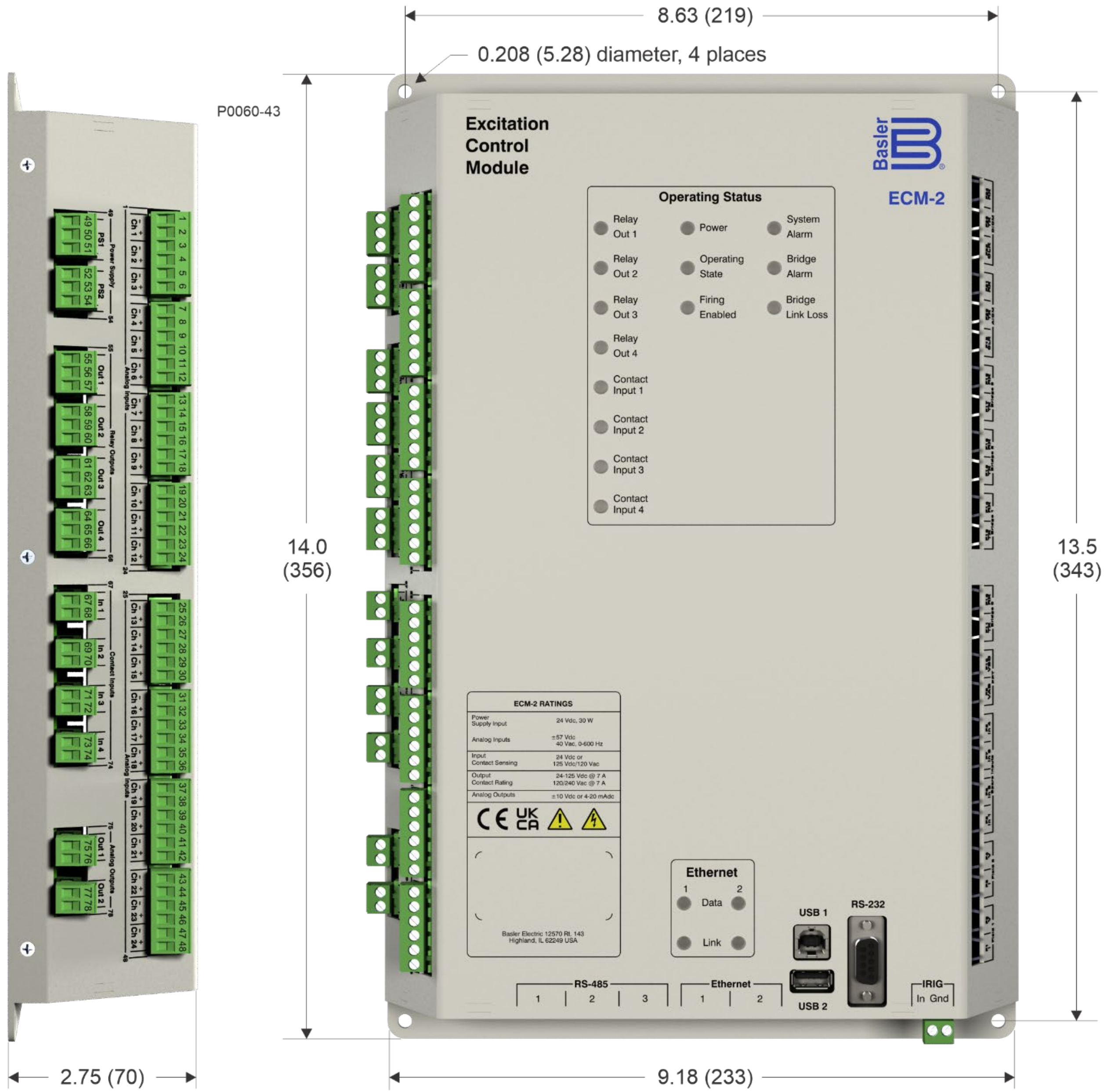

Figure 4-1. ECM-2 Outline Dimensions

5 • Terminals and Connections

ECM-2 connections are made on the left, right, and lower sides of the module and use the following connector types. ECM-2 terminal connections are shown in Figure 5-1. The following paragraphs describe the physical aspects of the ECM-2 module.

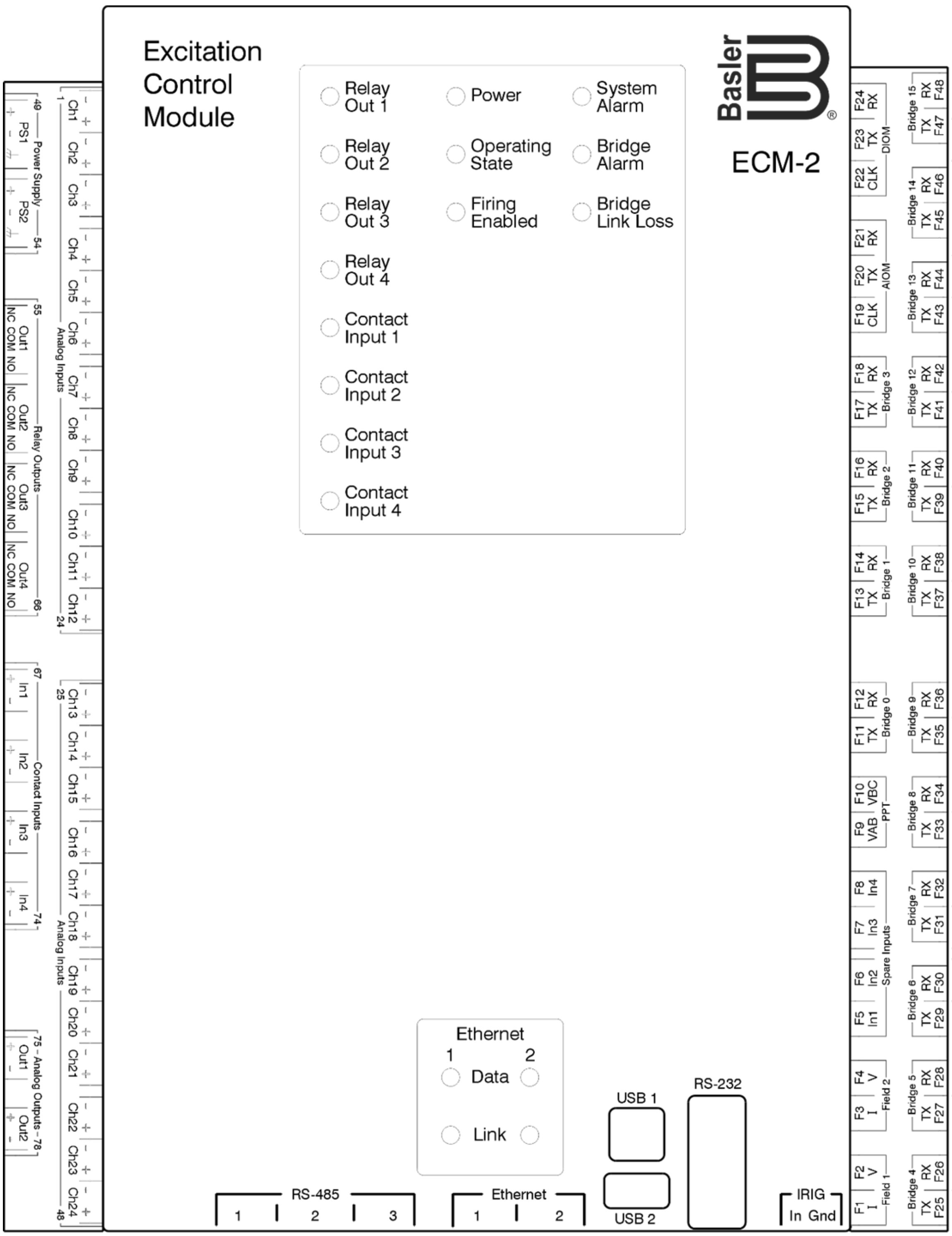

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Figure 5-1. ECM-2 Terminal Connections

Screw-Terminal Connectors

Connections on the left side and bottom of the module use connectors with screw-down, compression terminals. The connectors, and the headers that they plug into, have a dovetailed edge that ensures proper connector orientation. Similar-sized connectors and headers are uniquely keyed to ensure that a connector mates only with the correct header to prevent damage to the ECM-2. However, care must still be taken to ensure that the proper connector is inserted into the appropriate header. Connector screw terminals accept a maximum wire size of 12 AWG or 2.5 mm^2. The maximum screw torque is 5 in-lb or 0.6 N•m. Screw terminal connectors are used for the analog inputs, power supply inputs, relay outputs, contact inputs, analog outputs, and the IRIG input.

Analog Inputs

The ECM-2 module has 24 analog inputs (channels) available to receive generator PT and CT metering signals as well as other analog signals. Each of the 24 high-speed inputs is differential and accepts a 40 Vac rms signal (+57 or –57 Vdc peak). Inputs are sampled simultaneously every 64 microseconds and averaged every 512 microseconds for an 8-sample average. Analog inputs are identified by channel numbers: Ch1 through Ch24. Analog input terminal assignments are listed in Table 5-1.

Table 5-1. ECM-2 Analog Input Terminal Assignments

Channel	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12
Terminals	1 (–) 2 (+)	3 (–) 4 (+)	5 (–) 6 (+)	7 (–) 8 (+)	9 (–) 10 (+)	11 (–) 12 (+)	13 (–) 14 (+)	15 (–) 16 (+)	17 (–) 18 (+)	19 (–) 20 (+)	21 (–) 22 (+)	23 (–) 24 (+)
Channel	**Ch13**	**Ch14**	**Ch15**	**Ch16**	**Ch17**	**Ch18**	**Ch19**	**Ch20**	**Ch21**	**Ch22**	**Ch23**	**Ch24**
Terminals	25 (–) 26 (+)	27 (–) 28 (+)	29 (–) 30 (+)	31 (–) 32 (+)	33 (–) 34 (+)	35 (–) 36 (+)	37 (–) 38 (+)	39 (–) 40 (+)	41 (–) 42 (+)	43 (–) 44 (+)	45 (–) 46 (+)	47 (–) 48 (+)

Power Supply Inputs

Two power supply inputs accept 24 Vdc operating power from two separate sources for failsafe operation. (One 24 Vdc power source applied to one of the power supply inputs is sufficient for ECM-2 operation. Only one should be energized at a time.) Each power supply input has an operating range of 16.8 to 36 Vdc. Internal holdup circuitry maintains ECM-2 operation through power interruptions as long as 200 milliseconds. The power supply inputs are designated PS1 and PS2. PS1 terminal assignments are 49 (+), 50 (–), and 51 (chassis ground). PS2 terminal assignments are 52 (+), 53 (–), and 54 (chassis ground).

Relay Outputs

Four SPDT relay outputs are available for annunciation of user-defined conditions. Relay outputs are configured to annunciate the desired conditions in BESTCOMS™*Pro*. Relay output ratings are listed in the *Specifications* chapter. The relay outputs are designated Out 1, Out 2, Out 3, and Out 4. Out 1 terminal assignments are 55 (NC), 56 (COM), and 57 (NO). Out 2 terminal assignments are 58 (NC), 59 (COM), and 60 (NO). Out 3 terminal assignments are 61 (NC), 62 (COM), and 63 (NC). Out 4 terminal assignments are 64 (NC), 65 (COM), and 66 (NO).

Contact Inputs

Four sets of terminals accept wetted contact inputs from external switches or other system devices. Contact inputs can be individually configured within BESTCOMS*Pro* to trigger ECM-2 responses to the inputs. Contact inputs are designated In1, In2, In3, and In4. In1 terminal assignments are 67 (+) and 68 (–), In2 terminal assignments are 69 (+) and 70 (–), In3 terminal assignments are 71 (+) and 72 (–), and In4 terminal assignments are 73 (+) and 74 (–).

The interrogation voltage for each contact input is switch-selectable and set at the factory for 24 Vdc or 125 Vdc/120 Vac depending on the DECS-2100 system configuration. If the ECM-2 is supplied as a stand-alone or replacement unit, the switches should be set according to your system. The switches are accessed just above the In1, In2, In3, and In4 connectors on the left side of the unit. See Figure 5-2.

Caution

Ensure that the unit is de-energized before attempting to set the contact input switches. A thin non-conductive rod should be used to set the switches.

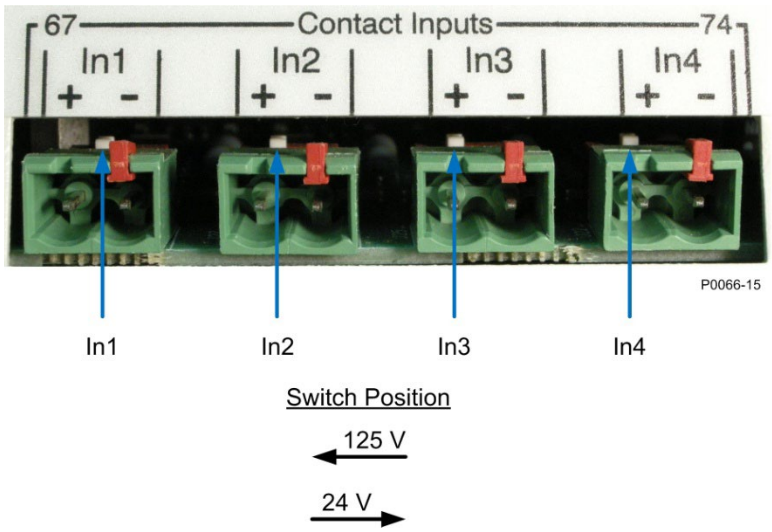


Figure 5-2. Contact Input Switch Locations (Left-Side View of ECM-2 with Cover On)

Alternately, removing the unit cover provides access to the contact input switches. The following paragraphs describe how to remove the unit cover and adjust the contact input switches.

Caution

Ensure that the unit is de-energized. Observe all electrostatic discharge (ESD) precautions when handing the ECM-2.

1. De-energize the ECM-2 and the system. Remove all connections to the ECM-2.
2. Remove the six cover screws (located on the left- and right-hand side of the ECM-2) and carefully remove the cover.
3. Locate the contact input switches and set according to your system. See Figure 5-3.
4. Reattach the cover using the six screws that were removed in Step 2. Torque the cover screws to 5 in-lbs (0.56 N•m). Reconnect the ECM-2 to the system.

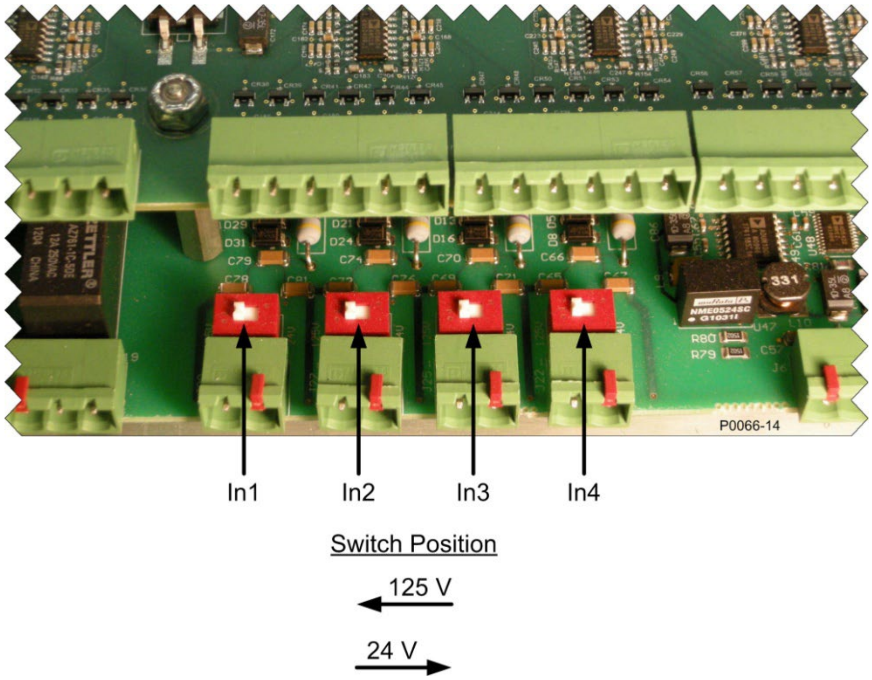


Figure 5-3. Contact Input Switch Locations (Left-Side View of ECM-2 with Cover Off)

Analog Outputs

Two isolated outputs provide analog signals that are directly proportional to ECM-2 or DECS-2100 system values selected by the user. Each analog output is individually adjustable for a signal range of –10 to +10 Vdc or 4 to 20 mAdc. The analog outputs are designated Out1 and Out2. Out1 terminal assignments are 75 (+) and 76 (–) and Out2 terminal assignments are 77 (+) and 78 (–).

IRIG Input

This input can be used to synchronize the internal ECM-2 clock with a time signal supplied by an IRIG time source. Keeping the ECM-2 clock synchronized with other devices enables accurate time stamping of data during power system disturbances. The IRIG input complies with IRIG Standard 200-04 which supports time, day, month, and year information. Input specifications include an input voltage range of ±20 Vdc, a logic-low voltage of 0.5 Vdc (maximum), and a logic-high voltage of 3.5 Vdc (minimum). IRIG input terminal assignments are In and Gnd.

Fiber Optic Connectors

Connections on the right side of the module consist of interlocking, fiber-optic transmitters, and receivers. Fiber-optic connectors are used for interlace with the Analog and Digital I/O Modules, sensing inputs from the DECS-2100 Isolation Transducers, and the system power bridge(s). The use of fiber-optic cable and connectors provides superior isolation and noise immunity. For systems using from one to four power bridges, the ECM-2 is equipped with a single row of fiber-optic connectors. Applications requiring from five to 16 power bridges have an ECM-2 module with two rows of fiber-optic connectors.

Analog I/O Module Connections

These three fiber-optic connections link the ECM-2 with up to four Analog I/O Modules. Each module is polled by the ECM-2 for the status of the module's two analog inputs and one RTD input. BESTCOMS*Pro* software can be used to connect the Analog I/O Module input and output data to any control software block input or output in the ECM-2. Analog I/O Module connections consist of F19 (CLK), F20 (TX), and F21 (RX).

Digital I/O Module Connections

These three fiber-optic connections link the ECM-2 with up to four Digital I/O Modules. Each module is polled by the ECM-2 for the status of the module's 12 digital inputs. BESTCOMS*Pro* software can be used to connect the Digital I/O Module input and output data to any control software block input or output in the ECM-2. Digital I/O Module connections consist of F22 (CLK), F23 (TX), and F24 (RX).

Isolation Transducer Connections

Fiber-optic communications to/from the DECS-2100 Isolation Transducers include provisions for monitoring the digitized generator field voltage and current, exciter field voltage and current, and PPT voltage. Four additional spare inputs may be used (with additional Isolation Transducers) to monitor other system/generator values. Generator field connections are made at connectors F1 and F2. Exciter field connections are made at connectors F3 and F4. PPT voltage connections are made at connectors F9 (VAC) and F10 (VAB). Spare input connections are made at F5 (In2) and F6 (In1) and F7 (In4) and F8 (In3).

Power Bridge Connections

In its standard configuration, the ECM-2 is equipped with connections for controlling and monitoring up to four power bridges. For applications requiring the control of up to 16 power bridges, the ECM-2 is equipped with a second row of fiber-optic connections. Power bridge thyristor firing control data is routed through these connections to the DECS-2100 Bridge Control Module(s). Power bridge temperature and thyristor conduction data is also received from the Bridge Control Module(s) through these connections. Table 5-2 lists the power bridge connection assignments.

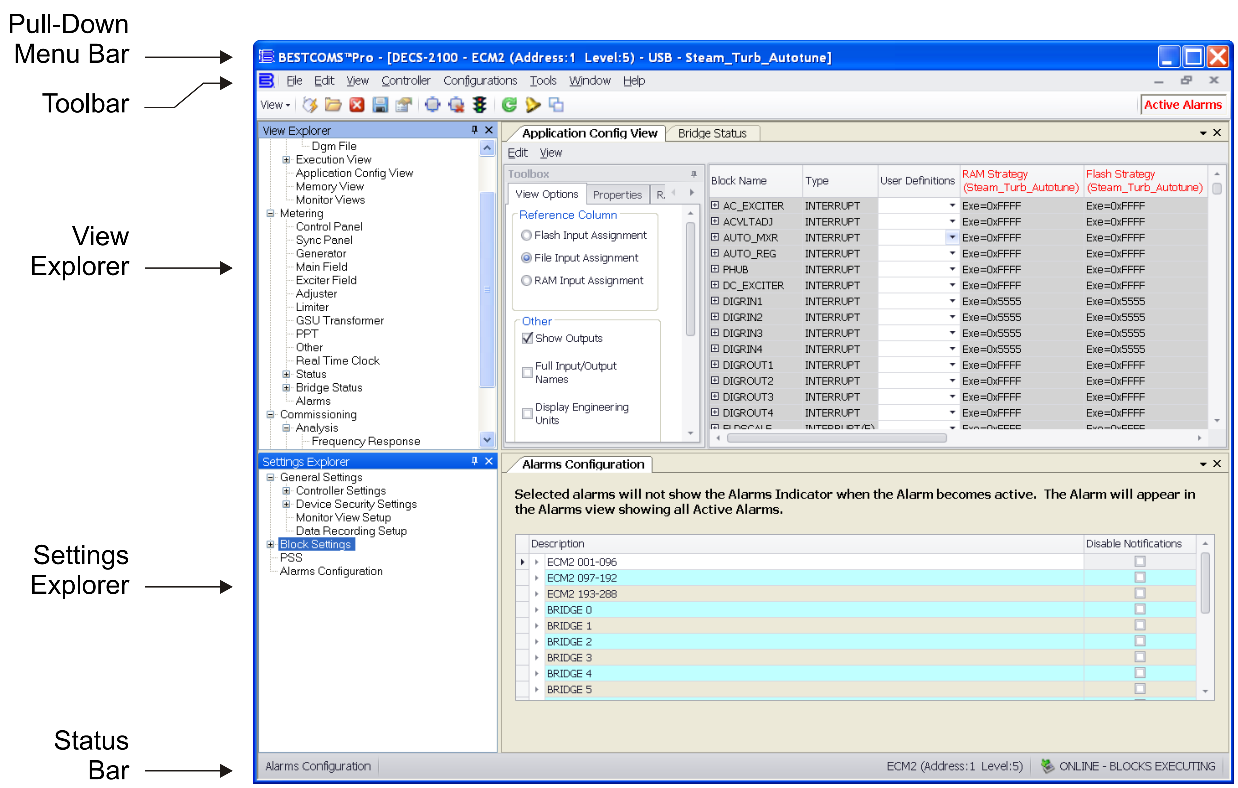
Table 5-2. ECM-2 Power Bridge Connection Assignments

Bridge	Bridge0	Bridge1	Bridge2	Bridge3	Bridge4	Bridge5	Bridge6	Bridge7	Bridge8
Connections	F11 (TX) F12 (RX)	F13 (TX) F14 (RX)	F15 (TX) F16 (RX)	F17 (TX) F18 (RX)	F25 (TX) F26 (RX)	F27 (TX) F28 (RX)	F29 (TX) F30 (RX)	F31 (TX) F32 (RX)	F33 (TX) F34 (RX)
Bridge	**Bridge9**	**Bridge10**	**Bridge11**	**Bridge12**	**Bridge13**	**Bridge14**	**Bridge15**	**—**	**—**
Connections	F35 (TX) F36 (RX)	F37 (TX) F38 (RX)	F39 (TX) F40 (RX)	F41 (TX) F42 (RX)	F43 (TX) F44 (RX)	F45 (TX) F46 (RX)	F47 (TX) F48 (RX)	—	—

6 • BESTCOMS™*Pro* Software

BESTCOMS™*Pro* is a Windows®-based, PC application that provides a user-friendly, graphical user interface (GUI) for use with Basler Electric communicating products. The name BESTCOMS*Pro* is an acronym that stands for Basler Electric Software Tool for Communications, Operations, Maintenance, and Settings.

BESTCOMS*Pro* provides the user with a point-and-click means to set and monitor Basler Electric products. The capabilities of BESTCOMS*Pro* make the configuration of one or several controllers fast and efficient. It is a sophisticated tool for configuring, monitoring, maintaining, and debugging a programmable controller. Typically BESTCOMS*Pro* is used at installation to configure the controller and, thereafter, is used to monitor operations and fine tune input values. BESTCOMS*Pro* has been designed to merge the high functionality of ccTool™ and the ease-of-use associated with BESTCOMS*Plus*®. A primary advantage of this software is its capability to allow the user to create a configuration settings scheme, save it to a file, and upload the settings to the controller at the user's convenience. Multiple security levels are provided to ensure that only authorized users can change the appropriate configuration information. Customized workspaces can be saved and loaded to make switching between tasks easier and more efficient. Figure 6-1 shows the key elements of the main working window.



P0066-95

Figure 6-1. Typical User Interface Components

Installation

System Requirements

BESTCOMS*Pro* operates with systems using Windows 7 (64-bit) SP1 and later, Windows 8.1 (64-bit), Windows 10, and Windows 11. BESTCOMS*Pro* is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Pro* on your PC also installs the required version of .NET Framework (if not already installed).

System recommendations for BESTCOMS*Pro* are listed in Table 6-1.

Table 6-1. System Recommendations for BESTCOMS*Pro*

Component	Recommendation
Processor	1 GHz
RAM	2 GB
Hard Drive Space	920 MB (~70 for BESTCOMS*Pro* and 850 MB for .NET 4.0, 32 bit)

Installation

Step 1: Download BESTCOMS*Pro* from www.basler.com.

Step 2: Click the installation button for BESTCOMS*Pro*. The setup utility installs BESTCOMS*Pro* and the .NET Framework on your PC (if not already installed).

When BESTCOMS*Pro* installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows *Start* button and then accessing the Basler Electric folder in the *Programs* menu. The Basler Electric folder contains an icon that starts BESTCOMS*Pro* when clicked.

Running BESTCOMS™*Pro*

To run BESTCOMS*Pro*, click *Start*, point to *All Programs, Basler Electric*, and then click the BESTCOMS*Pro* icon. During initial startup, the BESTCOMS*Pro Select Language* screen is displayed as shown in Figure 6-2. You can choose to have this screen displayed each time BESTCOMS*Pro* is started, or you can select a preferred language and this screen is bypassed in the future. Click *OK* to continue. This screen can be accessed later by selecting *Tools* and *Select Language* from the menu bar.

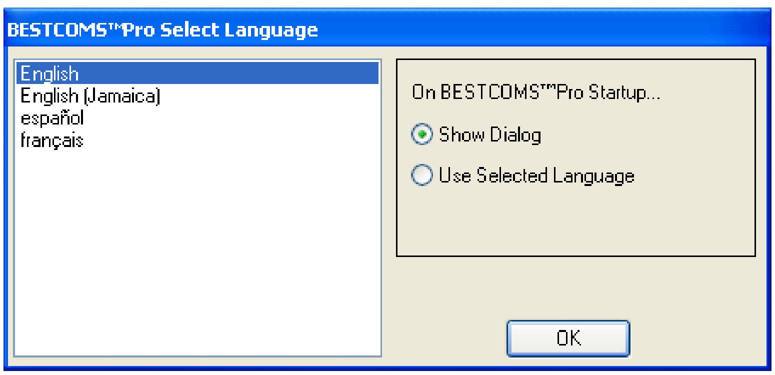


Figure 6-2. Select Language Window

The Basler Electric splash screen is displayed for a brief time. See Figure 6-3.

Figure 6-3. Basler Electric BESTCOMSPro Splash Screen

BESTCOMS*Pro* will load and a log on dialog box appears. See Figure 6-4.

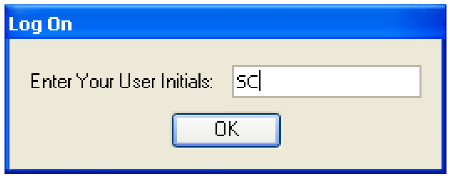


Figure 6-4. Log On Dialog Box

Enter your user initials and click the *OK* button.

Note

When you start BESTCOMS*Pro*, the main BESTCOMS*Pro* window contains limited pull down menus, a brief tool bar, and a gray working area.

To enable the full menu selection, toolbars, and windows a connection to a controller must be established or a valid configuration file must be loaded. After either of these occurs the following elements appear.

- An extended toolbar along the top of the window.
- Two panels, called the 'View Explorer' and 'Settings Explorer', which list the various windows and functions that are available.
- A status bar in the bottom border of the window. The status bar displays reference information such as the current controller state and your security level. It also displays a brief description of the block, input, or output as you work with objects in a window.

Activation Key

When BESTCOMS*Pro* is run for the first time, you are prompted to activate the software. If you choose not to activate, you will have Security Level 1 (Read-Only) access to the device and to any configuration files that are opened. If you choose to activate the software, you will receive an activation key from Basler which also contains your default security level. Refer to *Security Levels* in this chapter for more information.

To activate BESTCOMS*Pro* and unlock the ability to tune and modify the configuration to better fit your application, click *Help, Activate* BESTCOMS*Pro.* The *Activation Notice* dialog box appears (Figure 6-5).

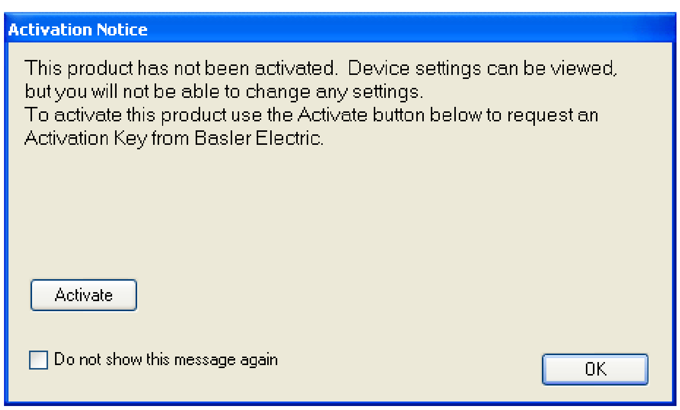


Figure 6-5. Activation Notice Dialog Box

If read-only access is the only type of access needed, then check the “Do not show this message again” box and click *OK.*

Click the “Activate” button to proceed with BESTCOMS*Pro* activation. The Activation window appears (Figure 6-6). Enter the name of your company into the *Company* field and click the *Email* button. This sets up an email to Basler Electric requesting an activation key. Click *Send*.

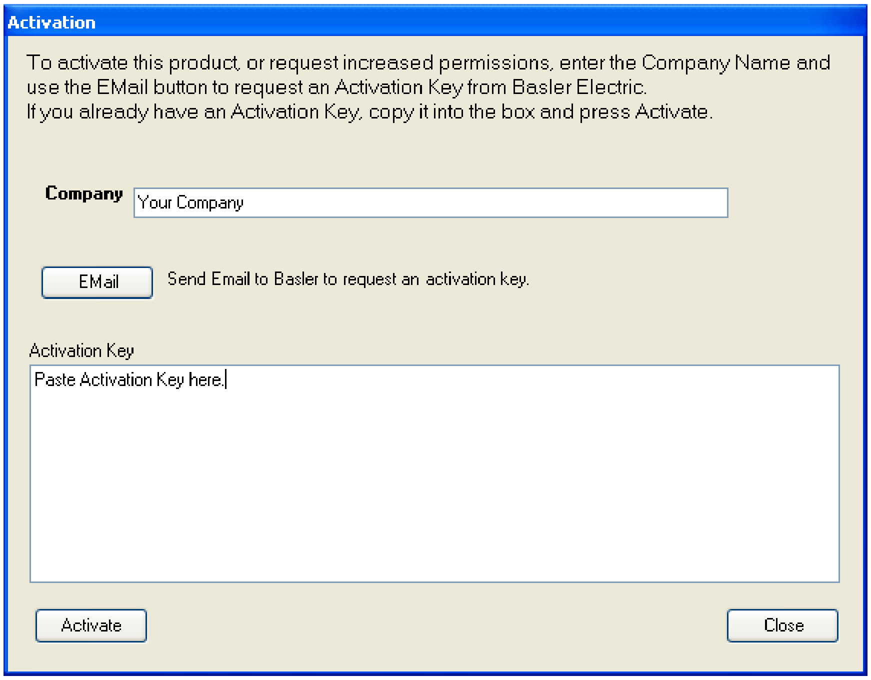


Figure 6-6. Activation Window

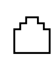
When the activation key is received, copy it from the email, paste it into the *Activation Key* field, and click the *Activate* button. A notification appears if the key is incorrect. If the activation is successful, a notification appears next to the *Activate* button. Click *Close*.

Connecting to an Excitation Control Module (ECM-2)

In order to utilize the capabilities of BESTCOMS*Pro* you must first connect to the Excitation Control Module (ECM-2), found within the DECS-2100. Connecting to the Bridge Control Module (BCM) is done through the ECM-2, See *Connecting to a BCM* below. There are several methods used to connect to a controller.

- Ethernet: Connect to a controller using a standard Ethernet cable.
- COM Port: Connect to a controller using a standard RS-232 cable.
- USB: Connect to a controller using a standard Type-B USB cable.
- Remote Connection: This option is not supported by the DECS-2100. It is used to connect to the ECS2100.

Ethernet

Ensure that the PC is connected to the controller using a standard Ethernet cable. 

Click *Connect* under the *File* menu or the  button on the toolbar.

The *Connect* dialog box appears as shown in Figure 6-7.

Select the Ethernet tab.

Click the down arrow to the right of the Host Name drop down list, a list of options appears.

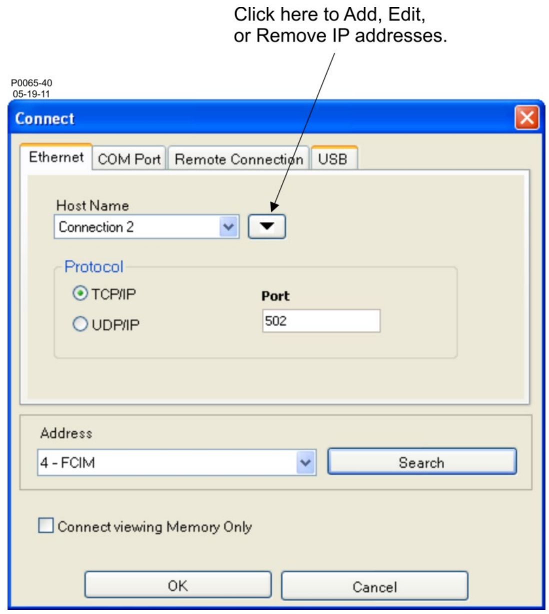


Figure 6-7. Connection Window, Ethernet Tab

Click Add IP address. The IP Address dialog appears as shown in Figure 6-8.

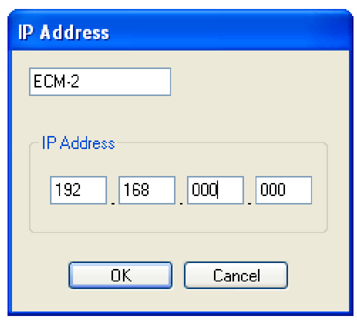


Figure 6-8. Adding an IP Address

Enter the desired name of the new connection in the top field.

Enter the IP address in the bottom four fields and click *OK.*

Click *Search*. The Search Controllers dialog box appears as shown in Figure 6-9.

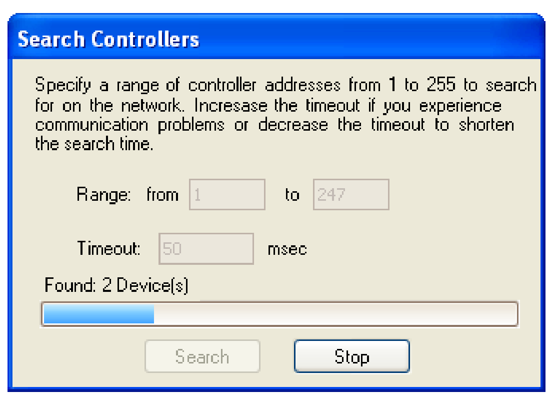


Figure 6-9. Searching for Controllers

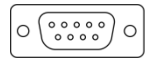
BESTCOMS*Pro* searches for connected devices. The search process can be shortened by decreasing the range and timeout duration.

Click *Close* after the search is complete.

Select the ECM-2 from the Address Drop down List and Click *OK*.

Wait for the connection process to complete.

COM Port

1. Ensure that the PC is connected to the controller using an RS-232 cable. 
2. Click *Connect* under the *File* menu or the  button on the toolbar.
3. The *Connect* dialog box appears as shown in Figure 6-10.
4. Select the COM Port tab.
5. Leave the default factory settings as they are.
6. Input “255” into the Address field.
7. Click OK.
8. Wait for the connection process to complete.

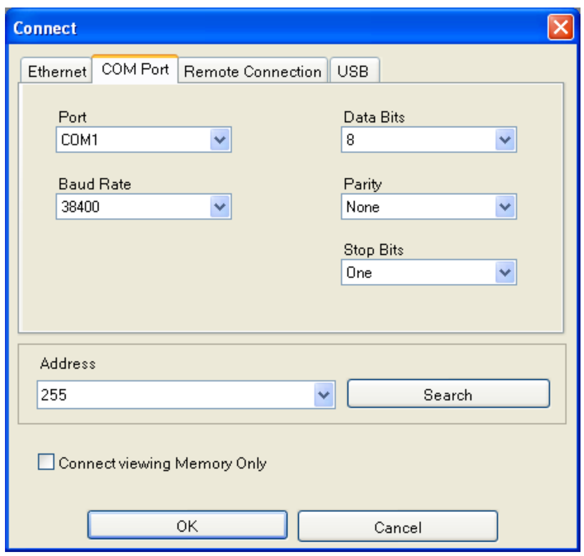


Figure 6-10. Connection Window, COM Port Tab

USB

1. Ensure that the PC is connected to the controller using a Type-B USB cable. 
2. The *Found New Hardware Wizard* appears after powering on the ECM-2 and connecting the USB cable.
3. Select, “No, not this time.” and click *Next.*
4. Select, “Install the software automatically (Recommended)”, and click *Next.*
5. Wait for the installation to complete. Click *Finish.*
6. Click *Connect* under the *File* menu or the  button on the toolbar.
7. The *Connect* dialog box appears as shown in Figure 6-11.
8. Select the USB Tab.
9. Input “255” into the Address field.
10. Click *OK*.

11. Wait for the connection process to complete.

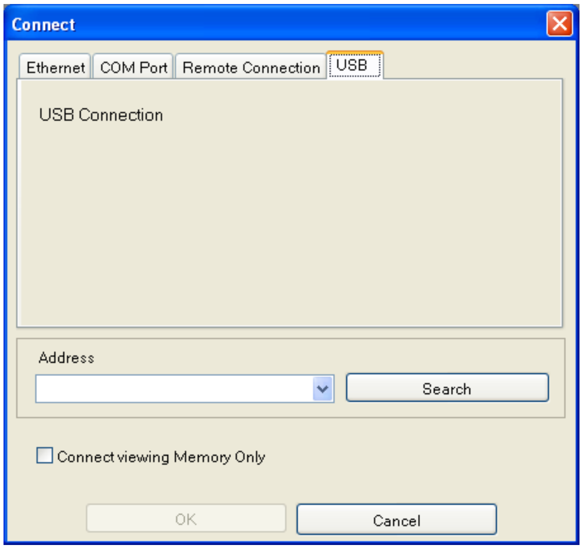


Figure 6-11. Connection Window, USB Tab

Manual USB Driver Installation

A failure to establish communication through the USB port may be caused by a failure of the automatic installation of the ECM-2 USB driver in Windows®. This condition is indicated by a Driver Software Installation error message. To install the ECM-2 USB driver manually, perform the following steps.

1. Open the Windows Device Manager. Under Other Devices, right-click on ECM-2 (or Unknown Device) and select Properties.
2. In the Properties window, select the Driver tab and click the Update Driver button.
3. Select "Browse my computer for driver software" and then navigate to:

   C:\Program Files\Basler Electric\USB Device Drivers\USBIO

   Install the USB driver software. Successful installation will be indicated by a confirmation message.

Connecting to a BCM

First establish a connection to an ECM-2 using one of the methods described above. Click *File, Bridge Connect…* The *Bridge Connect* dialog box appears (Figure 6-12).

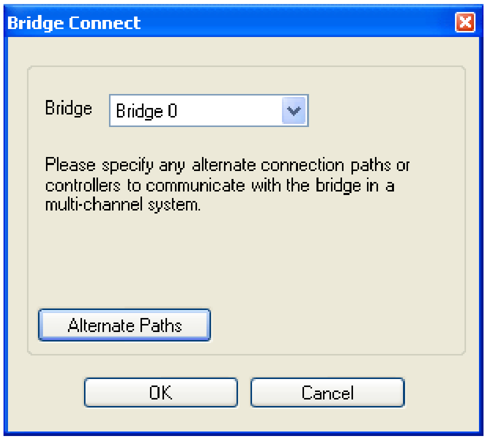


Figure 6-12. Bridge Connect Dialog Box

Select a bridge from the *Bridge* drop-down list and click *OK*. Wait for connection to complete. If connection cannot be established, alternate paths to the BCM can be specified. Click the *Alternate Paths* button; the Alternate Bridge Paths dialog box appears (Figure 6-13). Follow the directions in the dialog box. Use the *Search* button to automatically search for other controller addresses on the network. Click *OK* when done.

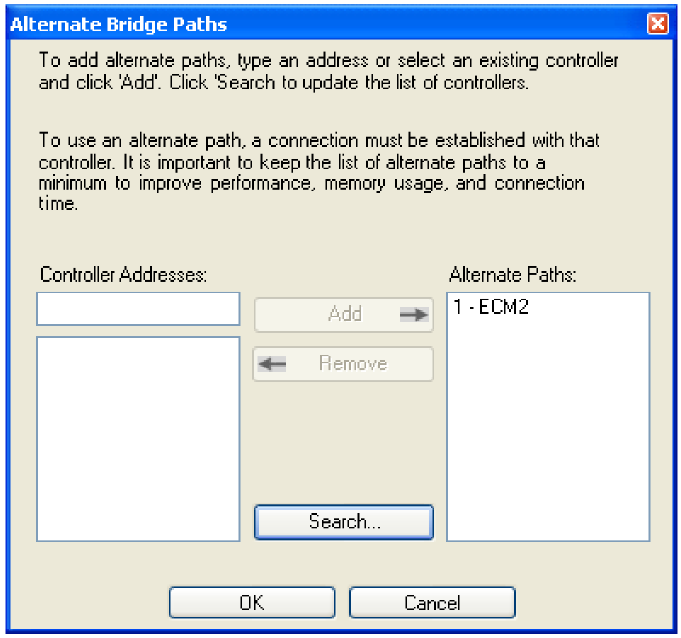


Figure 6-13. Alternate Bridge Paths Dialog Box

Overview of Functions

Introduction

Most BESTCOMS*Pro* capabilities lie in three main window types: the *Configuration Window*, the *View Explorer*, and the *Settings Explorer*. The functions of these windows are described in this chapter. See Figure 6-14 for locations of the configuration, *View Explorer*, and *Settings Explorer* windows.

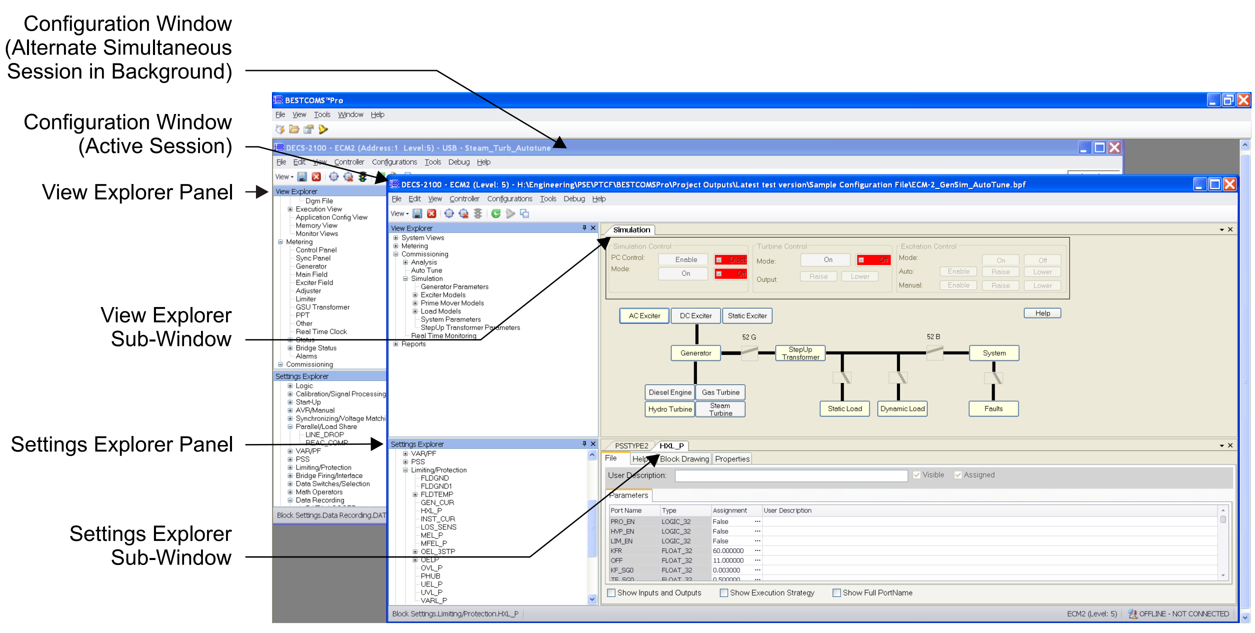


Figure 6-14. Multiple Sessions, View and Settings Explorers Sub-Windows

Set State Icon

The Set State icon is used to view or change the state of the device. See Table 6-2.

Table 6-2. Set State Icon Descriptions

State	Description
Open Config File	- all off
< Resolved	- all off
Resolved	- red, yellow on; green off
Initialized	- red on; green, yellow off - red, yellow on; green off
Blocks Executing	- green on; red, yellow off - all on
Application Go	- all off - all on

Configuration Window

A configuration file stores the programmable logic block configuration and all controller settings. In BESTCOMS*Pro* multiple configuration sessions may be opened simultaneously and each session is contained in its own window that can be manipulated via the 'Window' menu. The window in which you are currently working is referred to as the active window and has a blue header. The configuration window is indicated by the two configuration window locators in Figure 6-14.

Window Docking

A docking feature, within the view and settings explorers, allows arrangement and docking of multiple metering screens. Clicking and dragging a metering screen tab displays a blue, transparent square, several arrow boxes, and a tab box. These docking elements are illustrated in Figure 6-15.

Dragging the blue square to the “up” (locator A), “right” (locator B), or “down” (locator C) arrow box places the selected metering screen across the top, along the side, or at the bottom of the window. Once placed, the screen’s thumbtack icon can be clicked to dock the screen on the corresponding top, right, or lower bar. A docked screen is viewed by hovering the mouse pointer over the docked screen.

Dragging the blue square to one of the four arrow boxes (locator D) places the screen inside the selected window according to the arrow box selected. A metering screen can be placed as a tab inside the selected window by dropping the screen on the tab box at the center of the four arrow boxes.

Dragging the blue square anywhere other than one of the arrow/tab boxes places the selected metering screen as a floating window.

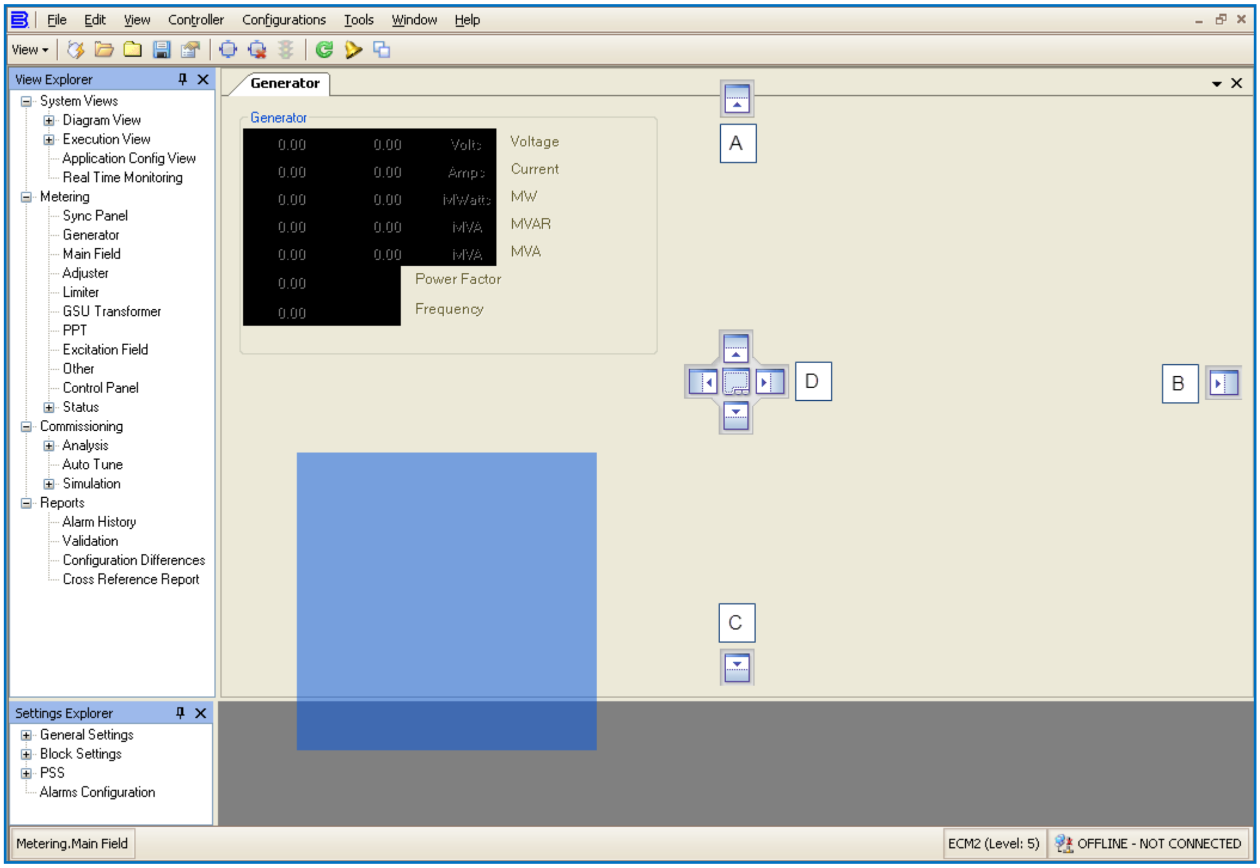


Figure 6-15. Window Docking

Programmable Logic

Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Introduction

BESTCOMS*Pro* programmable logic is a programming method used for managing the input, output, control, monitoring, and reporting capabilities of Basler Electric's DECS-2100 system. The DECS-2100 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in BESTCOMS*Pro*. Configurations entered and saved in the DECS-2100 system's nonvolatile memory integrate (electronically wire) the selected or enabled control blocks with control inputs and hardware outputs. A group of connected functions, defining the logic of the DECS-2100, is called a logic configuration.

One default active logic configuration is pre-loaded into the DECS-2100. This scheme is configured for a typical control application and virtually eliminates the need for "start-from-scratch" programming. BESTCOMS*Pro* can be used to open a logic configuration that was previously saved as a file and upload it to the DECS-2100. The default logic configuration can also be customized to suit your application.

The BESTCOMS*Pro* application is first used to define all configuration information in a file on the PC. Once the controller is in a resolved state, BESTCOMS*Pro* is used to download the information to the Random Access Memory (RAM) of the controller. You then use BESTCOMS*Pro* to fine tune configuration values as needed within RAM. Because information in RAM is lost in the event of a power cycle, you save the configuration information from RAM to permanent flash memory after you have tested and are satisfied with the configuration. At power-up, the configuration is taken from flash and overwrites the RAM values. Figure 6-16 illustrates the process.

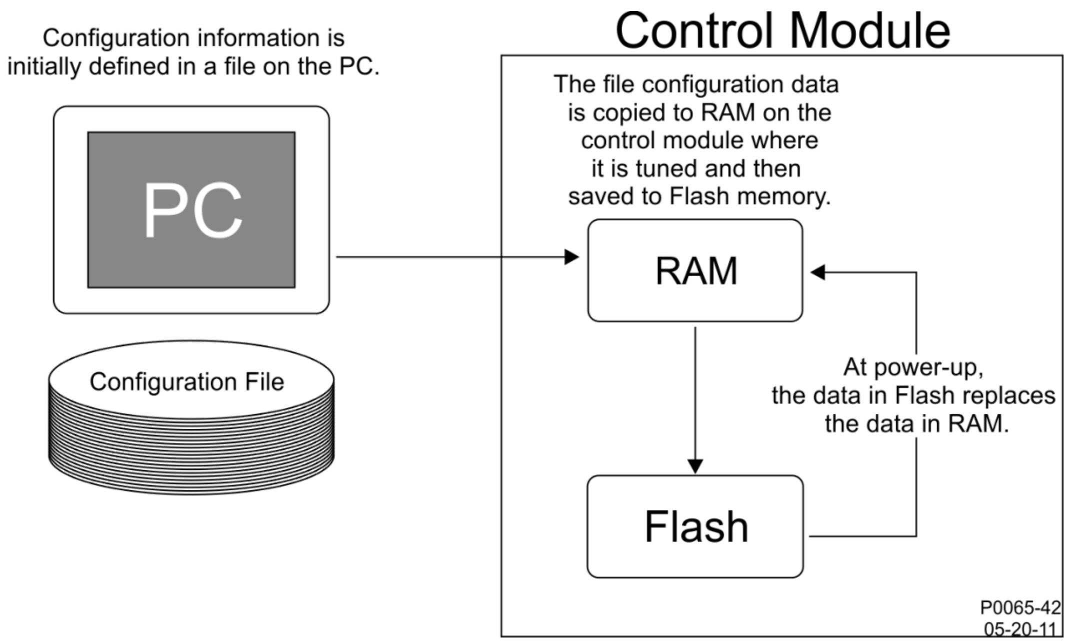


Figure 6-16. Model for Programming a Controller

Easy Screens

All special functions within BESTCOMS*Pro* are controlled by logic blocks including real-time monitoring, auto-tuning, and event recording to name a few. Logic block inputs and outputs are changed to fit a specific application, and when many changes are involved, the process can become tedious. BESTCOMS*Pro* provides *easy screens* to keep logic block tuning simple. Easy screens interface directly with the associated logic block. Entering information into the fields of an *easy screen* is equivalent to navigating to the block and changing the information manually. There are many different *easy screens*. One example is the event recorder configuration window located in the *Settings Explorer, General Settings, Event Recorder Setup, Configuration*. Typically, each of the four event recorder blocks are manually set up by adding the block and then assigning inputs in either the diagram or application configuration windows. When it is decided that a different set of events needs to be recorded, the data inputs need to be changed, the number of samples taken, the number of pre-trigger samples, the number of active channels, and so on. With the event recorder configuration window, there is no need to navigate to each event recorder block in the diagram or application configuration window; all of the relevant controls are in one place.

Controller States

Table 6-3 describes the controller states that are tracked within BESTCOMS*Pro*.

Table 6-3. Controller State Descriptions

State	Description
Unknown	This state indicates that there is no response from the controller or the response cannot be understood. An unknown state can result from losing the connection to the controller or an error in the controller. You cannot set this state. Once in this state, the connection or controller problem must be corrected before operation can continue.
Boot	Use the Boot state only when you need to load new firmware into the controller.

Click  in the toolbar or *Set State* under the *Controller* menu to open the Set Run State dialog box, Figure 6-17.

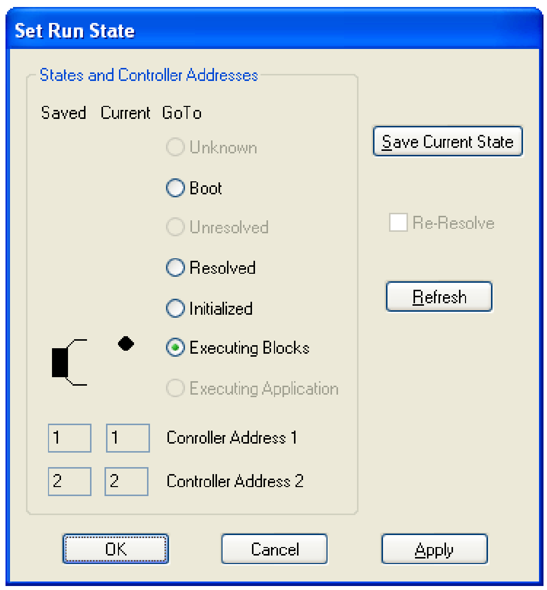


Figure 6-17. Controller States Dialog Box

Programming a Controller

The following steps lead you through adding and assigning a logic block into an already existing logic configuration. Since the DECS-2100 is already loaded with a working logic configuration, “starting-from-scratch” programming is not covered.

1) Connect to Controller

a) Establish a connection to the control module that is to be programmed. A connection can either be made to the excitation control module (ECM-2) or the bridge control module (BCM).

2) Copy RAM to File

a) Under the *Configurations* menu, click *Copy RAM to File*. The logic configuration currently loaded in RAM is copied to the file. The configuration in the file can be altered while disconnected from the control module.

3) Add Blocks

a) Navigate to a blank area of the diagram where you would like to place the logic block.

b) Click the *Add Block*  button. The add block window appears. Select one of the available "AND" blocks. The input, output, and execution strategies areas are enabled. See Figure 6-18.

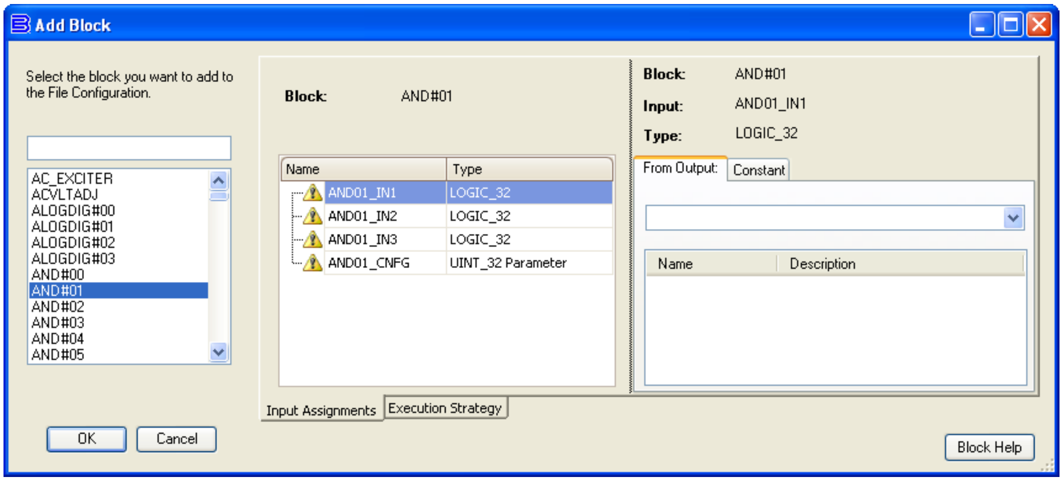


Figure 6-18. Add Block Window

4) Assign Inputs

a) The possible inputs are listed on the left side. Unassigned inputs are indicated by a yellow warning symbol. Constants and available outputs are on the right side.

b) Select input "ANDXX_IN1" from the list on the left.

c) Click the *From Output* tab and select an output from the drop down list. This list contains all possible outputs from all active logic blocks in the current configuration.

d) Assign outputs to the rest of the inputs for ANDXX.

e) Click *OK* when finished.

Connections can also be made by clicking and dragging a line from an output to an input in the diagram window. See *Assigning Blocks, Drawing a Connection Line* above.

5) Copying the Configuration to RAM

Copying to RAM sends the entire configuration to the control module and overwrites all values currently in RAM. The control module can then begin executing the new logic configuration. Be sure you want to do this before proceeding. Below are some notes about copying to RAM:

- If you added or removed a block in the file configuration, changed the type of an input, or changed input values, you must have a security level of *Change Configurations* to copy to RAM.
- All blocks in the file configuration must be completely configured before copying to RAM. If one or more blocks are not completely configured, the *Copy to RAM* command allows you to configure them at this point.
- The control module must be in the resolved state. If it is not, the *Copy to RAM* command asks if you want to change the state to *Resolved*.
- The configuration you copy to RAM is not automatically put into execution. After copying, you must change the state from *Resolved* to *Executing Blocks* as part of verifying the RAM configuration.

To Copy to RAM:

Choose Copy to RAM from the Configurations menu.

If one or more blocks in the file configuration are not completely configured, a dialog asks if you want to configure the blocks. Click Yes to have the operation proceed. Click No to cancel the copy.

If the controller state is not Resolved, a dialog asks if you want to change the state to Resolved. Click Yes to change the state to Resolved, or No to cancel the copy.

A dialog warns you that the current values in RAM are to be overwritten and asks if you want to continue. Click Yes to proceed, or No to cancel the copy.

The file configuration values are copied to RAM.

6) Verifying the RAM Configuration

After copying to RAM, the new RAM values must be put into execution. The values can then be monitored and fine tuned as needed to verify that they are correct.

a) Click the *Set State*  icon in the toolbar, or choose *Set State* from the *Controller* menu.

b) Click the *Executing Blocks* radio button, and then click *OK*. The RAM configuration is put into execution.

c) In the *View Explorer, Diagram View*, select *Dgm RAM*.

d) Check the *Display RAM Values* checkbox in the diagram window toolbox to display the actual RAM values.

e) Monitor the RAM values to ensure that they are correct. If necessary, you can change an input value but cannot change the input type.

7) Saving to Flash and File

When fine-tuning of the RAM configuration is complete, it can then be saved to flash. To create a backup copy of the fine-tuned configuration, copy RAM or flash to the file configuration.

a) To save the RAM configuration to flash, choose *Copy RAM to Flash* from the *Configurations* menu. A dialog asks you to confirm that you want to overwrite everything in flash.

b) To copy to the file configuration, choose *Copy RAM to File* or *Copy Flash to File* from the *Configurations* menu. A dialog asks you to confirm that you want to overwrite everything in the file configuration. After you copy, use *Save* or *Save As* to save the file configuration to disk.

Data Monitoring

BESTCOMS™*Pro* has two data monitoring functions: a data logger and an event recorder. The data logger is used to sample system data at specified intervals. The event recorder is used to record system data when specific triggers occur.

Data Logger

The data logger is a special function block that logs samples of data at designated intervals. Outputs from other function blocks that you want to monitor are applied to the inputs of the data logger function block. The time interval for sampling the data is also specified. Once the data logger is configured and enabled, it records data at the prescribed intervals. Viewing of logged data is done at the user's convenience.

Note
The data logger writes the sampled data to a 100,000 point buffer. When the buffer is full, the data logger begins to overwrite the existing data from the top of the buffer. The buffer is cleared when the state changes to Executing or when you change an input while in the Executing state. Before clearing the buffer, save the data to the PC (See *Managing Logger Data* below). The logged data is saved to flash memory every hour.

Data Logger Setup

Data logger setup is accomplished on a single BESTCOMS™*Pro* screen, illustrated in Figure 6-19. The setup process consists of adding a data logger block to the configuration and then assigning other logic block outputs to the data logger inputs. This process is outlined in the following steps.

1. In the Settings Explorer of BESTCOMS™*Pro,* select and view the Data Recording Setup screen.
2. Select DATA_LOGGER from the list of logic blocks.
3. Place a checkmark in the *Assigned* checkbox to enable the data logger.
4. Select the number of desired data channels.
5. Enter the desired sample rate (interval) in seconds.
6. Make a data assignment for each monitored channel. Once the data assignments are made, the data logger begins logging data from the specified logic block outputs at the logging interval specified.

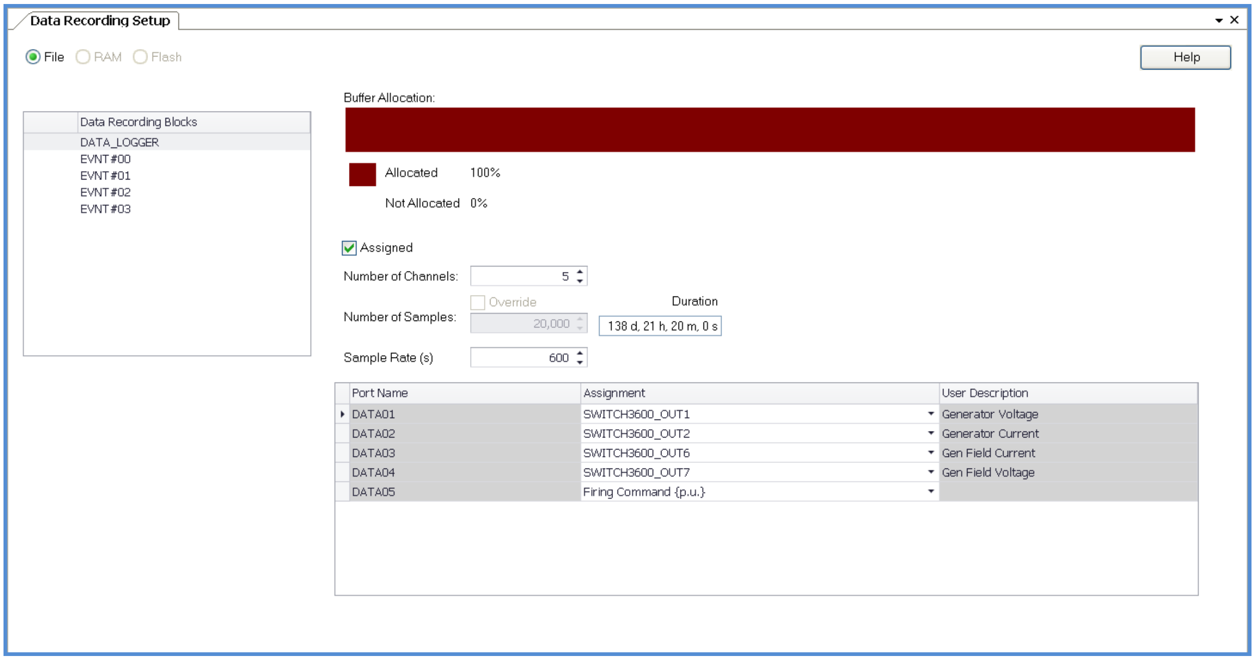


Figure 6-19. Data Logger Configuration Screen

Event Recorders

An event recorder is a special function block that records the values related to an event. Set up an event recorder when you want to capture the data related to a single event. You specify the inputs to the function block as the event triggers and you specify the outputs that you want to record. You enable the event recorder when you want the controller to start monitoring for an occurrence of the trigger. When the trigger occurs, the event is recorded and an *Attentions* notification is displayed in the upper, right area of the BESTCOMS™*Pro* window. This notification informs you that event data is available for viewing. Event recorders are configured on a single event recorder setup screen which is illustrated in Figure 6-20. event recorder attributes and settings are described in the following paragraphs.

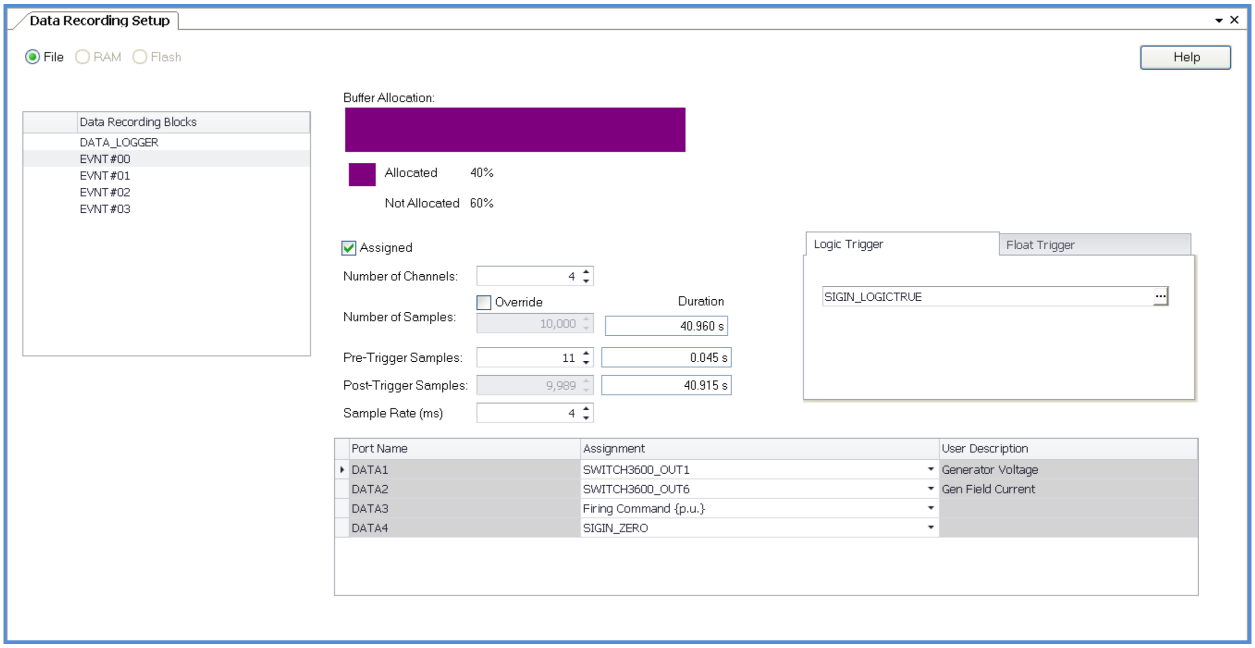


Figure 6-20. Event Recorder Configuration Screen

Event Record Triggers

There are two types of event record triggers: logic and float. For a logic trigger, you define whether a true or false value for a specific output triggers the event. For a float trigger, an event is triggered if the value of a specific output falls outside a minimum and maximum value that you define. The event recorder saves both pre-trigger and post-trigger data. You specify a time interval for sampling the data and how many samples you want taken for the pre-trigger and total samples.

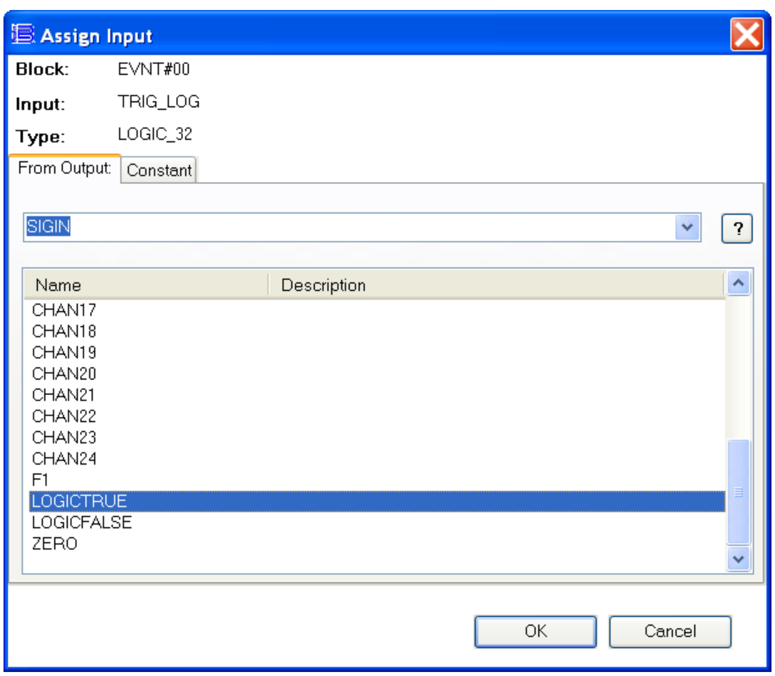


Figure 6-21. Assign Input Window

Logic Triggers

Logic triggers are selected through the Logic Trigger tab of the event recorder setup screen. Clicking the button beside the logic trigger field opens the Assign Input window of Figure 6-21. This window has two tabs: From Output and Constant. Any active logic block (and its outputs) on the From Output tab can be selected as a trigger.

Float Triggers

Float triggers are selected through the Float Trigger tab of the vent recorder setup screen. Clicking the button beside the float trigger field opens the Assign Input window of Figure 6-21. This window has two tabs: From Output and Constant. Any active logic block (and its outputs) on the From Output tab can be selected as a trigger.

Rise/Fall Levels

The Rise Level and Fall Level values define the threshold at which the selected trigger signal will trigger the event.

Buffer Allocation

The event recorder does not have any of the buffer overwrite concerns that were noted previously for the data logger. Four event recorder logic blocks are available in BESTCOMS*Pro*. Eight channels of data can be recorded per block. A total of 100,000 samples can be taken per block. This number of samples is divided equally between the active channels, so 50,000 samples can be recorded per channel on a two-channel record and 12,500 samples can be recorded per channel on an eight-channel record.

The buffer allocation bar, found on the event recorder configuration screen shows the percentage of the buffer that has been reserved for recording.

Function Block Inputs

Table 6-4 lists the event recorder block inputs.

Table 6-4. Event Recorder Block Inputs

Input Name	Description
DATA1 – DATA8	These inputs represent the eight data channels. Each channel records data from a logic block output.
ENABLE	This input enables or disables the event recorder.
NSAMPLES	This input accepts the total number of samples to be taken.
PRE_TRIG	This input accepts the number of total samples to be recorded before the trigger.
RATE	This input accepts the multiplier of the sampling rate. The minimum sampling rate is 1 millisecond between samples.
NSIGNALS	This input accepts the number of channels to use when recording data.
TRIG_FLT	This input is assigned to the output of a logic block to act as the trigger source. If a float trigger is not needed, then a constant (0) can be assigned to this input, disabling it.
RISE_LEVEL	This input accepts the high level. When the TRIG_FLT input value exceeds this input value then the event triggers.
FALL_LEVEL	This input accepts the low level. When the TRIG_FLT input value drops below this input value then the event triggers.
TRIG_LOG	This input is assigned to the output of a logic block to act as the trigger source. When this input receives a 1 (true) from the source it triggers the event. If a logic trigger is not needed, then a constant (false) can be assigned to this input, disabling it.

Configuration

An event recorder block can be added to the file configuration or removed from the file configuration by using the *Assigned* checkbox. This option is enabled only when the *File* radio button is selected.

Up to eight channels of data can be selected for an event record through the *Number of Channels* field.

The default, total number of data samples can be customized by clicking the *Override* button and entering the desired number in the *Number of Samples* field. The number of pre-trigger data samples can be adjusted, up to the value of the total number of samples, through the *Pre-Trigger* Samples field. The read-only *Post-Trigger Samples* field automatically adjusts to reflect changes in the number of pre-trigger samples selected.

The data sample rate, expressed in milliseconds, is used to establish a multiplier of the sampling rate and is entered in the *Sample Rate* field.

Channels

Data channels for each event recorder can be viewed and edited by selecting the desired event record located under *Data Recording Blocks*. The selected channels and their assignments are then displayed in tabular format on the event recorder configuration screen. Clicking a channel assignment field presents a submenu containing a button beside the channel assignment field. Clicking this button opens an *Assign Input* window where logic outputs and the corresponding constants can be selected.

Setup

Event recorder setup is accomplished on a single BESTCOMS™*Pro* screen, illustrated in Figure 6-20. The setup process consists of selecting the trigger source, configuring the record parameters, and making the logic assignments for each channel. This process is outlined in the following steps.

1. In the Settings Explorer of BESTCOMS™*Pro* select and view the Data Recording Setup screen.
2. Select one of the four event recorders from the *Data Recording Blocks* list.
3. Decide whether a logic trigger or float trigger is appropriate for the task.
    a. If a logic trigger is desired, access the *Assign Input* window by clicking the button adjacent to the *Logic Trigger* field on the *Logic Trigger* tab. On the Assign Input window, select the desired logic block output to trigger the record and select the constant (condition) which will trigger the record.
    b. If a float trigger is desired, access the Assign Input window by clicking the button adjacent to the *Float Trigger* field on the *Float Trigger* tab. On the *Assign Input* window, select the desired logic block output to trigger the record and select the constant (condition) which will trigger the record. Return to the *Float Trigger* tab and enter the desired Rise and Fall levels (thresholds).
4. Assign the desired number of recording channels in the *Number of Channels* field.
5. If the number of desired record samples differs from the default value, place a checkmark in the *Override* checkbox and enter the desired number of samples in the *Number of Samples* field.
6. Establish the desired number of pre-trigger samples in the *Pre-Trigger Samples* field.
7. Enter the sample rate multiplier (in milliseconds) in the *Sample Rate* field.
8. Make variable assignments to each channel for the data record. This process consists of accessing the *Assign Input* window and selecting the desired logic block outputs and constants. Repeat this step for each of the remaining channels.

Managing Logger Data

Viewing, Saving, and Clearing Data

Select *Events & Data Loggers* in the *View Explorer, Reports*. This displays the *Events & Data Loggers* window, as shown in Figure 6-22.

Find the data logger or event recorder in the list and click the *View* button to display the graph.
Clicking *Save* gives you the option to save the graph as a data logger (.dlg), text (.txt), CSV (.csv), or IEEE COMTRADE (.cfg) file.

Clear resets the graph data.

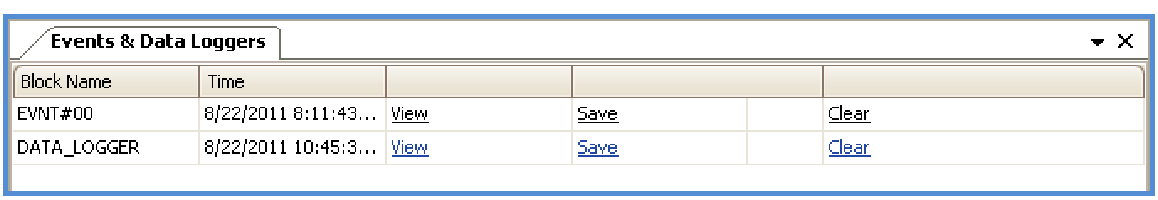


Figure 6-22. Events & Data Loggers Window

Loading Logger Data

Under the *File* menu, point to *Data Logger* and click *Open Data Logger File…* from the menu. The data logger graph appears and displays the file in graph form.

Manipulating the Graph

Figure 6-23 displays the locations of channel select, Y-zoom, zoom factor, C1, C2, and the status bar.

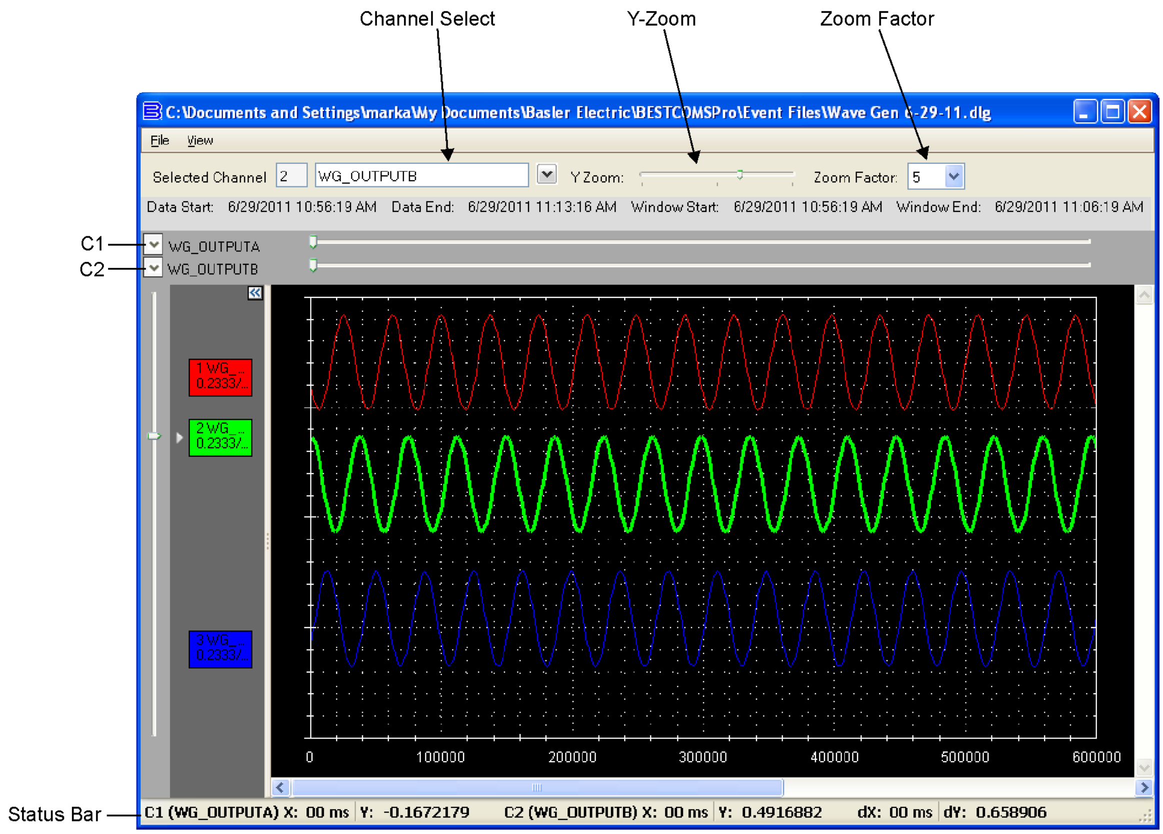


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Figure 6-23. Graph Window Locators

The data logger / event recorder graph commands are listed in Table 6-5.

Table 6-5. Graph Commands

Command	Description
File	
Close	Close the current file.
Save	Save the current file.
Save As…	Save the current file under a different name.
View	
Time Information	Show / hide time information.
Channel Data Properties	Displays a window containing a list of the data logger channel outputs.
Cursor 1 / 2	
Move into View	Move cursor 1 / 2 into center of view.
Goto	Move center of view to cursor 1 / 2.
Selected Item	
Goto	Move center of view to the selected item.

Command	Description
Move into View	Move the selected item into center of view.
Options: Cursors	
Snap to Data Points	The cursor snaps to the nearest data point.
Set Slider to Cursor Colors	The cursor slider becomes the color of the cursor.
Options: Channels	
Display Channel Names	The channel name is displayed on the left.
Set Slider to Selected Channel Color	The channel slider becomes the color of the channel.
Highlight Selected	Highlights the selected channel. The data points and lines become bold.
Set all Channels to Default Vertical Scales	Resets zoom on all channels.
Zoom all Channels	Enable or disable simultaneous zoom on all channels.
Options: Data Lines	
Display Data Points	Show / hide data points.
Show Point Values on Mouseover	The data point value is displayed in the tooltip.
None	Hides the connecting lines between data points.
Step	Connecting lines between data points are displayed as a series of steps.
Interpolated	Connecting lines between data points are smoothed.
Smooth	Connecting lines between data points are smoothed.
Options: X-Axis	
Auto Fit	Automatically fits the window to the width (x-axis) of the data points.
Show Dates on Axis	The time and date appears along the x-axis at each major division.
Format: No Format	Displays time along the x-axis in milliseconds.
Format: Duration (00:05:45)	Displays time along the x-axis in this format.
Format: Formatted Time (5 min, 45 s)	Displays time along the x-axis in this format.
Set Window Size	Choose window size between 25 ms and 12 months.
Options: Grid	
Set Background Color	Choose any color to set as the background.
Hide Grid Lines	Show / hide the grid lines.
Set Grid Height	Set grid height between 100 and 5000.
Below the Toolbar	
Selected Channel Y-Zoom	This slider changes the Y-axis zoom.
Zoom Factor	The Y-axis zoom slider position is multiplied by the number selected in this list.
C1, C2	Assign the cursor to a different channel by selecting the channel from this list.
Right Click in the Graph	
Copy	Copy an image of the graph to the clipboard.

Command	Description
Save Image As…	Save the image of the graph as a .emf, .png, .gif, .jpg, .tif, or .bmp file.
Page Setup…	Prepare the page for printing.
Print…	Print the graph.
Show Point Values	Enables or disables the data point value to be displayed in the tooptip on mouseover.
Goto Cursor 1 / 2	Move center of view to cursor 1 / 2.
Move Cursor 1/ 2 into View	Move cursor 1 / 2 into center of view.
Goto Selected Item	Move center of view to selected item.
Move Selected Item into View	Move selected item into center of view.
Status Bar	
C1 X	Displays the current position of cursor 1 on the x-axis in seconds.
C1 Y	Displays the value of the data point that intersects with cursor 1.
C2 X	Displays the current position of cursor 2 on the x-axis in seconds.
C2 Y	Displays the value of the data point that intersects with cursor 2.
dX	Displays the time difference between cursor 1 and 2 on the x-axis in seconds.
dY	Displays the difference between the data point values that intersect cursor 1 and 2.

Channel Select Drop-down List: Displays a list of all active channels (up to 12). Each channel has options for channel select, ID number, name, visibility, color, cursor 1 and cursor 2. See Figure 6-24.

Click the box in the first column of the channel to select it as the active channel, an arrow icon appears in the box to indicate that the channel has been selected.

The ID number corresponds to the data logger logic block input of the same number.

The *Name* field stores the name of the channel, a custom name can be entered.

Clicking the *Visible* box shows or hides the channel.

Channel colors can be selected by clicking the *Color* button.

One or both cursors can be assigned to a channel by clicking the corresponding radio button.

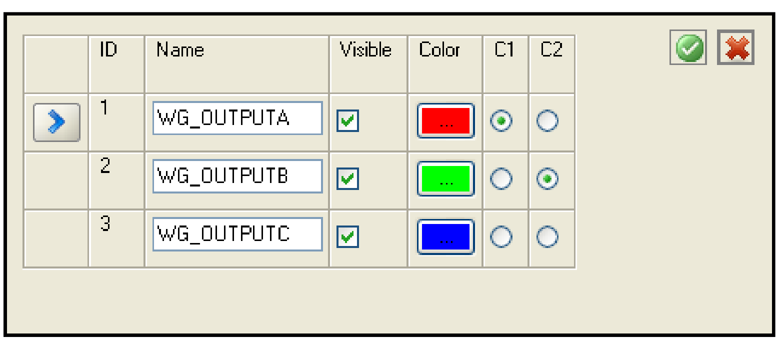


Figure 6-24. Channel Select Drop-down List

Monitor View Setup

A monitor view is a set of memory locations that can be monitored in one place. The user can select between logic block inputs and outputs, memory / MODBUS, holding registers, and coils.

Setup Procedure

1. Open the *Monitor View Setup* window under *Settings Explorer, General Settings* (Figure 6-25).

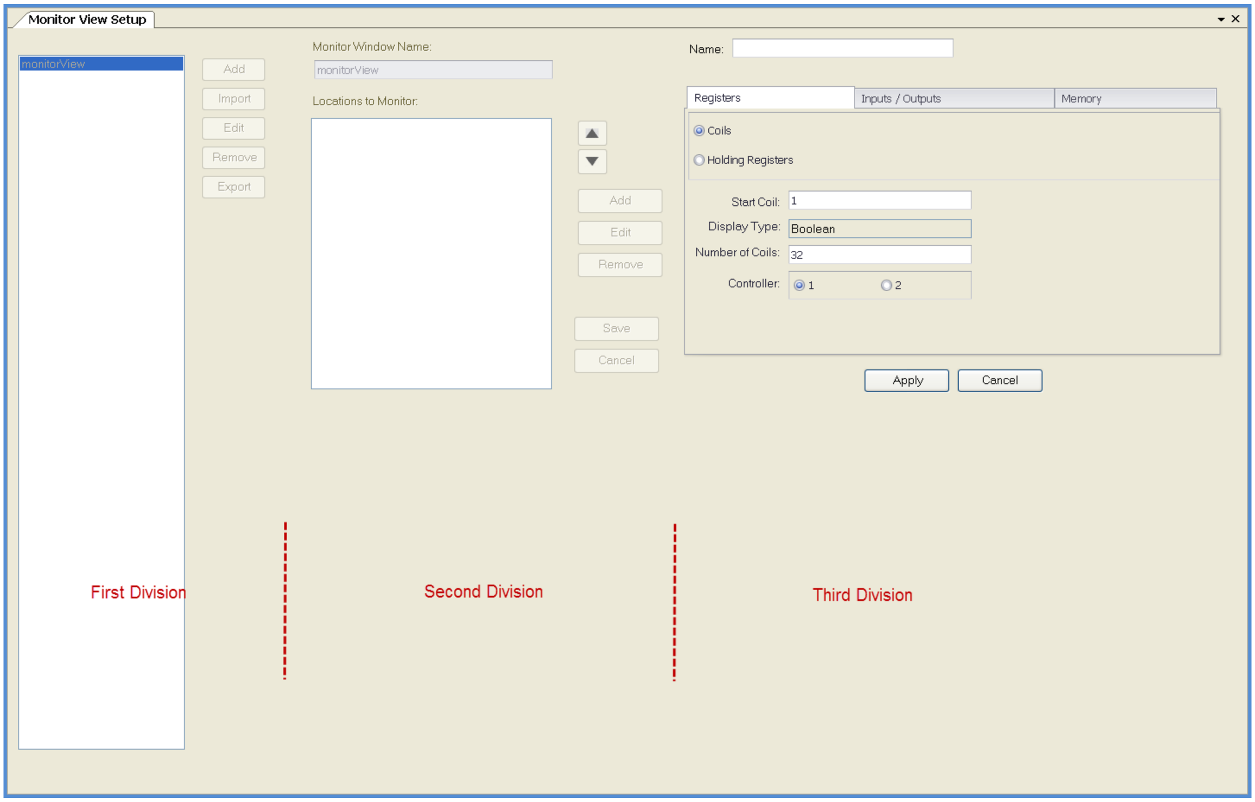


Figure 6-25. Monitor View Setup Screen

2. Click *Add* to add a new monitor view. This expands the current window, adding a second division.
3. In the second division, there is a *Monitor Window Name* field. Enter the desired name for the new monitor view.
4. In the second division, click *Add* to add a new memory location. This expands the current window further, creating a third division.
5. In the third division, select a location to monitor from one of the three tabs labeled *Registers*, *Inputs/Outputs*, and *Memory*. The *Registers* tab has additional selections for configuring coils as monitored locations. It also has additional controls (not shown here) for working with 32-bit values. Two 16-bit holding registers can be combined into a single 32-bit value. The Swap button specifies how the registers are combined while the Swap Registers checkbox reverses the sequence of the registers.
6. Click *Apply*. The third division of the window is removed. More locations can be added at this point by repeating steps 4 and 5.
7. In the second division, click *Save* when all of the desired memory locations are set. The second division is removed and new monitor view appears in the original monitor view setup window.
8. The monitor view that was just created now appears in *View Explorer, System Views, Monitor Views*. Clicking the monitor view displays a window containing all the specified memory locations in table form.

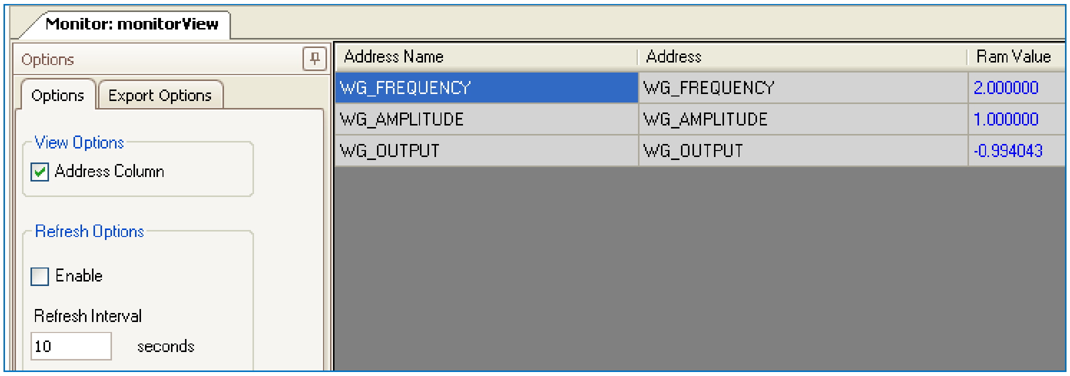


Figure 6-26. Monitor View Window

View Explorer

The *View Explorer* is a convenient tool within BESTCOMS*Pro* used to navigate through the various windows. After you connect to a controller or load a saved configuration file, you can use the *View Explorer* to display one or more of the following windows in the working area of the main configuration window. Different window options appear depending on the type of connected control module. Each tab displayed to the right upon clicking the *View Explorer* options can be undocked and made into a free floating window. The *View Explorer* panel can be hidden via the *View* drop down button on the toolbar. The ‘x’ button hides the *View Explorer* and the thumbtack icon allows it to be docked. A docked screen is viewed by hovering the mouse pointer over the docked screen.

View Explorer Windows

The window options that are available to an excitation control module (ECM-2) differ from those available to a bridge control module (BCM). Table 6-6 lists the windows available to the specific control modules.

Table 6-6. Control Module View Explorer Window Availability

Window	ECM-2	BCM
System Views		
Diagram View Windows	●	●
Execution View Windows	●	●
Mainline Execution View		●
Application Config View	●	●
Memory View (only available with Security Level 5)	●	●
Monitor Views	●	●
Metering		
Control Panel	●	
Sync Panel	●	
Generator	●	
Main Field	●	
Adjuster	●	
Limiter	●	
GSU Transformer	●	
PPT	●	
Exciter Field	●	

Window	ECM-2	BCM
Other	●	
Real Time Clock	●	●
Status		
System Status	●	
Alarms (Status)	●	
Limiters	●	
System Trip	●	
Transfer	●	
Inputs	●	●
Outputs	●	
Bridge Status	●	
Commissioning Windows (All)	●	
Reports Windows (All)	●	●

Indicators

Many of the metering screens, within the *View Explorer*, contain indicators. These color-coded indicators display the current mode of their corresponding function. Usually associated with status or mode indicators, green denotes a TRUE condition. A red indicator denotes a TRUE condition as well, but is associated with alarm/error and breaker status. Yellow denotes a picked-up status for alarms and limiters. Indicators are always gray when denoting a FALSE condition. Figure 6-27, Figure 6-28, and Figure 6-29 illustrate the different indicator colors.

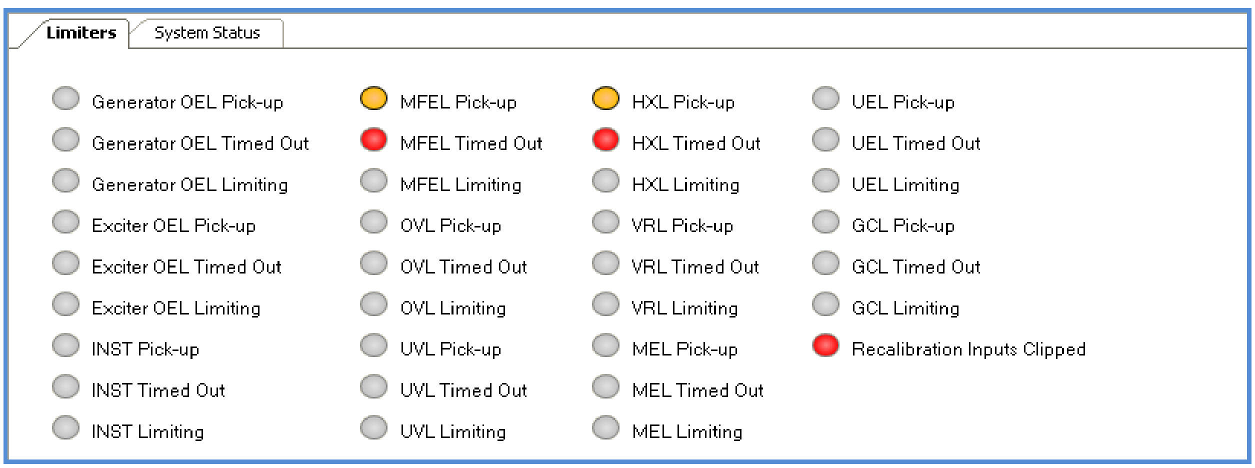


Figure 6-27. Limiters Window: Yellow, Red, and Gray Indicators

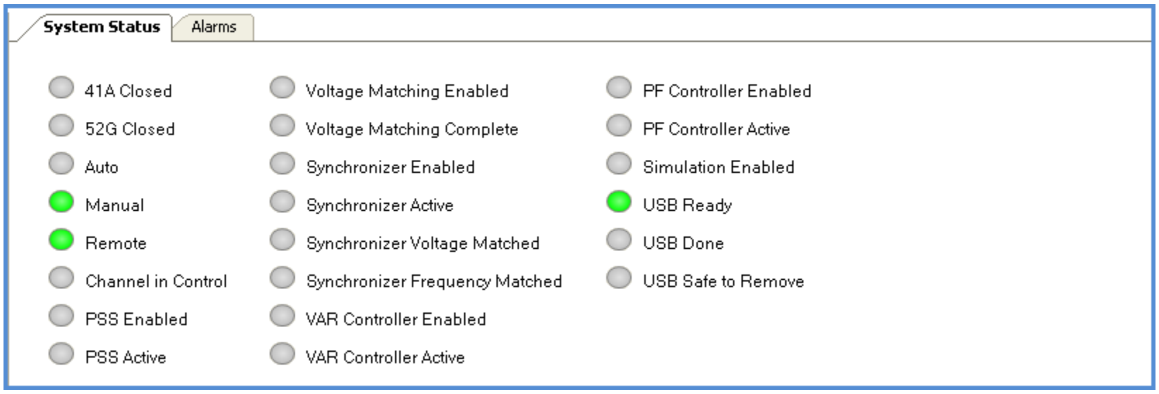


Figure 6-28. System Status Window: Green and Gray Indicators

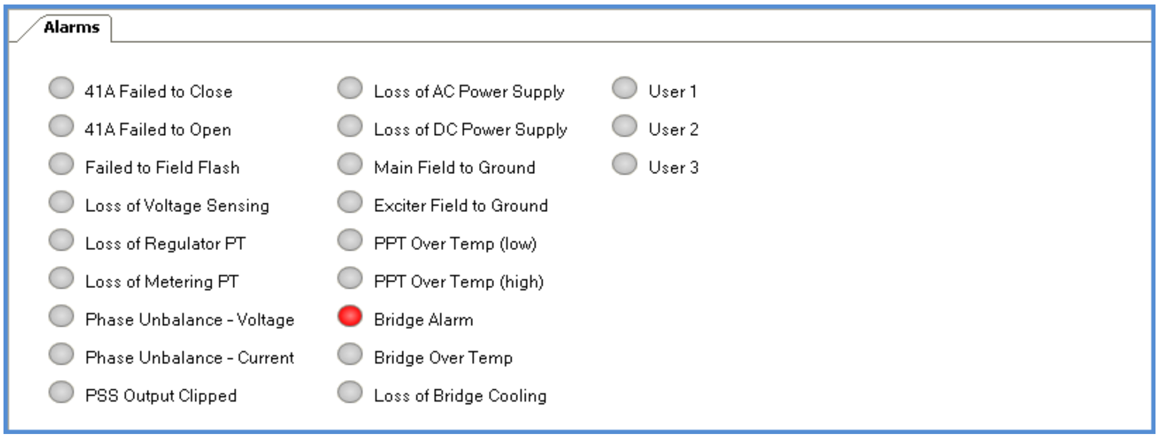


Figure 6-29. Alarms Window: Red and Gray Indicators

Diagram View

The Diagram View windows display and allow manipulation of a block diagram representation of a configuration in file and RAM. Flash diagrams can only be viewed. See Figure 6-30.

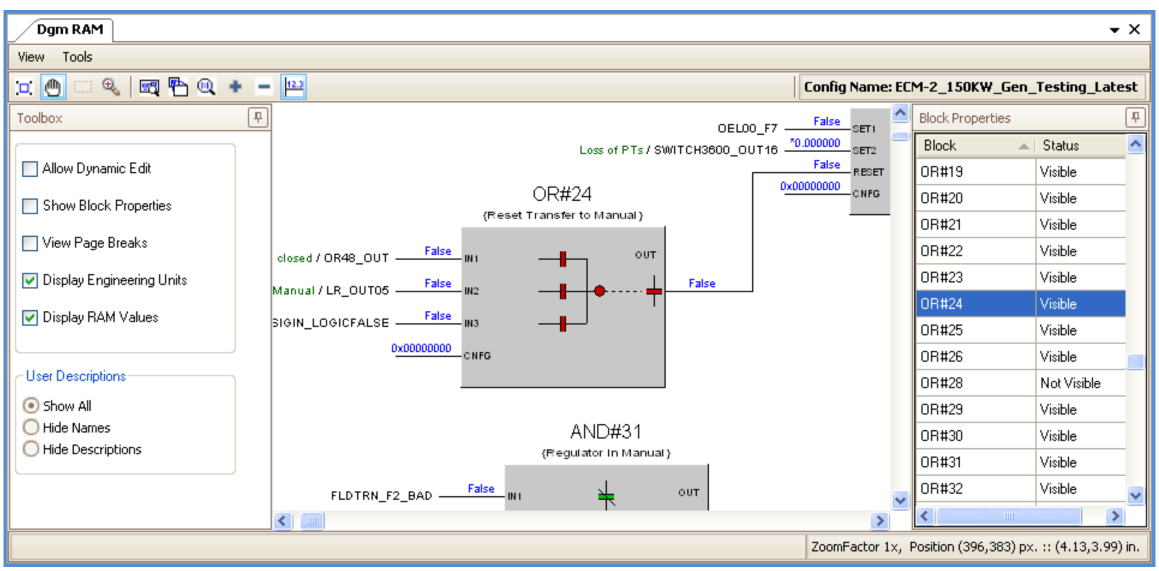


Figure 6-30. Diagram View Window

The diagram window is the workspace where programming can be done in BESTCOMS*Pro*. In this window the logic block configuration is represented graphically, logic blocks and their connections can be easily manipulated using click-and-drag and right click popup options. Undocking the diagram window allows the user to move it to a more convenient location or even a second monitor. Pan, zoom, and search functions are available for easy navigation.

Setting up the Diagram View Windows

There are three types of diagram windows.

- **Dgm Flash**: Allows the user to view the current logic configuration stored in the flash.
- **Dgm RAM**: Allows the user to view and fine tune the current logic configuration stored in RAM.
- **Dgm File**: Allows the user to view a configuration file saved on the PC, create a new configuration file, or make changes to an existing one.

In the View Explorer, System Views, Diagram View, Click Dgm Flash, Dgm RAM, or Dgm File to display the desired diagram window.

Window Contents

The diagram window displays a great deal of information to the user. The information is categorized and described below. Figure 6-31 shows connected logic blocks in the diagram window.

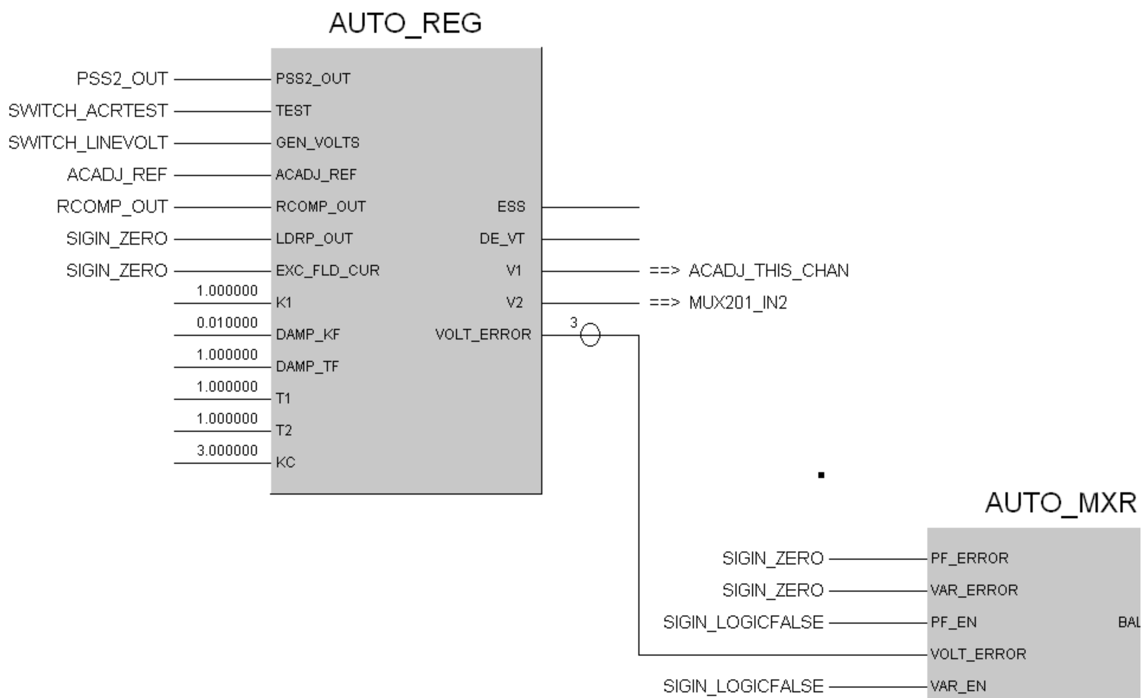


Figure 6-31. Block Inputs and Outputs

RAM Runtime Values: Monitor runtime values when the RAM configuration is displayed.

Object Specific Commands: Right-click on an input, output, connection, or block to display a menu of commands specific to that type of object.

Show / Hide Elements: Display or hide connections and blocks to view only the information of interest.

Block information is shown in the Diagram window (except when you are displaying the actual RAM runtime values) as follows:

- Inputs are shown on the left of the block and outputs on the right of the block. The input and output names (or abbreviated names) are shown inside the block.
- Constant values are shown above the connection line, such as for the K1 through KC inputs of the AUTO_REG block.
- Connections can be made visible or invisible. When visible, the connection line is shown as illustrated below for the connection between the VOLT_ERROR output of the AUTO_REG block and the VOLT_ERROR input of the AUTO_MXR block. When invisible, the output name appears next to the input line, as illustrated below for AUTO_REG inputs such as PSS2_OUT.

- When an output has multiple connections, the number of connections is shown on the output line, such as for the VOLT_ERROR output of the AUTO_REG block.
- Pink lines in the diagram indicate that the line is not orthogonal. You can add points to make the line orthogonal.

Diagram Toolbar Commands

The diagram window has its own special commands and tools for the creation and manipulation of logic block configurations. The location of the menu commands and the toolbar is shown in Figure 6-32.

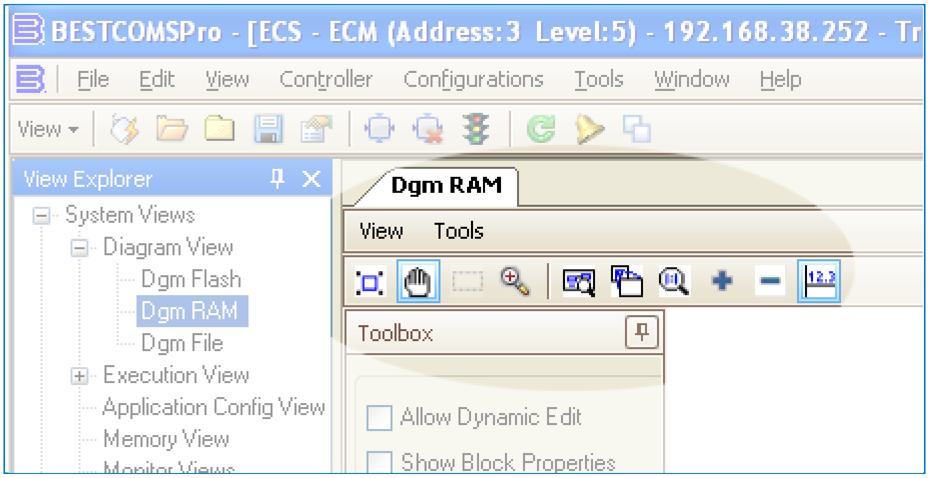
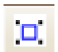
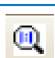
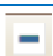


Figure 6-32. Diagram Window Toolbar Location

Table 6-7 describes the available menu and toolbar commands for the diagram window.

Table 6-7. Menu and Toolbar Commands

Menu Items	Description
View	
Zoom to Fit	Zooms out until the diagram fits into the current window.
Zoom to Box	Zooms in to an area that you specify by drawing a rectangle.
Zoom to Base View	Zooms the diagram to a one-to-one ratio. Position the cursor at the location that you want to be the center of the new zoomed area, and then left click.
Zoom In	Zooms in incrementally.
Zoom Out	Zooms out incrementally.
Block Properties	Opens a window showing the status of existing blocks.
View Page Breaks	Displays lines in the diagram to represent the boundaries of individual pages if printed.
Display Engineering Units	Toggles visibility of engineering units in diagram.
Display RAM Values	Toggles visibility of RAM values in diagram.
Redraw	Redraws the diagram.
Refresh RAM Values	Refreshes RAM values.
Navigation Window	Displays a map of the diagram in a new window. Drag a box to zoom to that location.
Tools	
Find…	Search for blocks.

Menu Items	Description
Allow Dynamic Edit	Enables or disables dynamic edit. You must enable dynamic edit in order to edit the drawing and configuration information.
Export to Metafile	Save diagram in metafile format.
Resize Drawing Canvas	Input exact dimensions to resize diagram window.
Page Setup…	Change printer settings and page size.
Show Invisible Ports	Toggles visibility of invisible ports.
Toolbar	
 Toggle Dynamic Edit	Enables or disables dynamic edit. You must enable dynamic edit in order to edit the drawing and configuration information.
 Pan	Dragging the cursor anywhere in the diagram (either on an object or outside an object) pans the diagram.
 Rectangle Select Mode	Dragging the cursor when not on a block or connection line draws a rectangle and selects the objects in the rectangle.
 Zoom In Mode	Click anywhere in the diagram to zoom in.
 Zoom to Fit	Zooms out until the diagram fits into the current window.
 Zoom to Box	Zooms in to an area that you specify by drawing a rectangle.
 Zoom to Base View (1:1)	Zooms the diagram to a one-to-one ratio. Position the cursor at the location that you want to be the center of the new zoomed area, and then left click.
 Zoom In	Zooms in incrementally.
 Zoom Out	Zooms out incrementally.
 Toggle RAM Values	In the RAM configuration when the controller is executing, you can use this command to view or hide RAM values.

Shortcut Menus

Different shortcut menus are displayed depending on where you right-click in the diagram window. The shortcut menus are illustrated below in Figure 6-33.

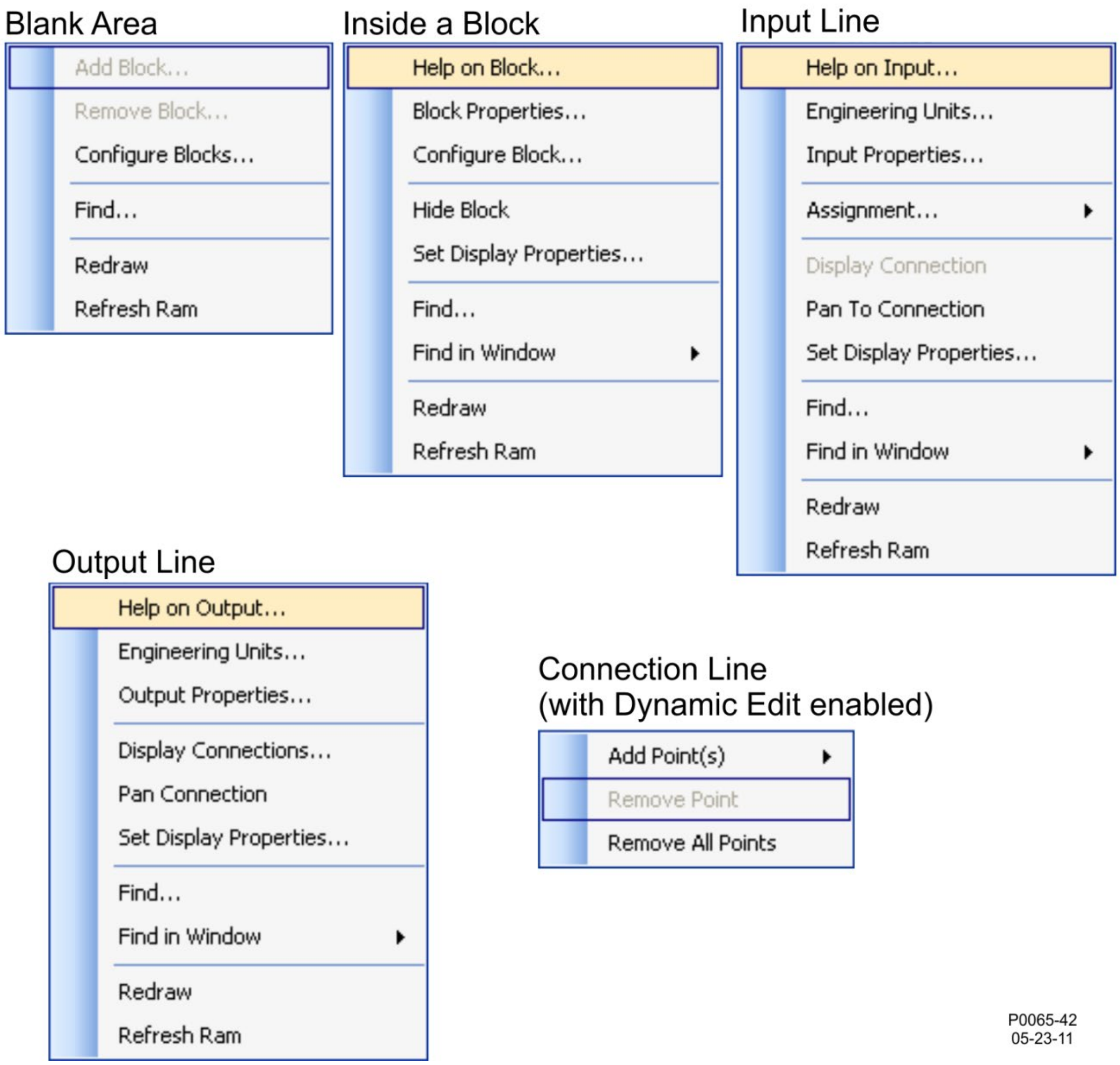
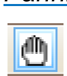


Figure 6-33. Right-Click Shortcut Menus in Diagram Window

Navigating in the Diagram

As stated above, there are three types of diagram windows. There are also three types of execution windows. All of these windows including others contain information on the active logic blocks in a configuration. Navigating to a specific logic block in a specific window can be confusing. BESTCOMS*Pro* has several powerful tools to make navigation easy.

Panning and Scroll Bars

 **Pan:** Use the pan tool to move the diagram in any direction by clicking in a blank area of the diagram and dragging.

Scroll Bars: Standard scroll bars.

The Find Command

Use the *Find* command (Tools menu, *Find…*) to search for any logic block in any window. The drop down list at the top contains all of the searchable windows, the list at the bottom contains all of the searchable logic blocks, and specific names can be entered into the blank field in the middle.

Pan to Connection

Use *Pan to Connection* to automatically center view on the opposite end of the current connection. Right click on an input or output (not the connection line) and select *Pan to Connection*. The entire connection line blinks blue and the input / output connectors blink red. Click anywhere to end the blinking.

Pan to Block

Use *Pan to Block* to automatically center view on a block selected from a list of active blocks. Click the *Show Block Properties* check box in the diagram window. This opens a docked window containing a list of all active blocks. Find the desired block in the list and right click, select *Pan to Block*. The block is centered in view and blinking.

Find in Window

Use *Find in Window* to center view on the same selected logic block, input, output, or connection line in a different window. For example, if you're viewing a logic block in the *Dgm Flash* window and want to make changes to the same block in the *Dgm RAM* window. Right click on a logic block, input, output, or connection line and point to *Find in Window* a sub-menu appears with a list of window options.

Navigation Window

The navigation window displays a miniature map of the entire diagram. Click and drag a box in the navigation window to zoom to that location in the diagram window. The *Navigation Window* command is found under the *View* menu.

Zooming

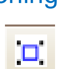
The zoom commands and their descriptions can be found above in the *Menu and Toolbar Commands* table.

Assigning Blocks in the Diagram

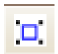
Adding a Block

- Under the *Configurations* pull down menu click *Add Block* or click the  icon on the toolbar.
- Select the block to be added from the list.
- Select the execution strategy tab and select a number of execution cycles from the drop down list.
- Click on a lower cell in the table to change the position of the time slices.
- Select the Input Assignment tab.
- To change the assignment type, click the *Constant* or *From Output* tab.
- For a constant value, type a value and click the radio button that identifies the type of value as decimal, hexadecimal...
- For a *From Output* value, select the block and output from the drop-down lists.
- If there are any potential problems with this assignment, a confirmation dialog asks you to verify making the assignment. Click *Yes* to continue, or *No* to return to the *Input Assignment* dialog.
- Repeat for all remaining inputs.
- In this example all block inputs have been assigned. To end the command, click *OK*. If all inputs had not been assigned, the unassigned input(s) would be listed in the *Configure Blocks* dialog under *Configurations*.
- The block is now added to the configuration. However, the newly added block is not visible in the diagram. See *Displaying and Positioning a Block,* below, for details on block visibility.

Displaying and Positioning a Block

Enable *Dynamic Edit* . Click the *Show Block Properties* check box in the diagram window. This opens a docked window containing a list of all active blocks and their visibility status. Find the desired block in the list and right click, select *Display Block*. The block is centered in view and blinking. Click and drag the block to the desired location.

Selecting and Moving Blocks

Enable *Dynamic Edit*  to move blocks.

To move a single block, click and drag the block. (In Pan Mode  or Select Rectangle Mode )

To move multiple blocks, hold down the *Ctrl* key and select each block, then click and drag one of the selected blocks to move them all.

In Rectangle Select Mode , position the cursor outside of the blocks and drag to draw a selection box around the blocks. Click and drag one of the selected blocks to move them all.

Any connection lines to the blocks are automatically adjusted as you move the blocks. You do not need to select the connection lines.

Drawing a Connection Line

Position the cursor over the input line for which you want to draw a connection. The input can be unassigned, a constant that you want to change into a connection, or a connection that you want to change into a different output. The cursor must be positioned exactly over the input line.

Click and drag to draw a line representing the connection.

Release the button over the output to which you want to connect. The output line is highlighted.

If there are any potential problems with this assignment, a confirmation dialog asks you to verify making the assignment. Click *Yes* to make the assignment, or *No* to cancel it.

Adding Points and Reshaping Connection Lines

To add one point, position the cursor over the line at the location you wish to add the point. To add multiple evenly spaced points, position the cursor anywhere over the line.

Right click on the connection line to display the shortcut menu.

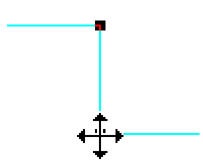
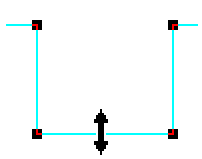
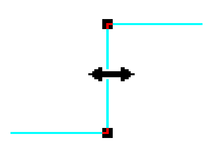
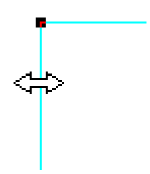
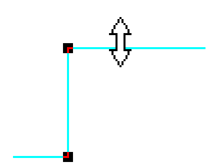
Choose *Add Point(s)*, and then choose the number of points from the submenu. If you chose to add 1 point, it is added at the location you clicked. If you choose to enter multiple points, they are evenly placed along the line (or along the line segment if you previously added points and re-shaped the line to have multiple segments).

To re-shape the line, click and drag a point.

You can repeat these steps as needed to continue to add points and re-shape the line.

You can only drag line segments that are vertical or horizontal, and are not the starting or ending line segment. The shape of the cursor indicates the type of movement allowed. See Table 6-8.

Table 6-8. Connection Line Movement Cursors

Move Point	Move Segment Vertically	Move Segment Horizontally	Unable to Move Segment	
				

Entering Assignment Values

In addition to assigning input in the diagram window by drawing connection lines, you can assign inputs by entering the values in a dialog box. This method can be used to assign inputs that are constants or block outputs.

Enable Dynamic Edit .

Navigate to the desired block.

Right click the block and select *Configure Block*. This opens the *Configure Block* dialog box, as shown in Figure 6-34. The possible inputs are listed on the left side. Unassigned inputs are indicated by a yellow warning symbol. Constants and available outputs are on the right side.

Select an input from the list on the left.

To connect the input to an output of a different logic block, click the *From Output* tab and select that output from the drop down list.

To assign the input a constant value, click the *Constant* tab, input the constant value in the field, and select the radio button of the appropriate numbering system (decimal, hexadecimal…).

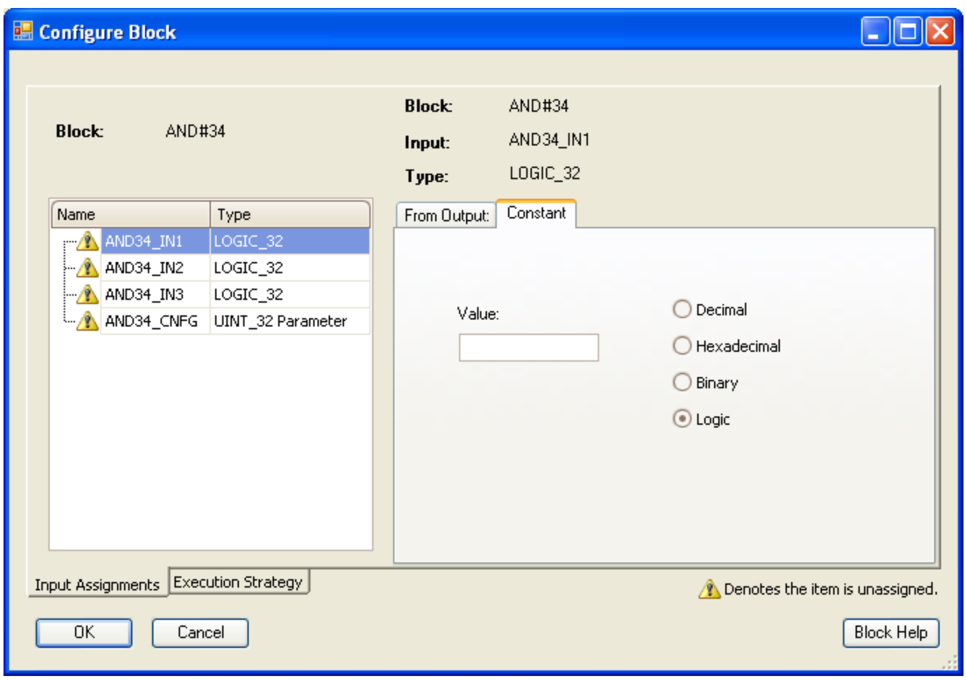


Figure 6-34. Assigning Inputs in the Configure Block Dialog Box

Execution View

The *Execution View* presents execution strategy (cycles) in matrix form. The time slots of the cycles are listed along the top of the matrix. The logic blocks are listed down the side. The cells within the matrix represent block execution in that cycle. See Figure 6-35.

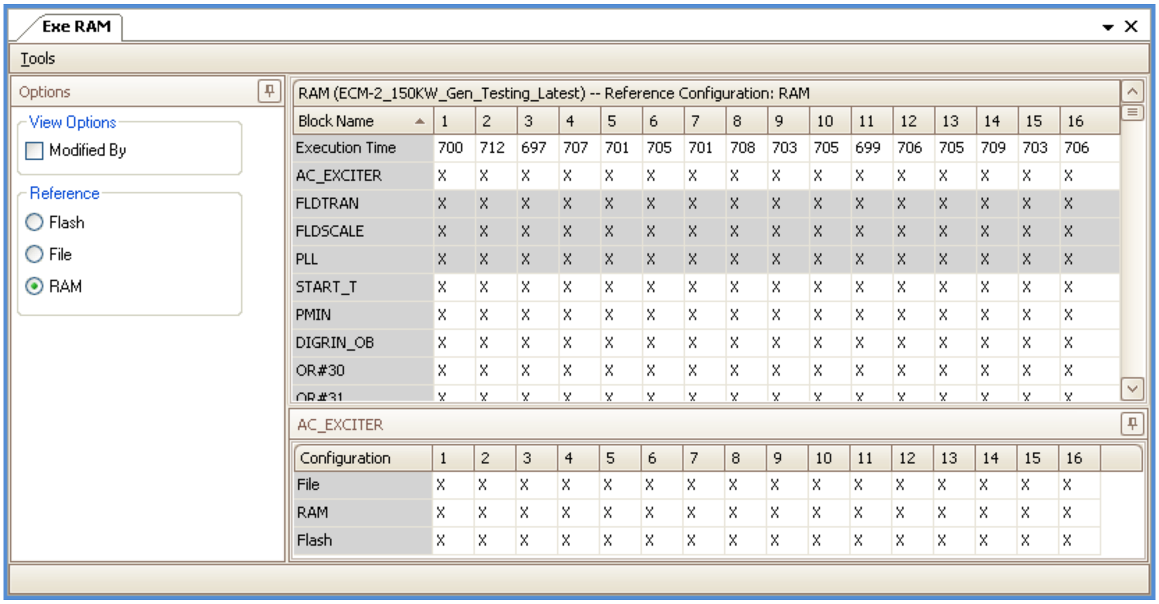


Figure 6-35. Execution View Window

Setting up the Execution View Windows

There are three types of Execution View windows.

- **Exe Flash:** Allows the user to view the execution strategy configuration stored in flash.
- **Exe RAM:** Allows the user to view and fine tune the execution strategy configuration stored in RAM.
- **Exe File:** Allows the user to view and fine tune the execution strategy configuration stored in the file.

In the View Explorer, System Views, Diagram View, Click Exe Flash, Exe RAM, or Exe File to display the desired execution view window.

Window Contents

The file, RAM, or flash execution strategy of all logic blocks is displayed in the execution view windows.

Execution Toolbar Commands

The *Tools* menu is different for each type of execution view window. Table 6-9 shows the options available in flash, file, and RAM.

View Options: Show or hide the *Modified By* column.

Reference (Radio Buttons): Set file, RAM, or flash as a reference. When you display a configuration that is not the reference, values that differ from those in the reference configuration are shown in red.

For example, the *Exe File* window is open and the reference is set to RAM. File is compared to RAM, and any differences are in red.

Table 6-9. Execution View Window Commands

Tools Menu Option	Description	Flash	File	RAM
Find	Search for blocks.	*	*	*
Reorder	Rearrange the logic block execution order.		*	*
Reset Execution Times	Resets the execution timer.			*
Refresh Execution Times	Refreshes execution times.			*
Right Click				
Set Executions per Cycle	Choose between 1, 2, 4, 6, 8, or 16 executions per cycle.		*	†
Reorder	Arrange logic block order of execution.		*	†
Find in Window	Find the selected block in a different window.	*	*	*

* This option is available.
† This option is available when the controller state is *Resolved*.

Changing Execution Cycles

Execution Order

Right click in the table to change the order in which the blocks execute.

Executions per Cycle

Right click a row to change the executions per cycle. If all cells for a block are blank, which means nothing has been assigned, you can click a cell to add one execution per cycle or right click to assign the executions per cycle. Click a cell that has a dash (-) and the block then executes in that time slot.

Application Configuration View

Displays all of the configuration information in table form. See Figure 6-36.

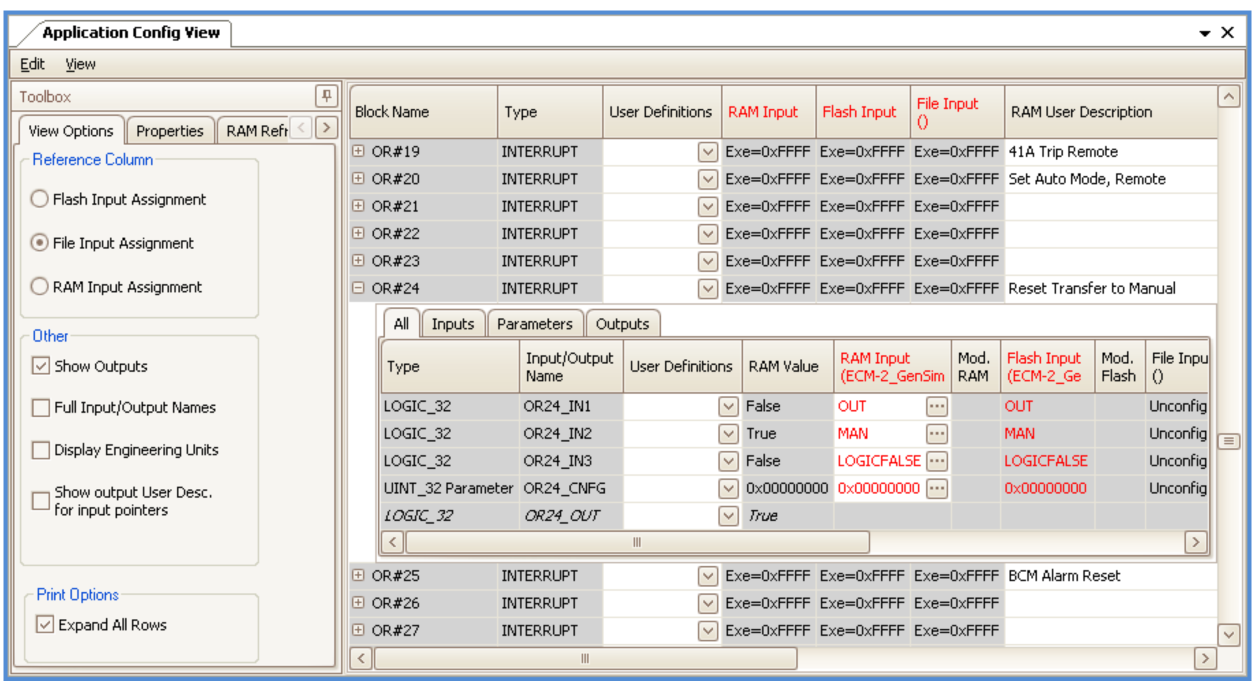


Figure 6-36. Application Config View Window

The application configuration window is a very powerful tool. It displays all information on every logic block in table form. The information can be easily navigated with the use of intuitive column sorting functions, search commands, information filters, and the ability to show or hide information. The application configuration table is commonly used to track the changes that have been made to a configuration in a file or RAM.

To open the application configuration window click *Application Config View*, in the *View Explorer*, under *System Views.*

Window Contents

The application configuration table displays a great deal of information. Every active logic block is shown in its own row. Each row can then be expanded to show all inputs, outputs, and parameters of that logic block, as shown in Figure 6-37.

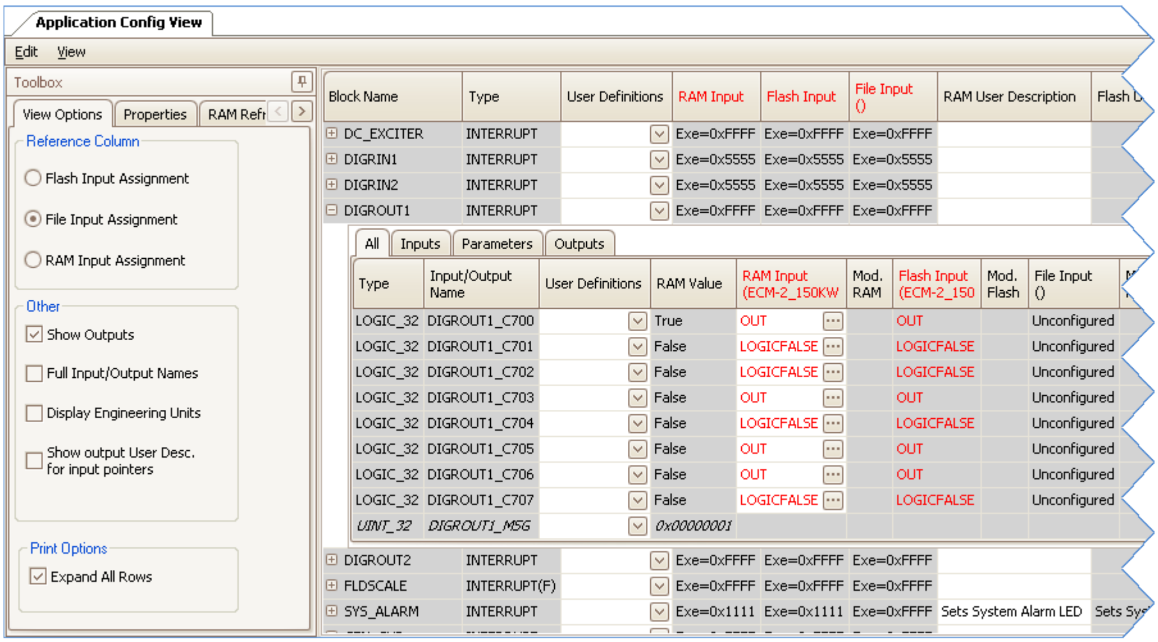


Figure 6-37. Application Configuration Table with an Expanded Block

Application Configuration Window Commands

Table 6-10 describes the available menu and toolbar commands for the application configuration window.

Table 6-10. Application Configuration Window Menus and Commands

Menu Items	Description
Edit	
Find… (F3)	Search for blocks.
Search Grid… (F4)	Search for blocks within the application configuration table.
Find Config Differences	Automatically searches for and displays configuration differences in the table.
Find Next Config Difference (F7)	Automatically searches for and displays the next configuration difference in the table.
Clear Highlights	Clears highlighted cells in the table.
View	
Collapse All	Collapses all sub-menus in table.
Refresh RAM Values	Refreshes RAM values in table.
Refresh Selected RAM Values	Refreshes the RAM values for the selected items in table.

Menu Items	Description
Clear Selected RAM Values	Clears the RAM values for the selected items in table.
Toolbox	
View Options Tab	Contains options for changing the *Reference Input Assignment* and other view related options.
Properties Options Tab	Contains options for hiding or displaying columns in the application configuration table.
RAM Refresh Tab	Contains options for setting RAM refresh rate and selecting which inputs refresh their RAM values.
Filters Tab	Contains options for hiding or displaying a selection and adding or editing filters.

Navigating in the Table

As stated above, the application configuration window displays all information on every logic block in table form. Navigating to a specific logic block, input, or output can be confusing. BESTCOMS*Pro* has several powerful tools to make navigation easy.

Scroll Bars and Arrow Keys

Arrow Keys: When a cell in the table is selected, the arrow keys move the selection one unit in the direction of the arrow that was pressed.

Page Up and Page Down Keys: When a cell in the table is selected, The *Page Up* key moves the selection up one page. The *Page Down* key moves the selection down one page.

Home and End Keys: When a cell in the table is selected, the *End* key moves the selection to the last cell of the row. The *Home* key moves the selection to the first cell of the row.

Scroll Bars: Standard scroll bars.

The Find Command

Use the *Find* command (Edit menu, *Find…*) to search for any logic block, input, or output in any window. The drop down list at the top contains all of the searchable windows, the list at the bottom contains all of the searchable logic blocks, and specific names can be entered into the blank field in the middle.

Search Grid

Use *Search Grid* (Edit menu, *Search Grid*) to search for blocks within the application configuration table. Input the specific name of the item in the field at the top. Choose current column only or entire grid and the search order.

Find Configuration Differences

Use the *Find Configuration Differences* command (Edit menu, *Find Config Differences*) to mark the differences in a configuration versus the reference configuration. For example, changes were made to a configuration stored in the file and needs to be compared to the original configuration stored in RAM. Under the *View Options* tab, select *RAM Input Assignment* (this sets it as the reference configuration) and then use the *Find Config Differences* command to highlight all of the changes that were made.

Find Next Configuration Difference: Use the *Find Next Config Difference* command (Edit menu, *Find Next Config Difference*) to view the configuration differences one at a time starting from the selected cell.

Pan to Connection

Use *Pan to Connection* to automatically display the cell containing the input or output connected to the current connection. Right click anywhere in the row of a block output that is a connection or the output value in the *File Input, Flash Input*, or *RAM Input* cell of a block input row and select *Pan to Connection*.

Find in Window

Use *Find in Window* to display the cell of the same selected logic block, input, or output from a different window. For example, if you're viewing a logic block in the *Dgm Flash* window and want to view the corresponding cell in the application configuration window. Right click on a logic block, input, output or connection line and point to *Find in Window* a sub-menu appears with a list of window options. Select *App Configuration*.

Assigning Blocks in the Table

In addition to assigning inputs in the diagram window by drawing connection lines, you can assign inputs by entering the values in a dialog box from within the application configuration window. This method can be used to assign inputs that are constants or connections.

Navigate to the cell of the desired input.

Right click the input cell and select *File Assignment* or *RAM Assignment*. This opens the *Assign Input* dialog box. Constants and available outputs are on the right side.

To connect the input to an output of a different logic block, click the *From Output* tab and select that output from the drop down list.

To assign the input a constant value, click the *Constant* tab, input the constant value in the field, and select the radio button of the appropriate numbering system (decimal, hexadecimal…).

Mainline Execution View (BCM only)

Displays a table showing whether or not each mainline block is going to execute. This view is only available by connecting to a BCM or opening the configuration file of a BCM. See Figure 6-38.

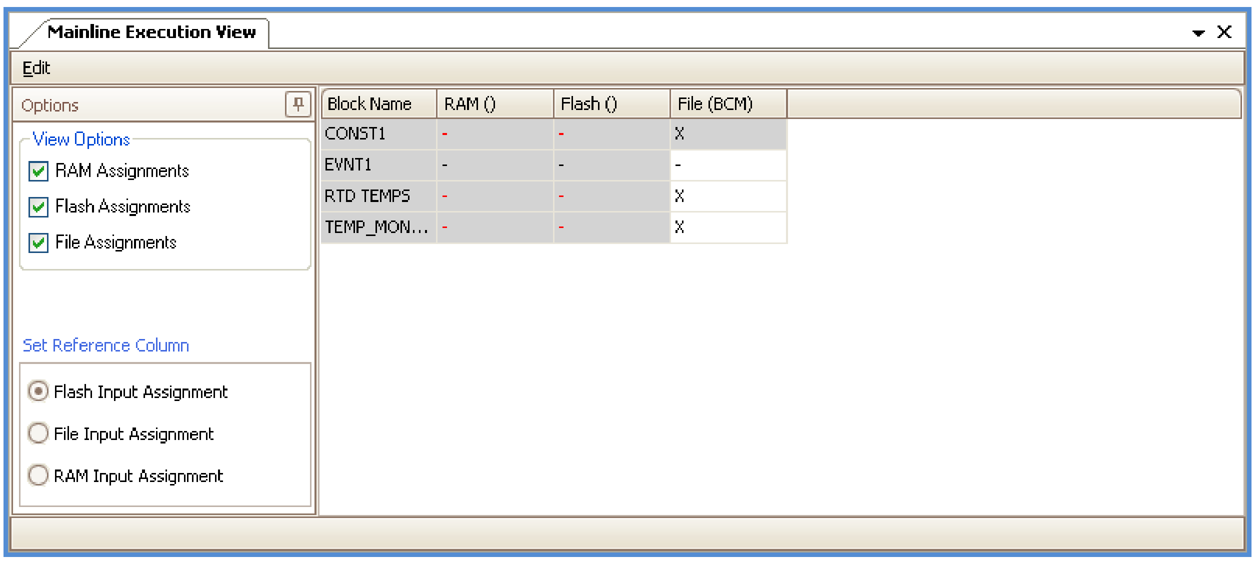


Figure 6-38. Mainline Execution View Window

Memory View

Displays the contents of all memory locations. See Figure 6-39.

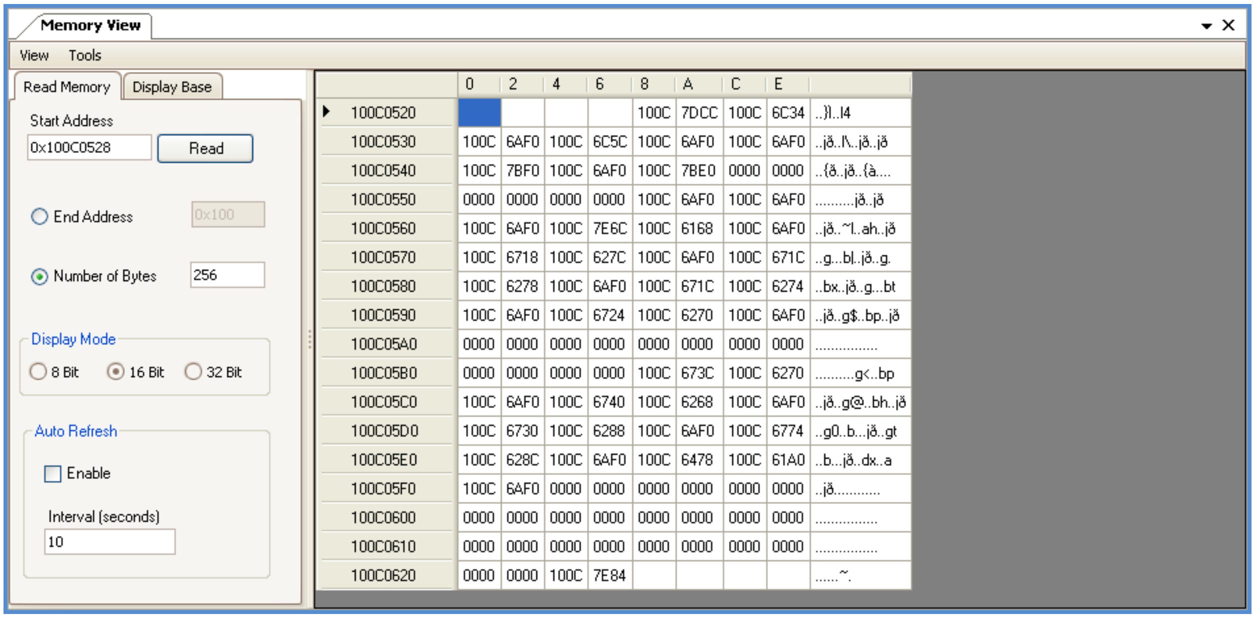


Figure 6-39. Memory View Window

Monitor View

This screen displays the contents of a set of pre-defined user-selected memory locations. See Figure 6-40.

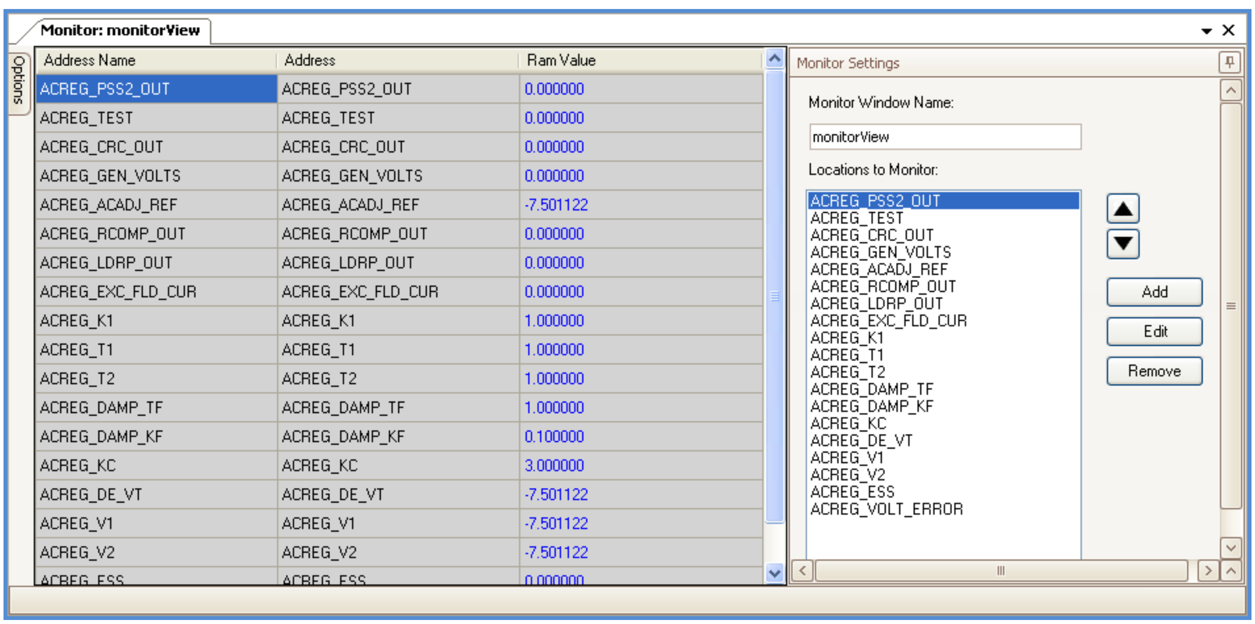


Figure 6-40. Monitor View Window

Real-Time Monitoring

Proper voltage regulator performance is critical to power system stabilizer performance. Step response measurements of the voltage regulator should be performed to confirm the AVR gain and other critical parameters. A transfer function measurement between terminal voltage reference and terminal voltage should be performed with the machine operating at very low load. This test provides an indirect measurement of the PSS phase requirement. As long as the machine is operating at very low load, the terminal voltage modulation does not produce significant speed and power changes.

The BESTCOMS*Pro* Real-Time Monitoring (RTM) Analysis screen can be used to perform and monitor on-line AVR and PSS testing. It is found in *View Explorer*, *System Views.* Up to six plots of user-selected data can be generated and the logged data can be stored in a file for later examination. In order to start plotting data, the following two conditions must be met. The RTM logic block must be in the logic configuration (it is by default) and its inputs assigned to block outputs (not constants). The controller run state must be set to *Executing Blocks*. RTM Analysis screen controls and indications are illustrated in Figure 6-41.

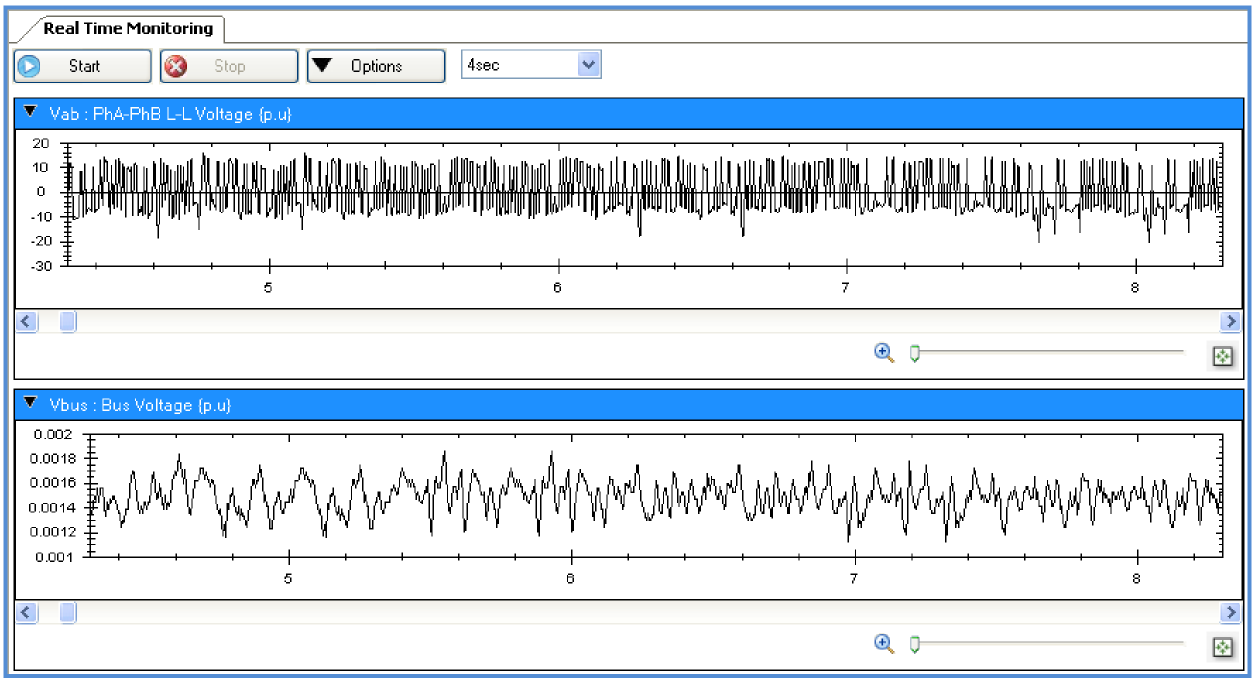
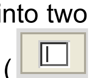
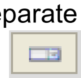
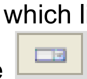


Figure 6-41. Real Time Monitoring Window

With the RTM Analysis screen controls, you can:

- Select the parameters to be graphed
- Adjust the resolution of the graph x axis and graph y axis
- Start and stop plot captures
- Export graph data as comma separated value (.CSV) or COMTRADE file formats.
- Print a captured graph

Graph Parameters

Logic block inputs/outputs and system parameters can be displayed in the graph areas. These graph parameters are sorted into two separate lists. The active list type can be toggled by clicking the *Change View/Data Type* button ( or ). This button visually changes depending on which list type is active. Clicking the  switches to the logic block data type mode, and clicking the  switches to the system parameters data type mode.

Logic Block Parameters

The logic block input/output selection window (Figure 6-42) is displayed by clicking on the  button at the top of the graph when logic block data type mode. Select the logic block from the drop down list at the top of the window and then the available inputs and outputs are displayed in the lower list area. Select the desired input or output from the lower list and click *OK*.

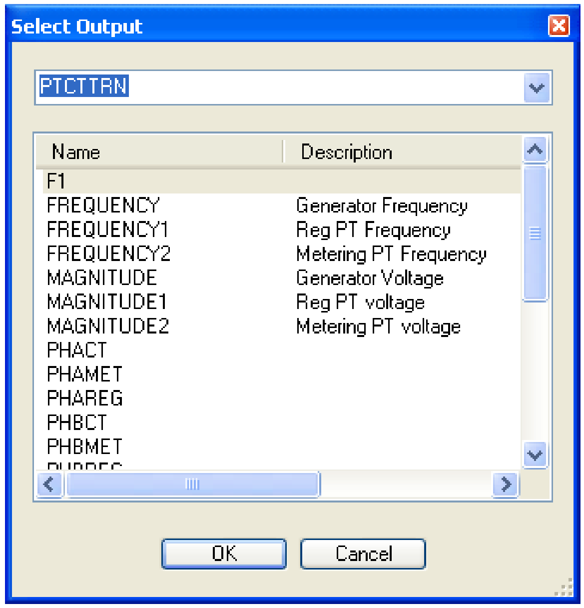


Figure 6-42. Logic Block Input / Output Selection

System Parameters

When in system parameters data type mode, the following system parameters can be selected for display in the graph areas through the drop down list at the top of the graph.

- AVR Control Signal
- AVR Error Signal
- Cross Current Compensation
- Droop Compensation
- Exciter Field Current
- Exciter Field Voltage
- Firing Command
- GCL Controller Output
- Generator Apparent Power
- Generator Frequency (Hz)
- Generator Line Current
- Generator Power Factor
- Generator Reactive Power
- Generator Real Power
- Generator Terminal Voltage
- HXL Controller Output
- INST Controller Output
- Line Drop Compensation
- Main Field Current
- Main Field Voltage
- Manual Control Signal
- Manual Error Signal
- MEL Controller Output
- MFEL Controller Output
- OEL Controller 00 Output
- OEL Controller 01 Output
- OVL Controller Output
- PF Error Signal
- PF Regulator Control Signal
- PSS Filtered Mechanical Power
- PSS Final Output
- PSS Integral Mechanical Power
- PSS Lead-Lag #1
- PSS Lead-Lag #2
- PSS Lead-Lag #3
- PSS Lead-Lag #4
- PSS Post-Limit Output
- PSS Power HP #1
- PSS Ramp Tracked Mechanical Power
- PSS Speed
- PSS Speed HP #1
- PSS Synthesized Speed
- PSS Torsional Filter #1
- PSS Torsional Filter #2
- PSS Washed Out Power
- PSS Washed Out Speed
- Regulator PID Derivative State
- Regulator PID Error
- Regulator PID Integrator State
- Regulator PID Output

- Test Signal
- UEL Controller Output
- UVL Controller Output
- VAR Error Signal
- VAR Regulator Control Signal
- VARL Controller Output

RTM Options

To display the options menu click the *Options* button and select *Display Options* from the drop down list. Both tabs of the options menu are displayed in Figure 6-43.

- **Stack / Tile:** These settings arrange the graph windows in stacks, tiles, or a mix of the two.
- **Number of graphs:** The number of graphs to be displayed is entered here with a maximum of six.
- **Graph Height:** The height, in pixels, of all displayed graphs is entered here.
- **Black Backgrounds:** This option changes the background of all displayed graphs to black.
- **Sync Graph Scrolling:** When the checkbox is checked, the graphs are all set to the same position on the X-axis and they scroll simultaneously when one of the graphs is scrolled.
- **Set X axis Range:** This function sets the graphs to display data within a window of time, specified by the user. The user-specified values are in seconds. The left field is the starting time and the right field is the ending time, so the left field value cannot be greater than the right field value.

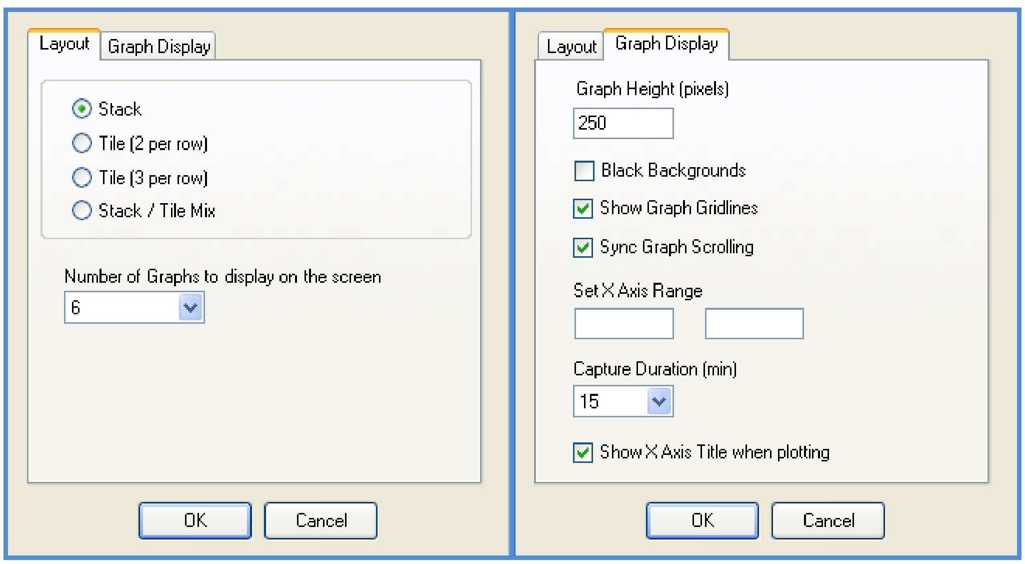


Figure 6-43. RTM Options Window

Right-Click Options

Table 6-11 describes the list of options that appears upon right-clicking in the graph area.

Table 6-11. RTM Graph, Right-Click Options

Command	Description
Copy	Copy the image of the graph to the clipboard
Save As…	Save the image of the graph as a .emf, .png, .gif, .jpg, .tif, .bmp
Page Setup…	Set up the printing options
Print…	Print the graph
UnZoom	Reset the zoom
Undo All	Reset the zoom and pan position to the original state
Export Data	Export the graph data as a .txt file

Command	Description
Cursors	Options for Goto Cursor 1 & 2 and Move Cursor 1 & 2 into View
Lines	Display Data Points, Show Point Values, Interpolated, Smooth, Step
Format	Toggle Background Color, Show Grid Lines, X Axis Autofit
Set X Scale	Scaling Options, Manual or Automatic, Minimum, Maximum
Set Y Scale	Scaling Options, Manual or Automatic, Minimum, Maximum

Rolling the mouse wheel up or down when the cursor is hovering over the graph area causes the view to zoom in or out.

Metering

BESTCOMS™*Pro* metering screens are organized according to the functions and parameters monitored. Many metering screens contain a Help button which can be clicked to obtain additional information about the metered parameters.

Control Panel

The Control Panel window, Figure 6-44, displays the status of exciter breakers, auto/manual mode, setpoints, pre-positions, VAR mode, PF mode, local/remote control, alarm, PSS, voltage matching, automatic synchronizer, simulation, and null balance. Control buttons are provided for auto, manual, VAR, and PF modes. These controls allow the user to enable modes, raise and lower setpoints, and apply pre-position setpoints. Status indicators are gray when FALSE and green when TRUE.

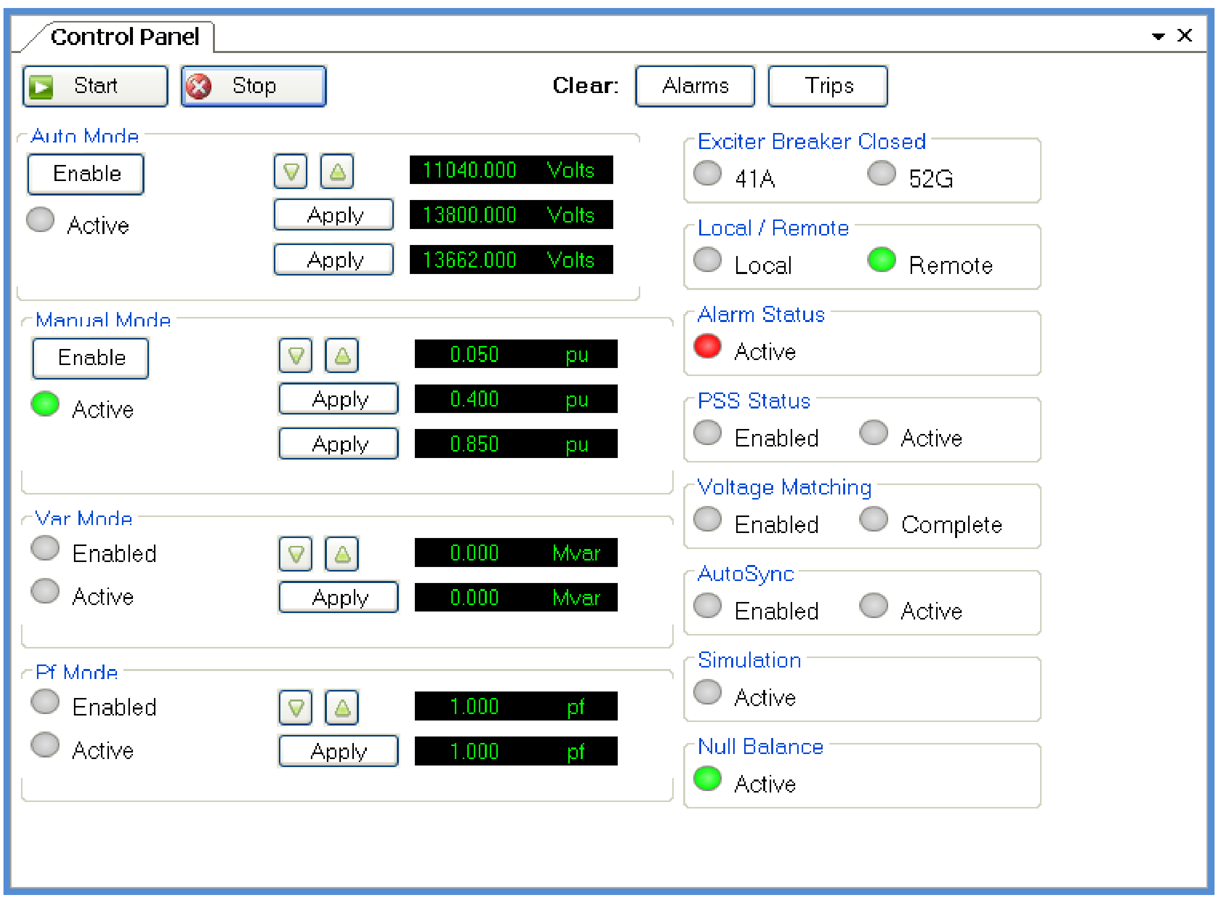


Figure 6-44. Control Panel Window

Sync Panel

The purpose of the sync panel, Figure 6-45, is to display the synchronization status of the generator and the bus. Slip Frequency (Hertz), Slip Angle, and Voltage Difference are metered. Right-clicking in the graph area displays options for saving, printing, and zoom controls.

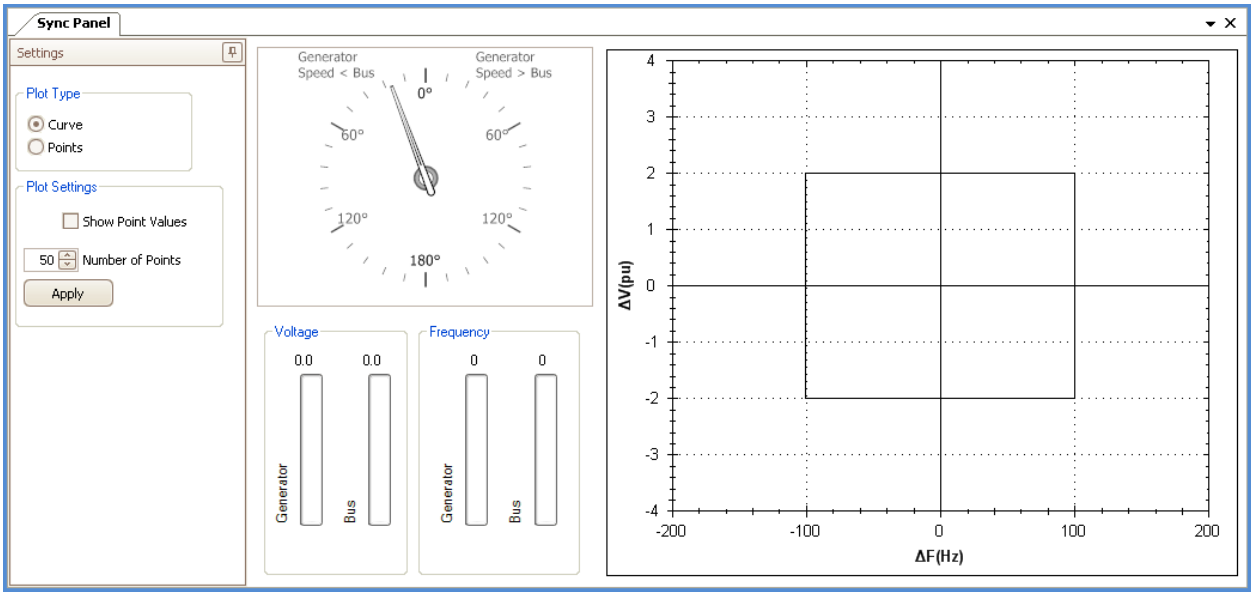


Figure 6-45. Sync Panel Window with Settings Panel Open

Generator

The Generator window displays the voltage, current, MW, MVAR, MVA, power factor, and frequency. See Figure 6-46.

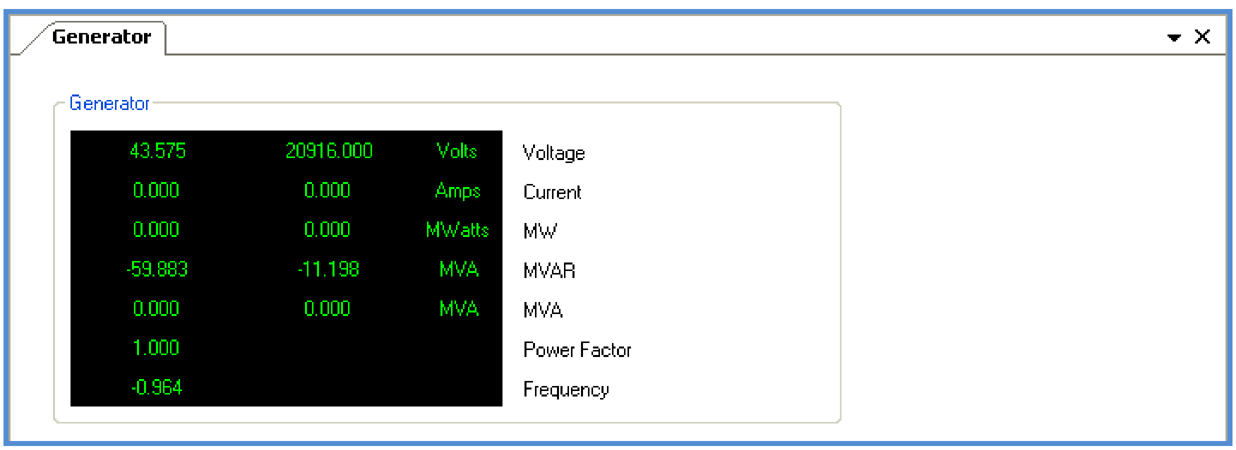


Figure 6-46. Generator Metering Window

Main Field

The Main Field window displays voltage, current, temperature, resistance, minimum field-to-ground resistance, and maximum field-to-ground resistance. See Figure 6-47.

Figure 6-47. Main Field Metering Window

Exciter Field

The Exciter Field window displays voltage, current, temperature, resistance, minimum field-to-ground resistance, and maximum field-to-ground resistance.

Figure 6-48. Exciter Field Metering Window

Adjuster

The Adjuster window displays the reference, position, and error of ac, manual, VAR, and PF. Automatic/Manual Balance and Tracker Error are also displayed. See Figure 6-49.

Figure 6-49. Adjuster Metering Window

GSU Transformer

The GSU Transformer window displays voltage, current, MW, MVAR, MVA, power factor, and frequency. See Figure 6-50.

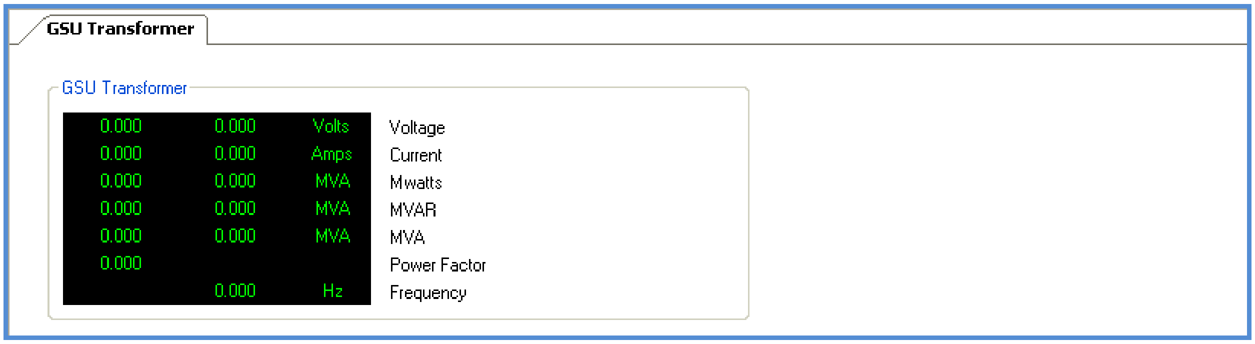


Figure 6-50. GSU Transformer Metering Window

Limiter

The Limiter window displays the status of all protective limiting. See Figure 6-51.

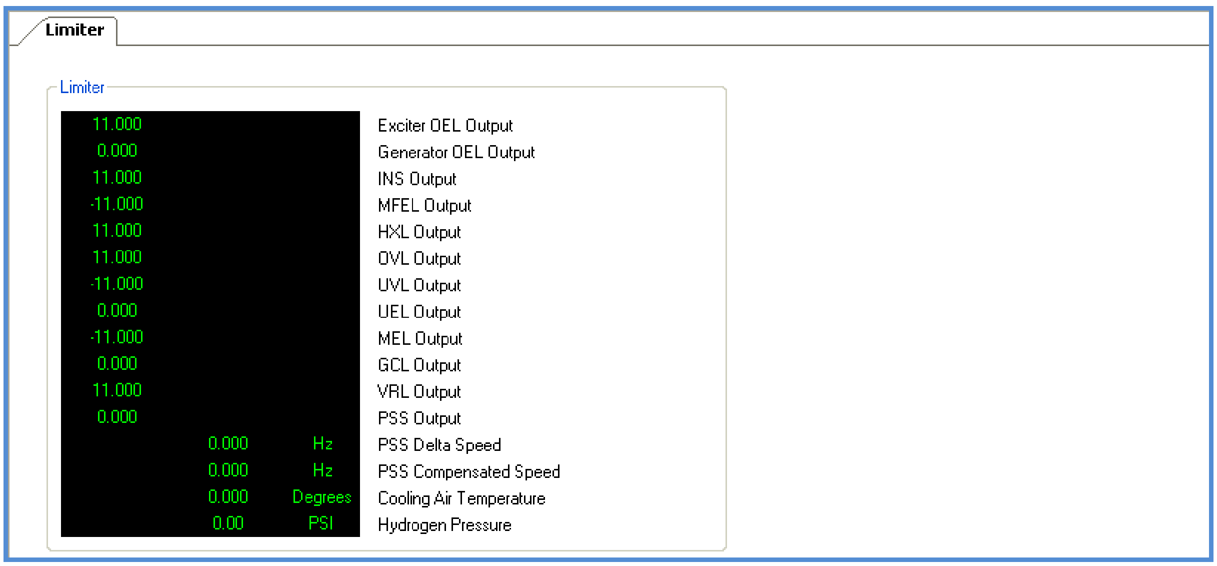


Figure 6-51. Limiter Metering Window

PPT

The PPT window displays voltage, primary current, secondary current, average temperature, and phase temperature. See Figure 6-52.

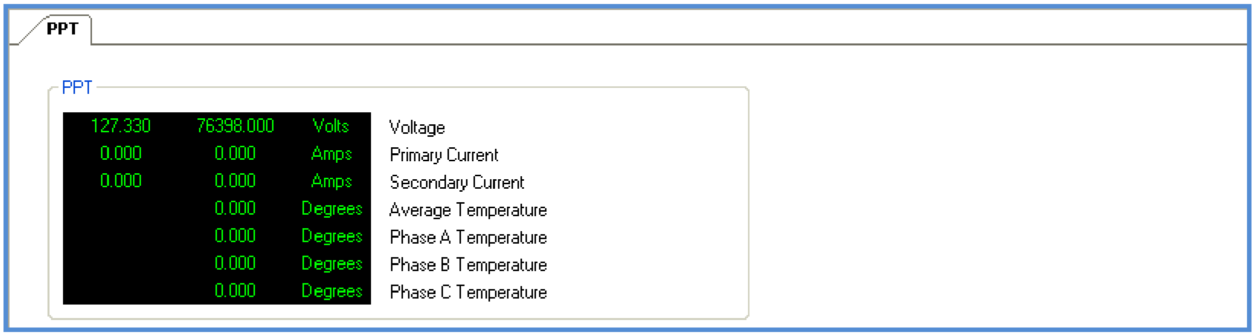


Figure 6-52. PPT Metering Window

Real Time Clock

Time and date settings can be made on the *Real Time Clock* screen by clicking the *Edit* button on the Real Time Clock screen. The Real Time Clock is shown in Figure 6-53.

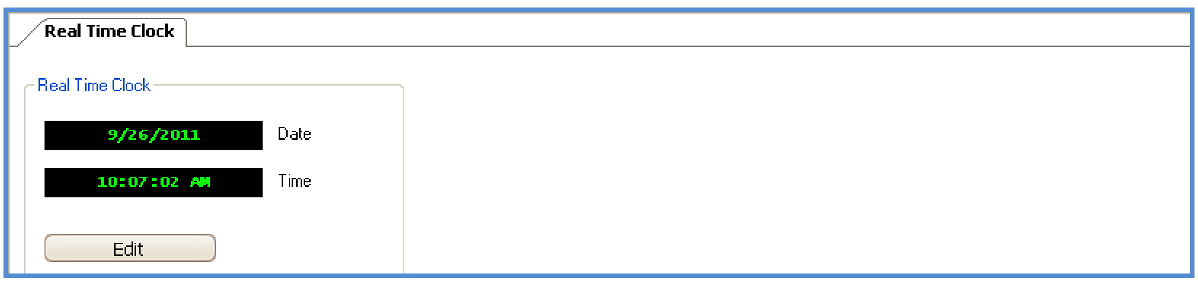


Figure 6-53. Real Time Clock

Other

The Other window displays PT magnitude, PID input, fire command, phase PT difference, phase CT difference, and User-defined metering signals 1, 2, and 3. See Figure 6-54.

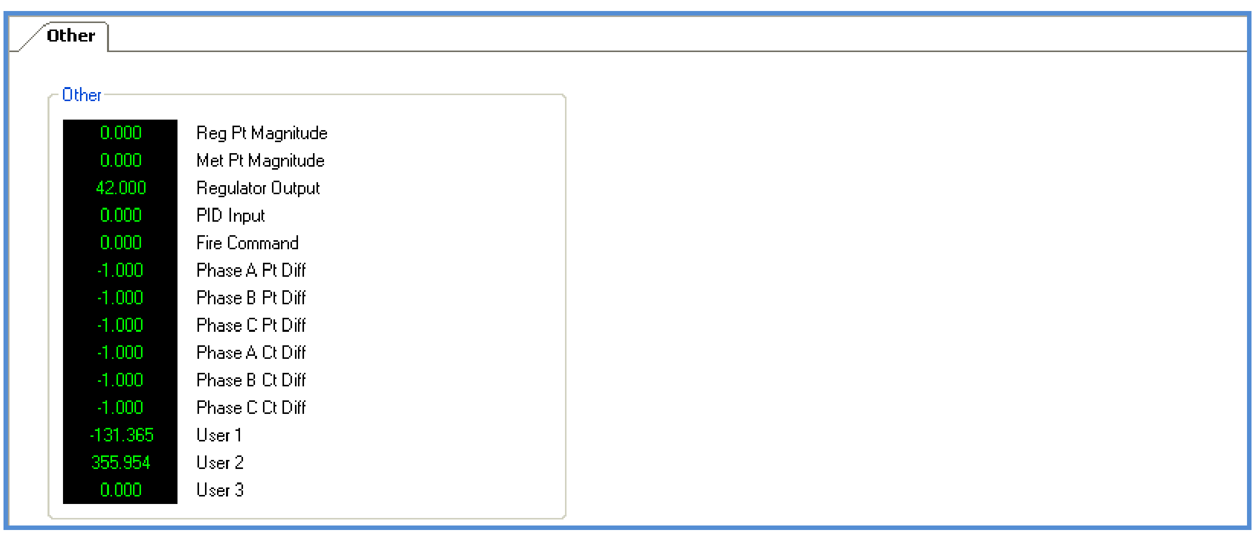


Figure 6-54. Other Window

System Status

The System Status window displays the status of the system breakers, operating modes, PSS, voltage matching, synchronizer, var controller, PF controller, simulation, and USB. See Figure 6-55.

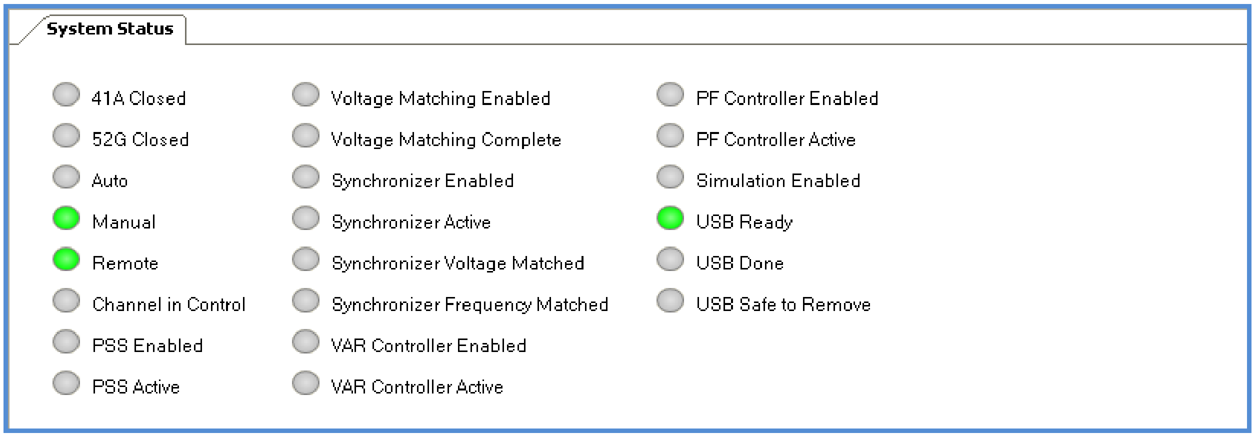


Figure 6-55. System Status Window

Alarms (Status)

The Alarms window, found under the *Status* category, displays the alarm status of the 41A close/open failure, field flash failure, phase unbalance, PSS output, main/exciter field to ground, PPT over temp (high/low), bridge, user-defined alarms, and loss of voltage sensing, regulator/metering PT, AC/DC power supply, and bridge cooling. See Figure 6-56.

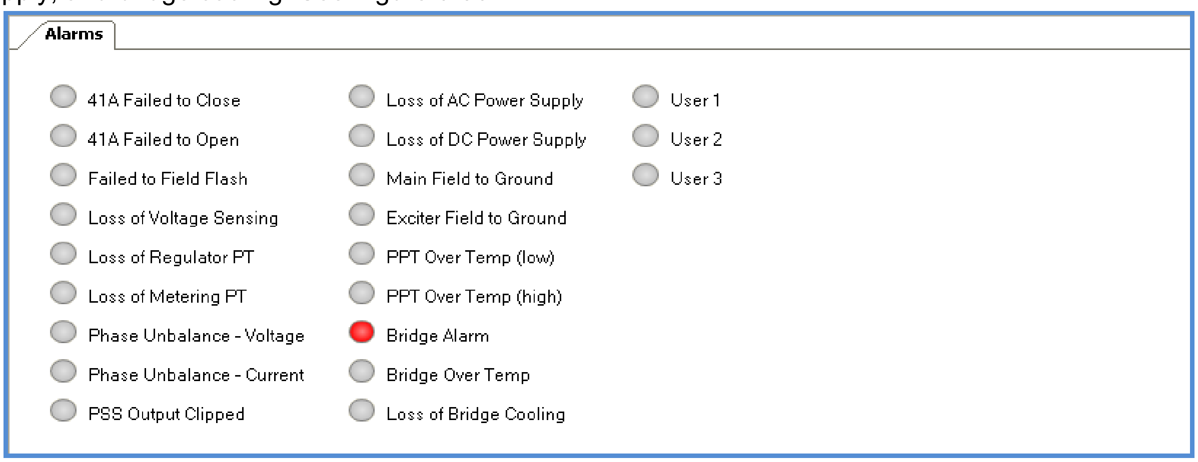


Figure 6-56. Alarms Window (Status)

Limiters

The Limiters window displays the limiter status of generator/exciter OEL, INST, MFEL, OVL, UVL, HXL, VRL, MEL, UEL, GCL, and recalibration inputs. See Figure 6-57.

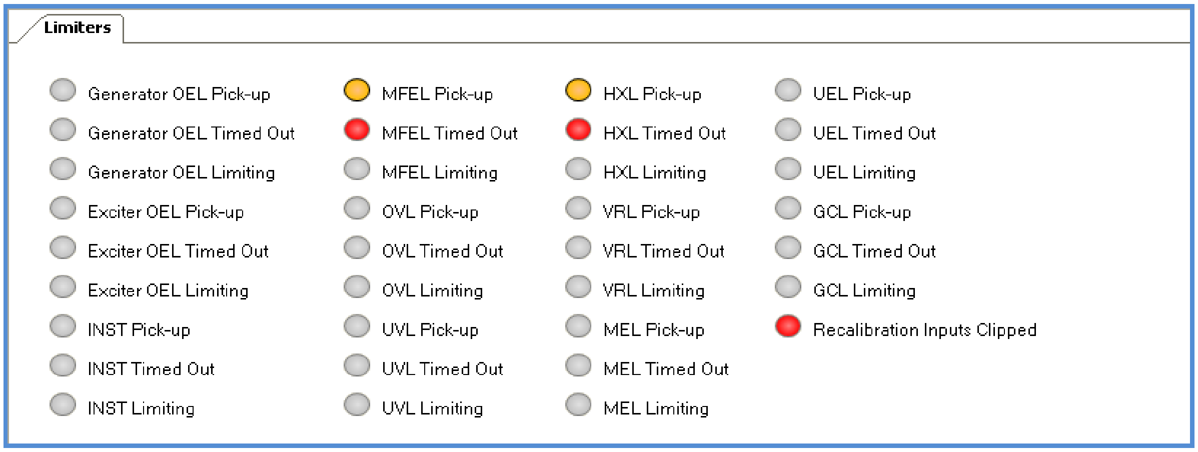


Figure 6-57. Limiters Window

System Trip

The System Trip window displays the trip status of generator/exciter OEL, INST, MFEL, OVL, UVL, HXL, VRL, MEL, UEL, GCL, field current transducer, de-excitation, crowbar, PPT over temp, emergency stop, and user-defined trips. See Figure 6-58.

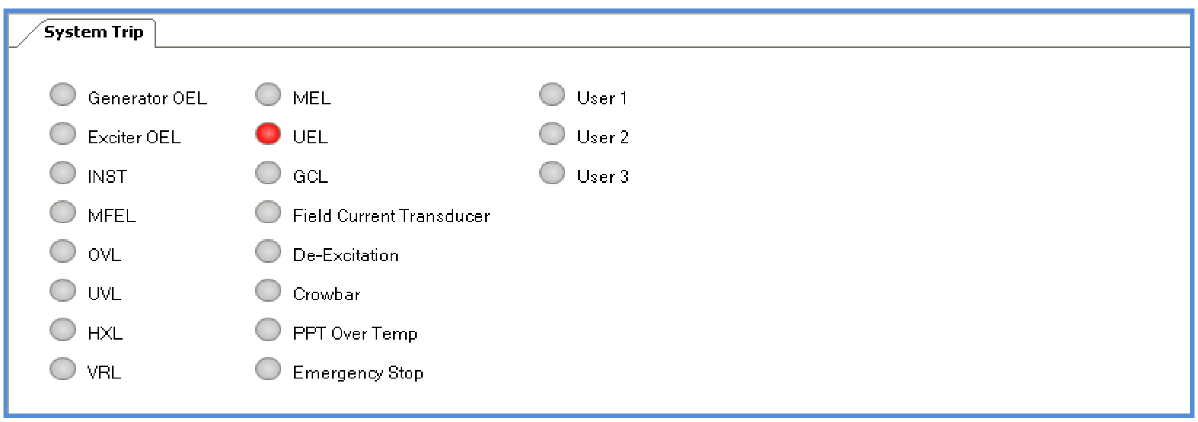


Figure 6-58. System Trip Window

Transfer

The Transfer window displays the transfer status of generator/exciter OEL, INST, MFEL, OVL, UVL, HXL, VRL, MEL, UEL, GCL, and LOS to redundant or manual. Transfer to redundant disabled, HMI transfer disabled, and channel not ready are also displayed. See Figure 6-59.

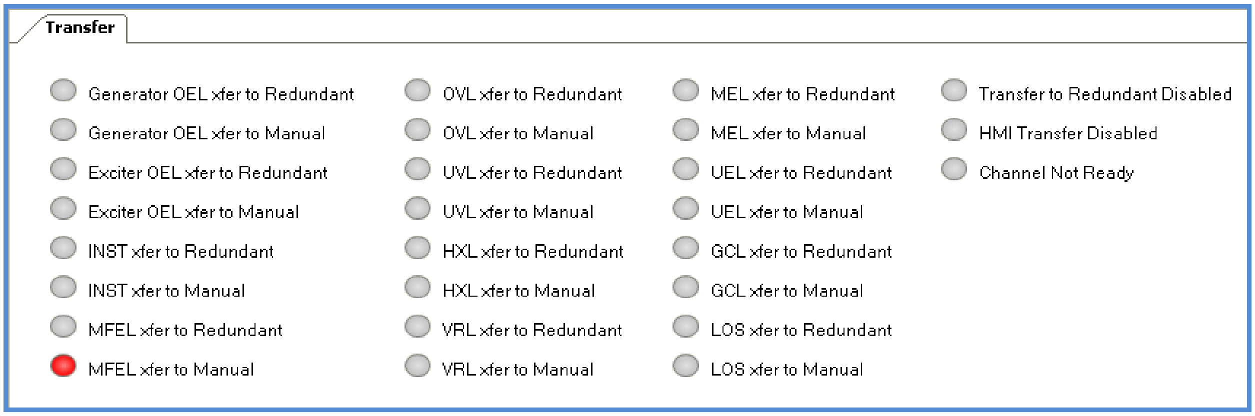


Figure 6-59. Transfer Window

Status Inputs

The Inputs window displays the status of inputs C600 to C623, F1 -, and DIGIN1 to 4. See Figure 6-60.

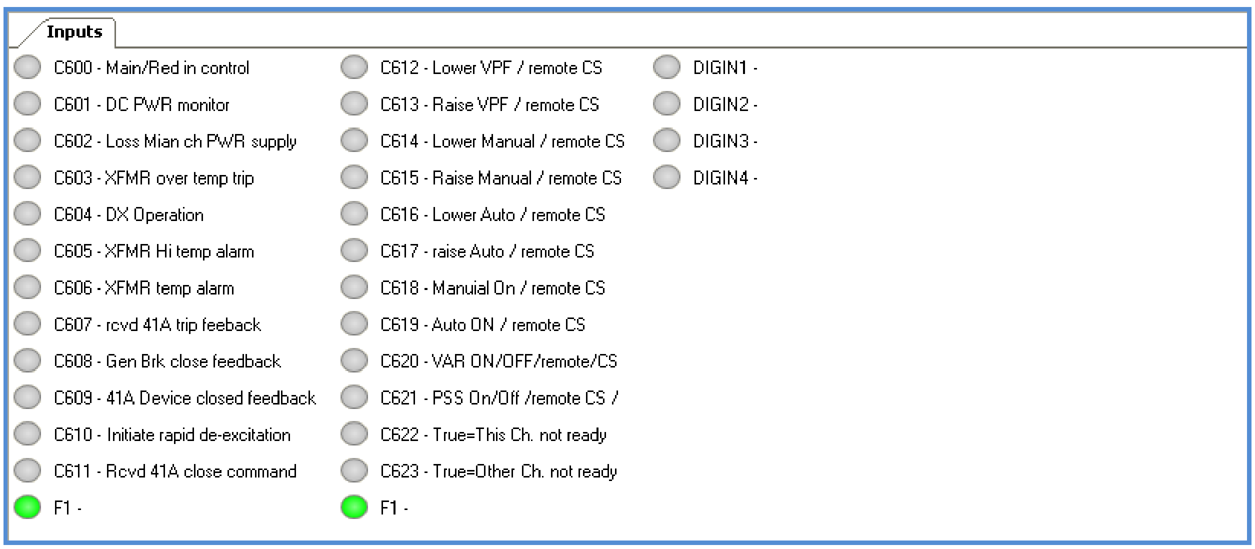


Figure 6-60. Status Inputs Window

Status Outputs

The Outputs window displays the output status of C700 to C715, and DIGOUT 1 to 4. See Figure 6-61.

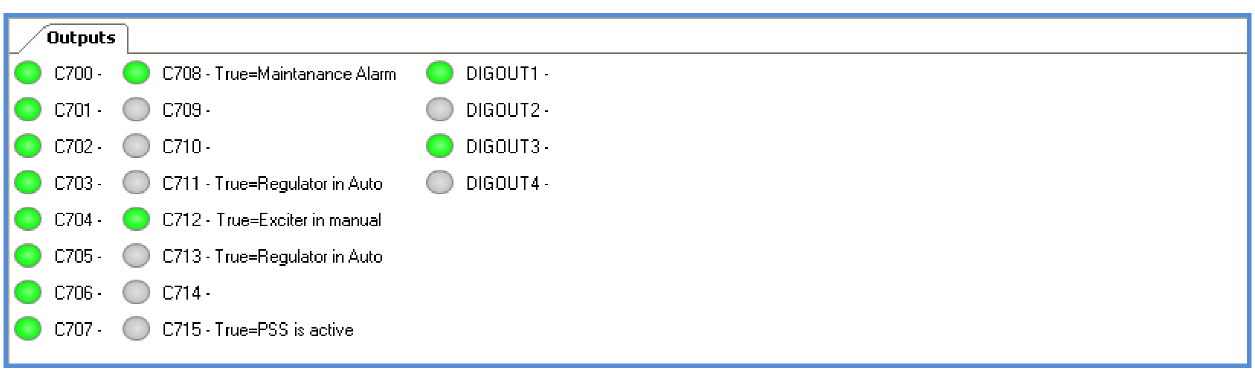


Figure 6-61. Status Outputs Window

Bridge Status

An overview of power bridge conditions and activity is available on the Bridge Status screen (Figure 6-62).

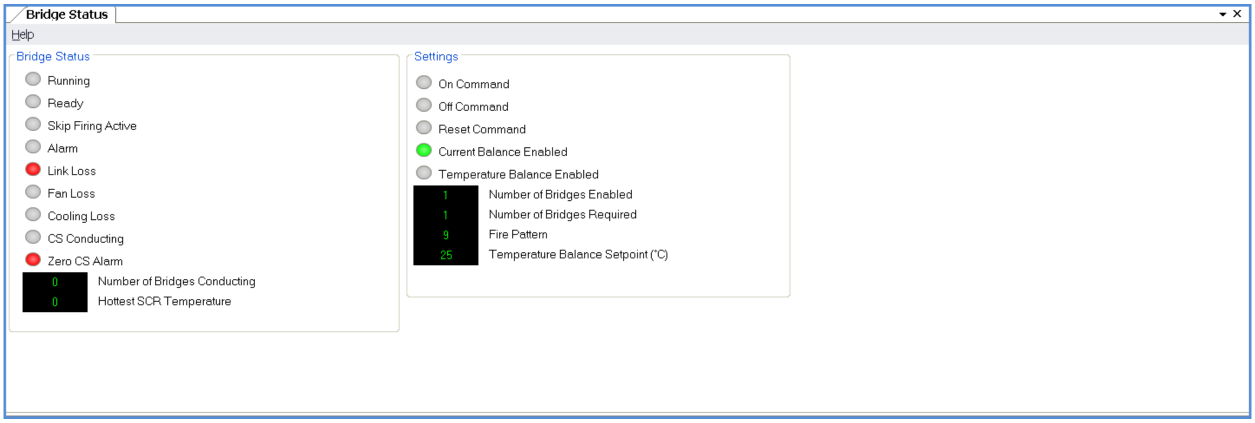


Figure 6-62. Brige Status Metering Screen

In-depth information about a specific bridge is provided on the corresponding screens labeled Bridge 0 through Bridge 15. The Bridge 0 screen is shown in Figure 6-63.

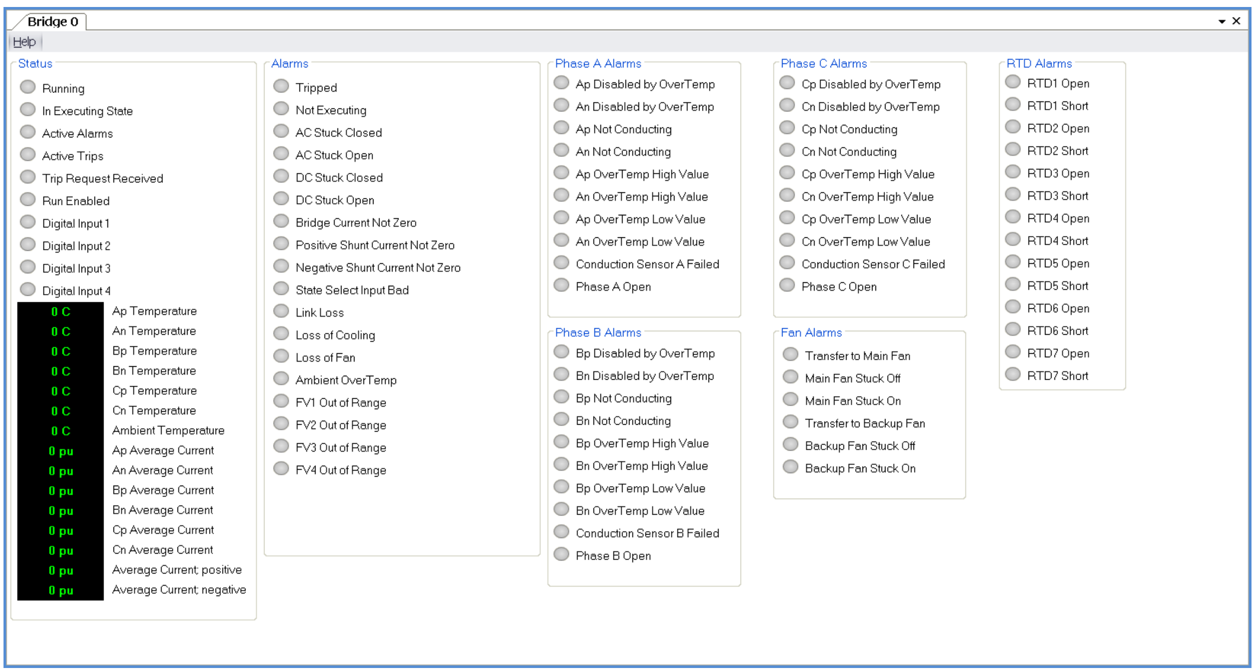
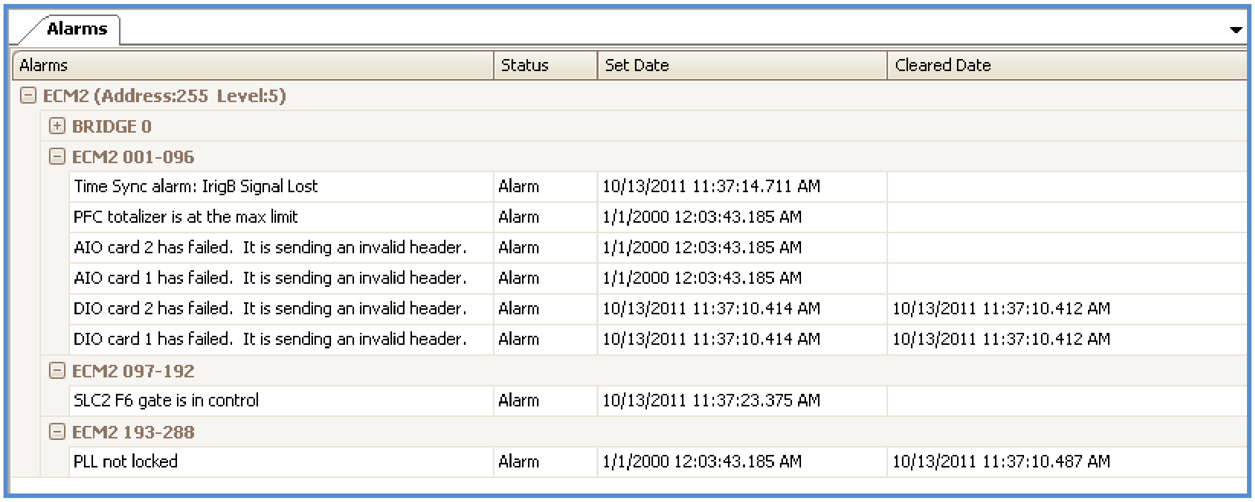


Figure 6-63. Detailed Bridge Status Screen

Alarms (Metering)

The Alarms window, found under the *Metering* category, displays the name, time, status, and date of all recent alarms. See Figure 6-64.



Alarms	Status	Set Date	Cleared Date
ECM2 (Address:255 Level:5)			
BRIDGE 0			
ECM2 001-096			
Time Sync alarm: IrigB Signal Lost	Alarm	10/13/2011 11:37:14.711 AM	
PFC totalizer is at the max limit	Alarm	1/1/2000 12:03:43.185 AM	
AIO card 2 has failed. It is sending an invalid header.	Alarm	1/1/2000 12:03:43.185 AM	
AIO card 1 has failed. It is sending an invalid header.	Alarm	1/1/2000 12:03:43.185 AM	
DIO card 2 has failed. It is sending an invalid header.	Alarm	10/13/2011 11:37:10.414 AM	10/13/2011 11:37:10.412 AM
DIO card 1 has failed. It is sending an invalid header.	Alarm	10/13/2011 11:37:10.414 AM	10/13/2011 11:37:10.412 AM
ECM2 097-192			
SLC2 F6 gate is in control	Alarm	10/13/2011 11:37:23.375 AM	
ECM2 193-288			
PLL not locked	Alarm	1/1/2000 12:03:43.185 AM	10/13/2011 11:37:10.487 AM

Figure 6-64. Alarms Window (Metering)

Commissioning

Frequency Response

Frequency response testing functions are available under *View Explorer, Commissioning, Analysis, Frequency Response*. Frequency Response screen functions are illustrated in Figure 6-65 and described in the following paragraphs.

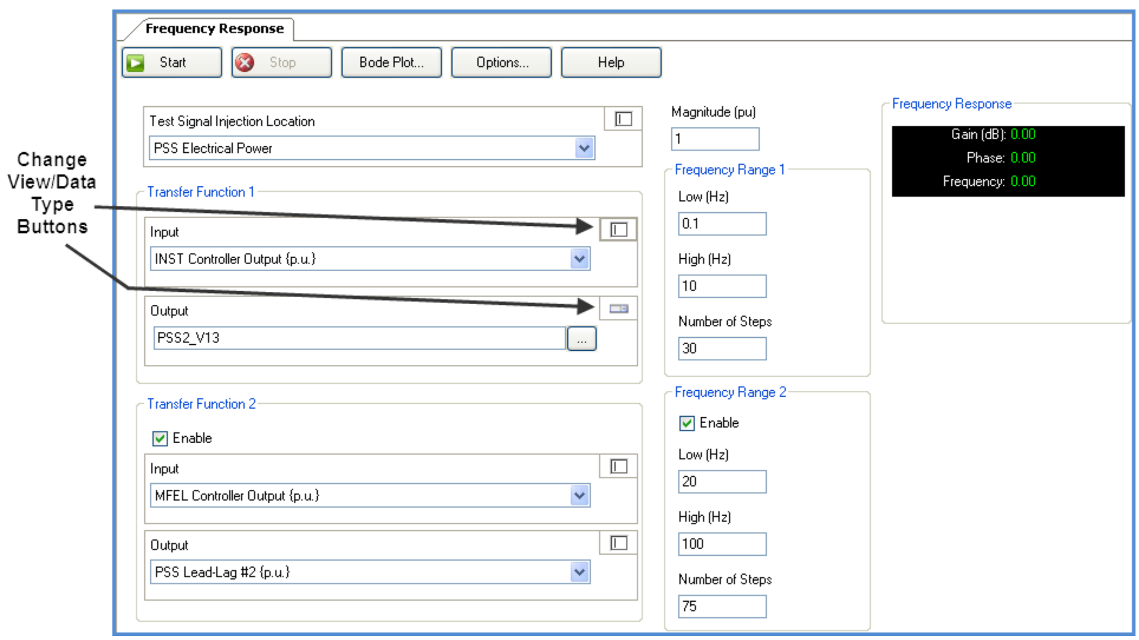


Figure 6-65. Frequency Response Window

Read-only frequency response fields (right side of window) indicate the magnitude response, phase response, and test signal frequency. The magnitude response and phase response corresponds to the test signal previously applied. The test frequency value reflects the frequency of the test signal currently being applied.

Caution

Exercise caution when performing frequency response testing on a generator connected to the grid. Frequencies that are close to the resonant frequency of the machine or neighboring machines are to be avoided. Frequencies above 3 Hz may correspond to the lowest shaft torsional frequencies of a genset. A torsional profile for the machine should be obtained from the manufacturer and consulted before conducting any frequency response tests.

Transfer Function

The point in the DECS-2100 logic circuitry where a signal is injected for analysis of magnitude and phase responses is selectable. Signal points are PSS Comp Frequency, PSS Electric Power, and logic block inputs/outputs. These signal points are stored in two separate lists. The active list can be toggled by clicking the *Change View/Data Type* button (or).

The transfer function input and output are selectable from the logic block outputs.

Range

The low frequency of the range is entered into *Freq 1*, the high frequency of the range in entered into *Freq 2*, and the number of steps in between is entered in to *Steps*.

Magnitude

This is the magnitude of the test signal as a per unit value.

Bode Plotting

Using the *File* menu a Bode plot (Figure 6-66) can be saved in, SSE, TXT, or CSV formats. The *View* menu contains options for customizing the appearance of data points and grid lines, and cursor behavior. An image of the magnitude plot or phase plot can be saved in EMF, PNG, GIF, JPG, TIF, or BMP formats by right-clicking in the graph area and selecting *Save Image As*. Other options available in the right-click menu are page setup, printing and scale settings.

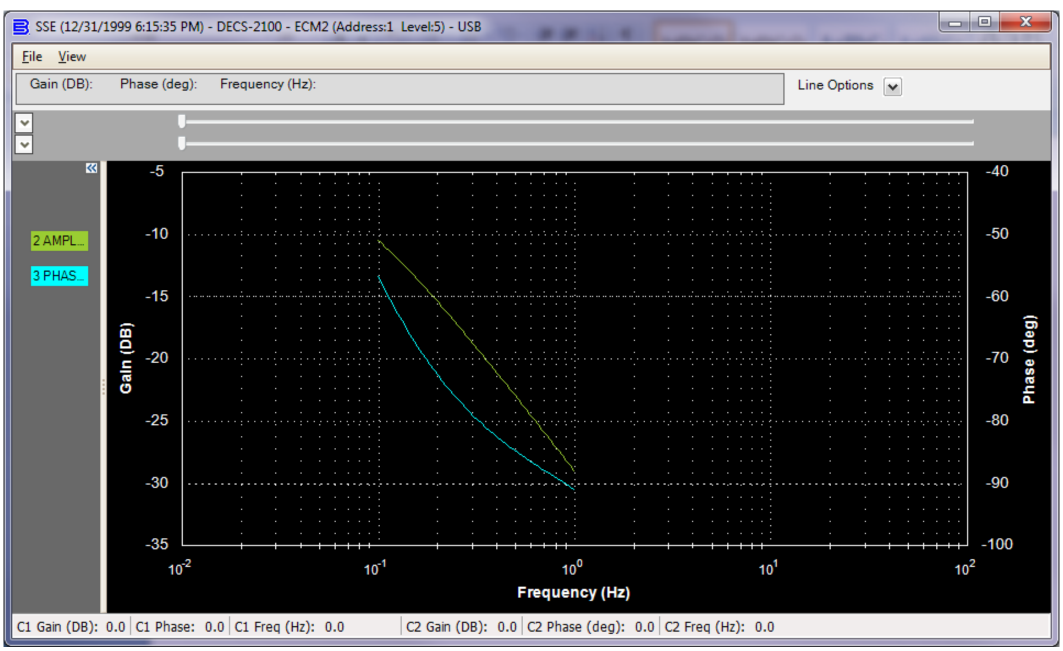


Figure 6-66. Bode Plot Window

Options

The Options menu allows selection of Scan High to Low Frequency, Magnitude Threshold, Phase Threshold, and Repetition Count. See Figure 6-67.

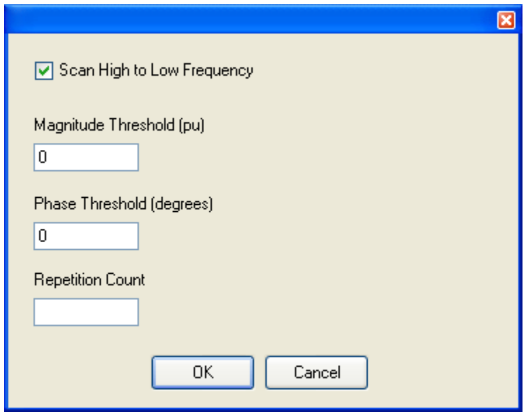


Figure 6-67. Frequency Response Options Window

Time Response

Tests should be performed at various load levels to confirm that the input signals are calculated or measured correctly. Since the PSS function uses compensated terminal frequency in place of speed, the derived mechanical power signal should be examined carefully to ensure that it does not contain any components at the electromechanical oscillation frequencies. If such components are present, it indicates that the frequency compensation is less than ideal, or that the machine inertia value is incorrect.

PSS test signal configuration settings are provided on the Time Response screen shown in Figure 6-68. The Time Response window is found under *View Explorer, Commissioning, Analysis*.

Signal Input

Signal input selections determine the point in the PSS circuitry where the test signal is applied. Test points include, PSS Comp Frequency, PSS Electric Power and logic block inputs and outputs.

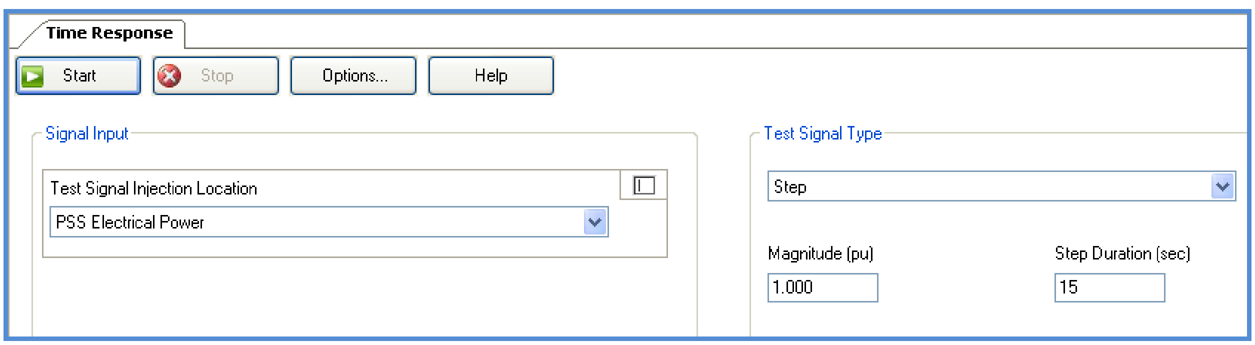


Figure 6-68. Time Response Window

Auto Tuning

During commissioning, excitation system parameters are not known. These unknown variables traditionally cause the commissioning process to consume a large amount of time and fuel. With the development of auto tuning the excitation system parameters are automatically identified and the PID gains are calculated using well-developed algorithms. Automatically tuning the PID controller greatly reduces commissioning time and cost. The auto tuning function, Figure 6-69, is accessed by clicking the *Auto Tune* option under *View Explorer, Commissioning*. This window is enabled when the AUTOTUNE logic block is added to the logic configuration. For more information on using the auto tune feature see *Programmable Logic.*

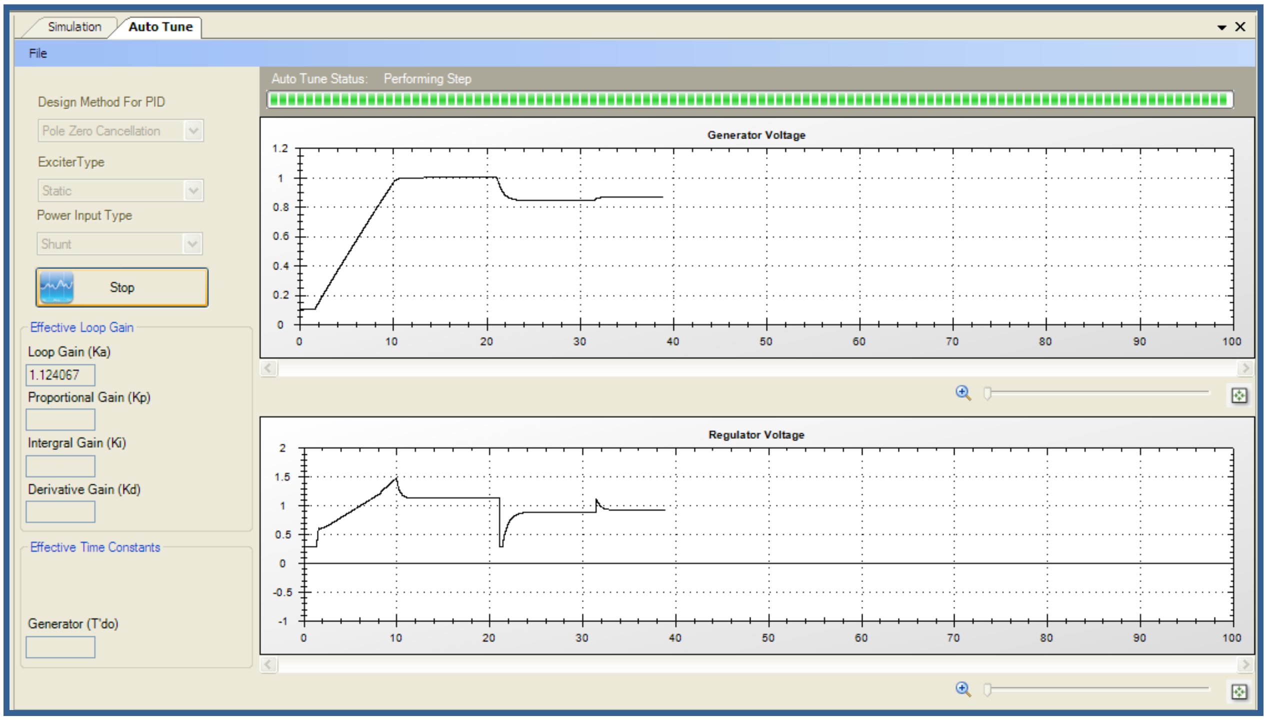


Figure 6-69. Auto Tune Window

Simulation

The simulation windows provide an easy way to control all aspects of a simulated gen-set. This window,

Figure 6-70, is enabled when the SIMCON logic block is added to the configuration. It displays overall status and controls of the active simulation. All commands contained in the individual simulation windows can be accessed from this window. For example, if the AC Exciter button is clicked, the AC Exciter window is displayed allowing easy data entry.

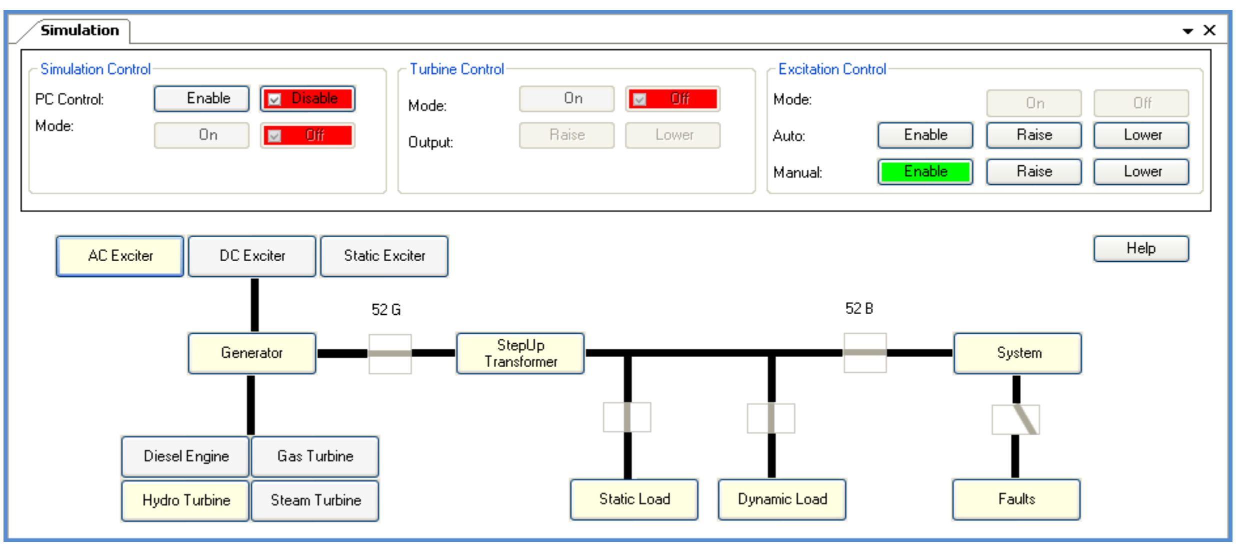


Figure 6-70. Simulation Window

Generator Parameters

This window is enabled when the GENSIM logic block is added to the configuration. See Figure 6-71.

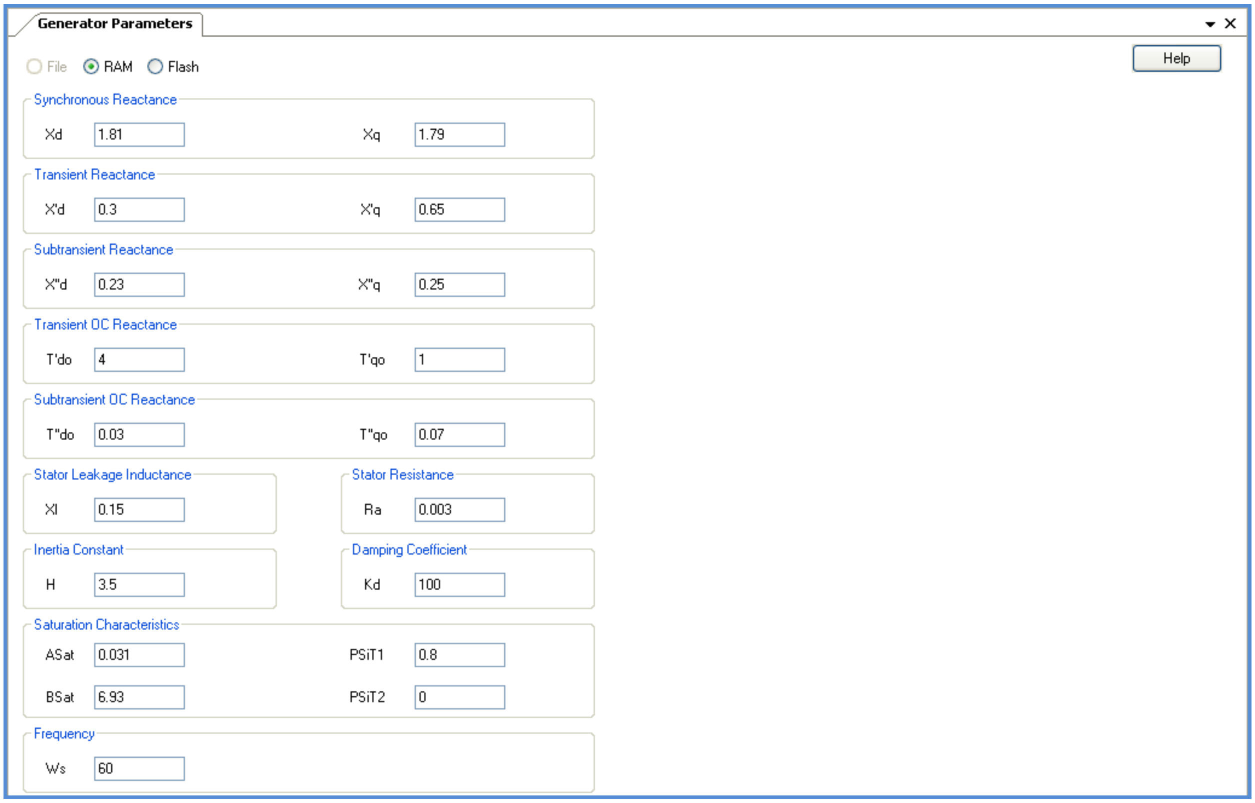


Figure 6-71. General Parameters Window

AC Exciter

This window (Figure 6-72) is enabled when the AC_EXCITER logic block is added to the configuration. See

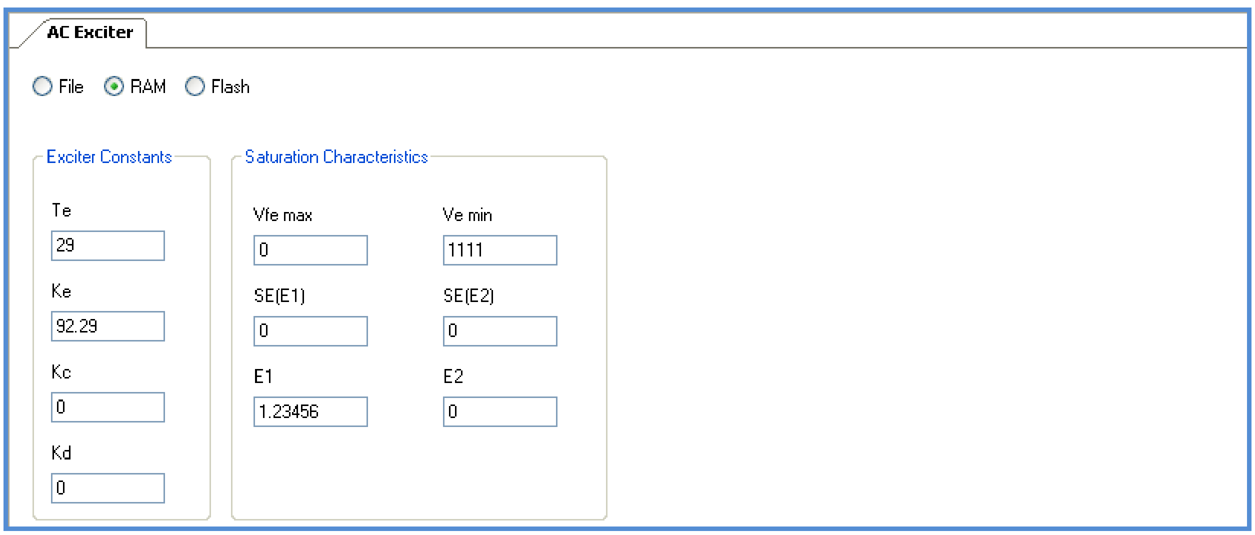


Figure 6-72. AC Exciter Window

DC Exciter

This window is enabled when the DC_EXCITER logic block is added to the configuration. See Figure 6-73.

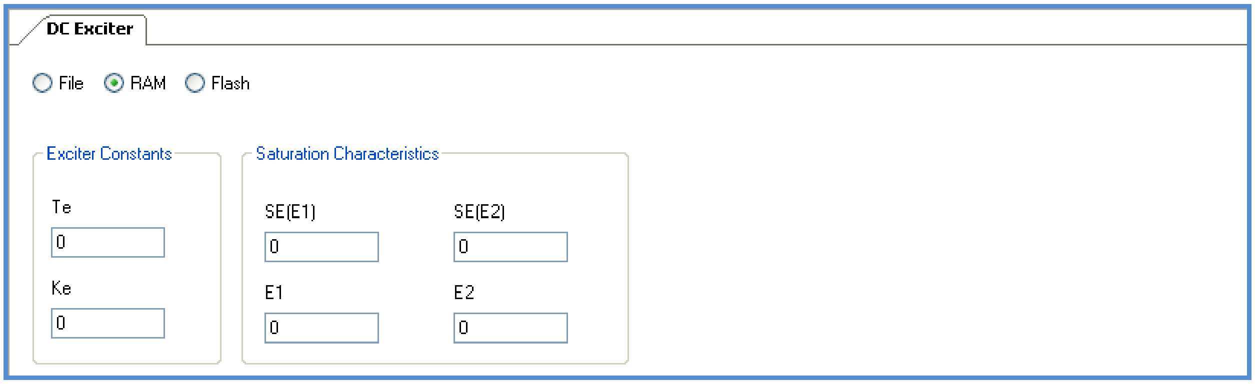


Figure 6-73. DC Exciter Window

Diesel Engine

This window is enabled when the DIESEL_ENG logic block is added to the configuration.

See Figure 6-74.

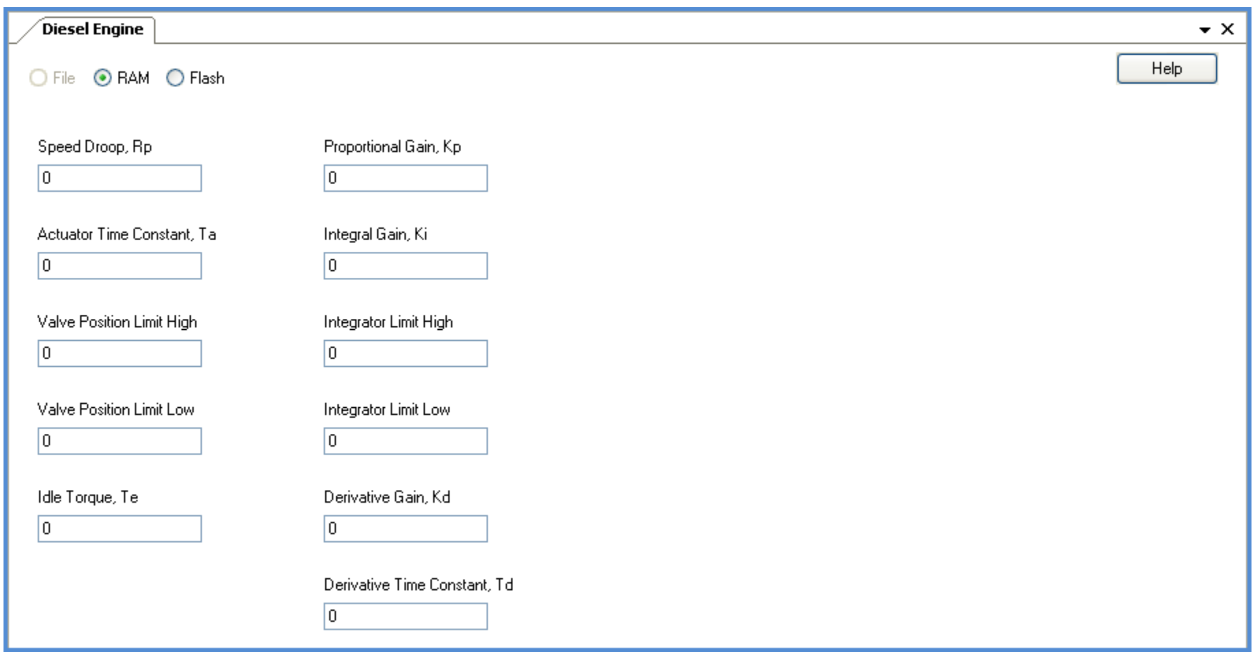


Figure 6-74. Diesel Engine Window

Gas Turbine

This window is enabled when the GAS_TURB logic block is added to the configuration.

The following figures show the Gas Turbine window, see Figure 6-75 for the PID Fuel Speed tab, and Figure 6-76 for the Turbine Temp Radiation tab.

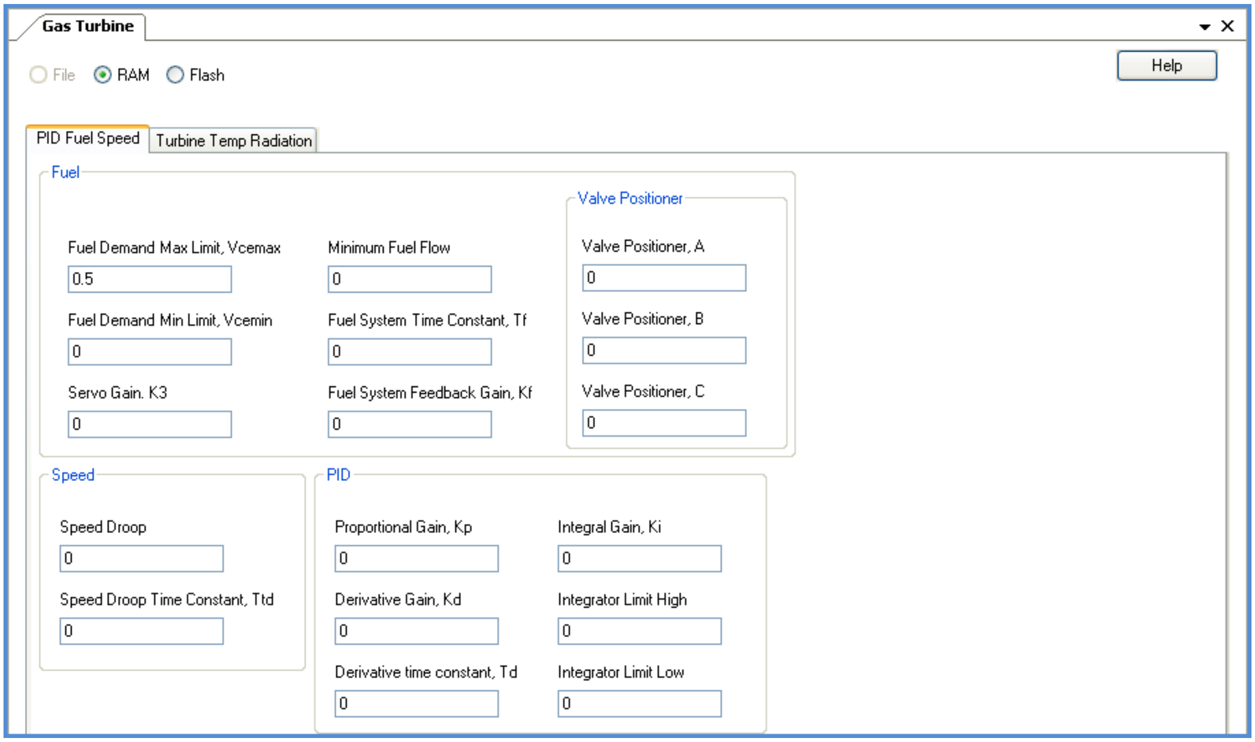


Figure 6-75. Gas Turbine Window, PID Fuel Speed Tab

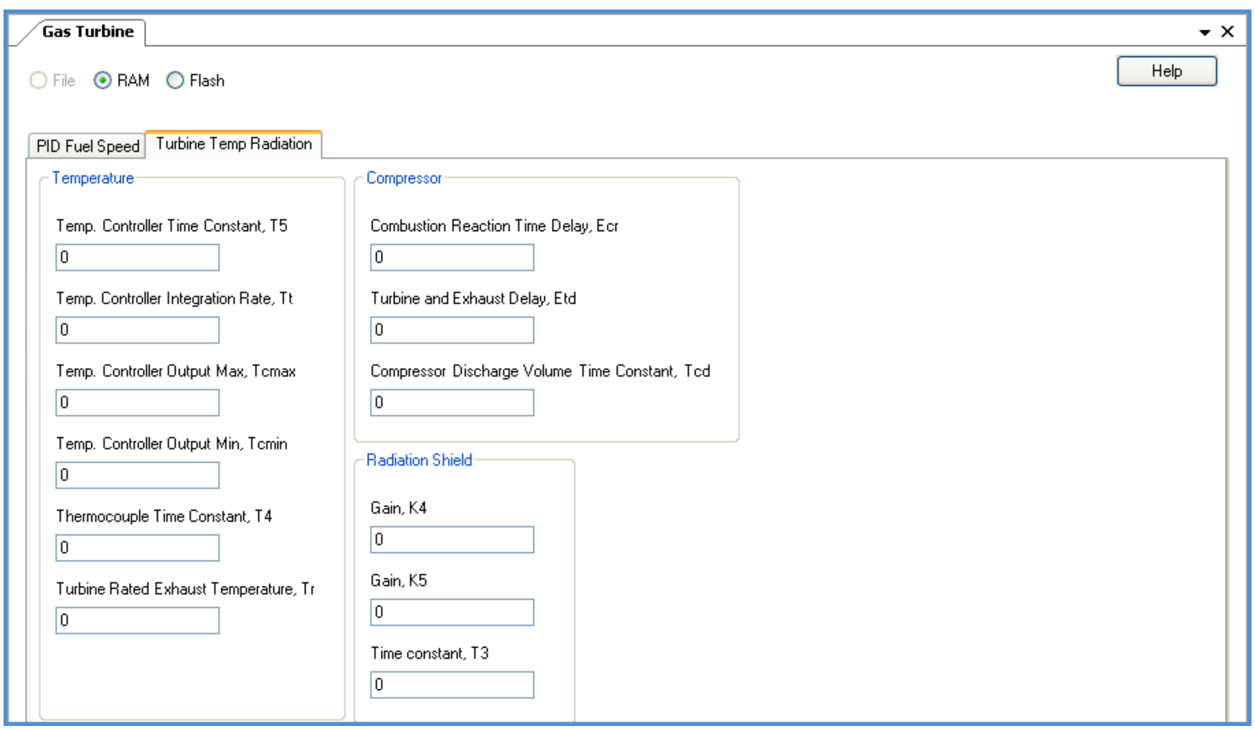


Figure 6-76. Gas Turbine Window, Turbine Temp Radiation Tab

Hydro Turbine

This window (Figure 6-77)is enabled when the HYDRO_TURB logic block is added to the configuration.

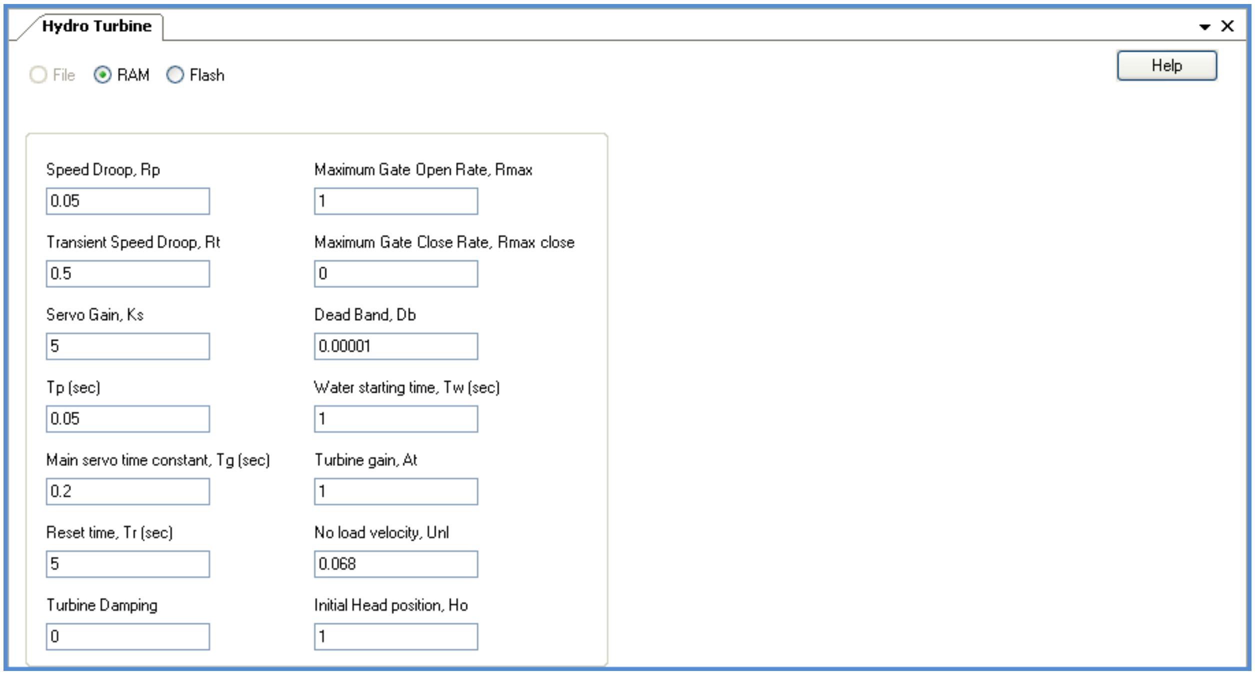


Figure 6-77. Hydro Turbine Window

Steam Turbine

This window (Figure 6-78)is enabled when the STEAM_TURB logic block is added to the configuration.

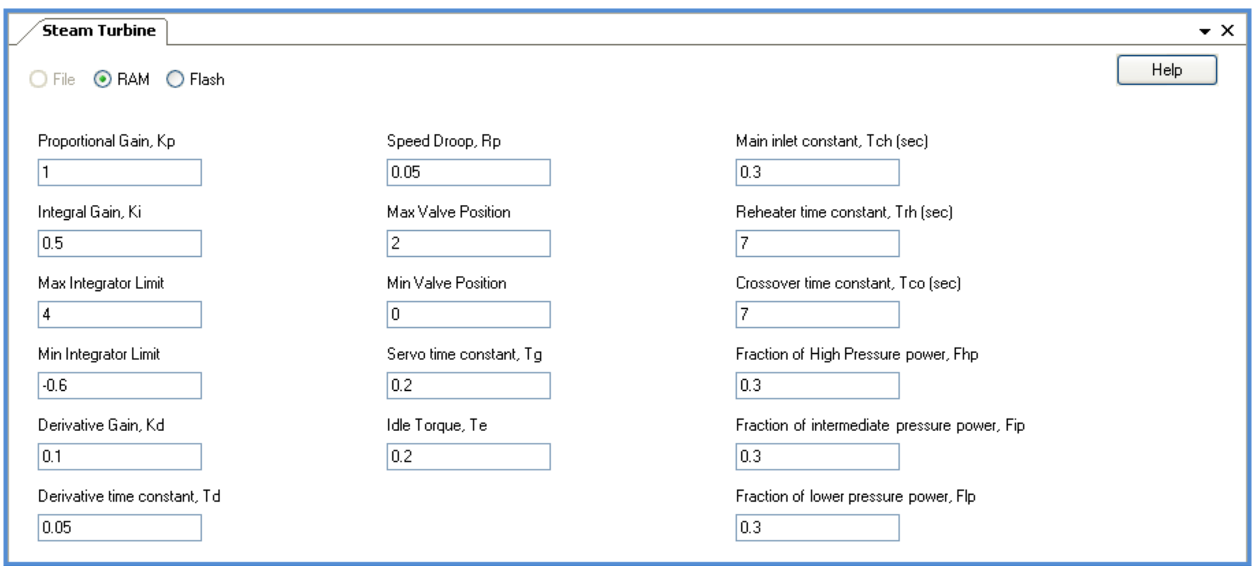


Figure 6-78. Steam Turbine

Static Load

This window (Figure 6-79) is enabled when the GENSIM logic block is added to the configuration.

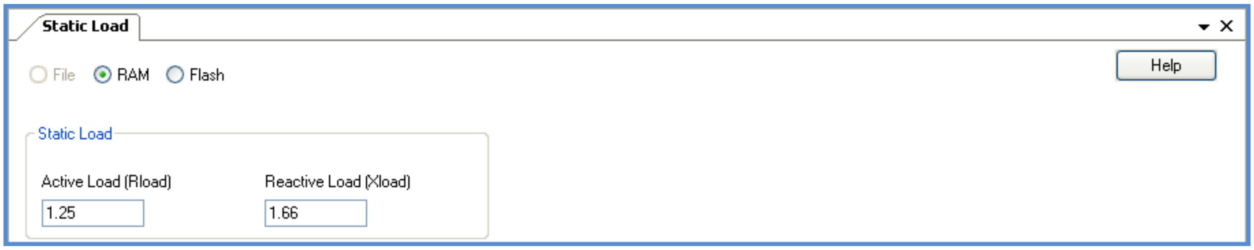


Figure 6-79. Static Load Window

Dynamic Load

This window (Figure 6-80)is enabled when the GENSIM logic block is added to the configuration.

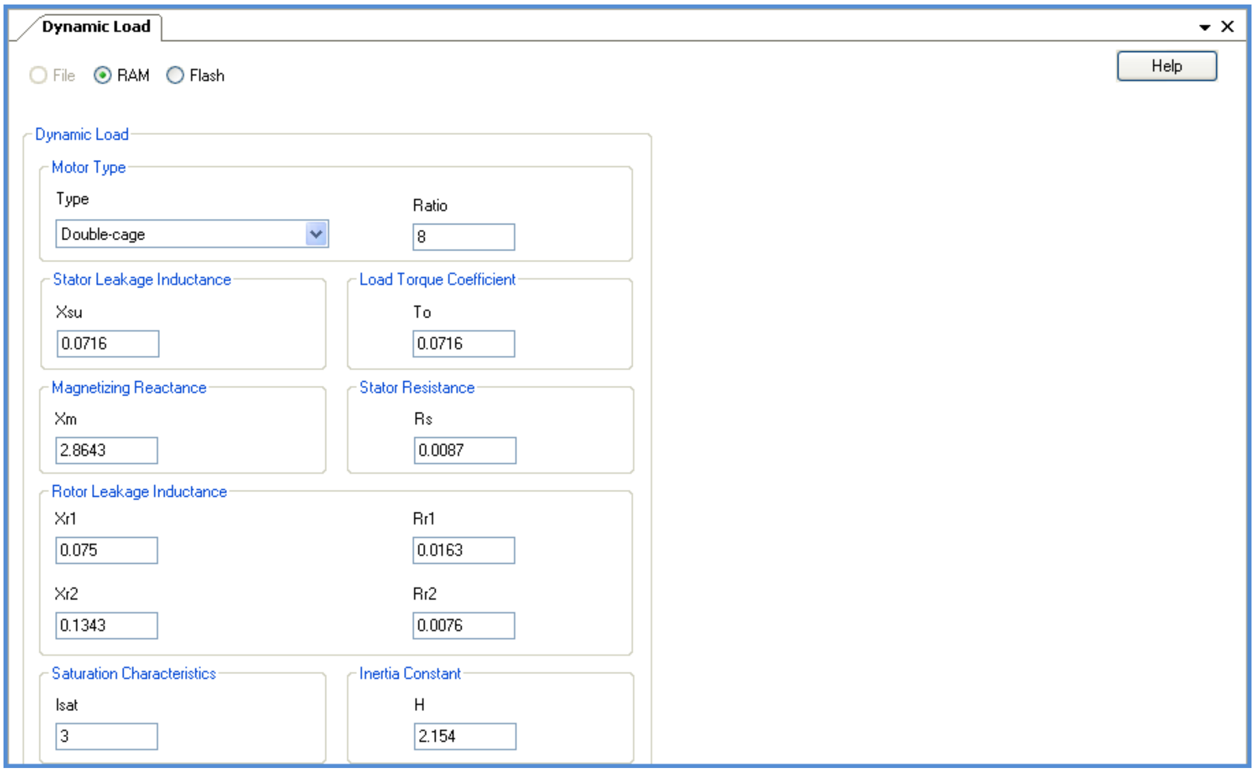


Figure 6-80. Dynamic Load Window

System Parameters

This window (Figure 6-81) is enabled when the SIMCON logic block is added to the configuration.

Figure 6-81. System Parameters Window

Step-up Transformer Parameters

This window (Figure 6-82)is enabled when the SIMCON logic block is added to the configuration.

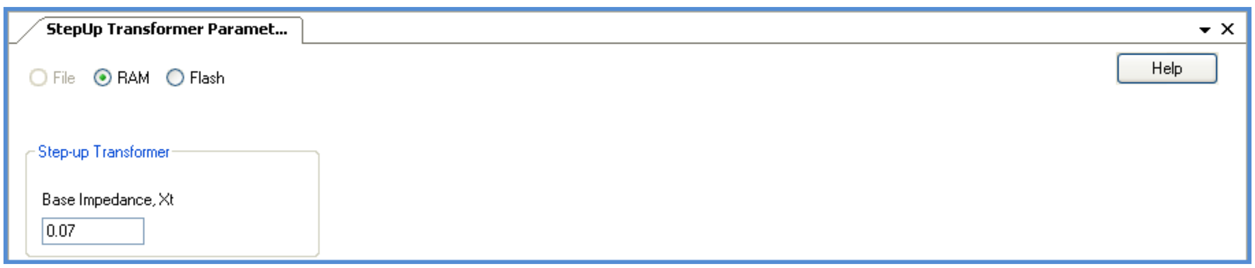


Figure 6-82. Step-up Transformer Parameters Window

Reports

Events & Data Loggers

Displays the active event recorders and data loggers. See Figure 6-83.

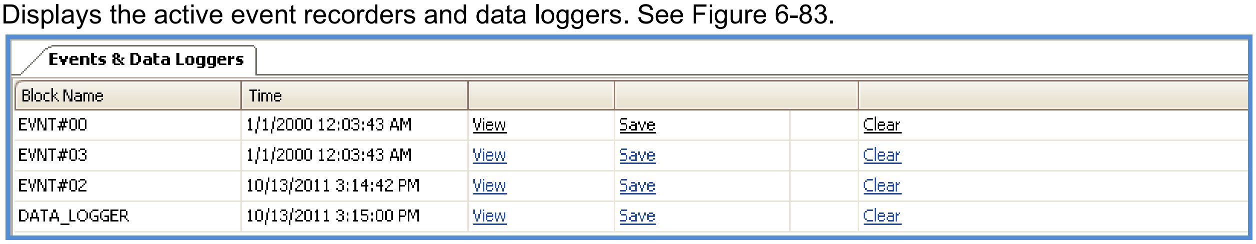


Figure 6-83. Events & Data Loggers Window

Table States

Displays the status of RAM and flash tables. See Figure 6-84.

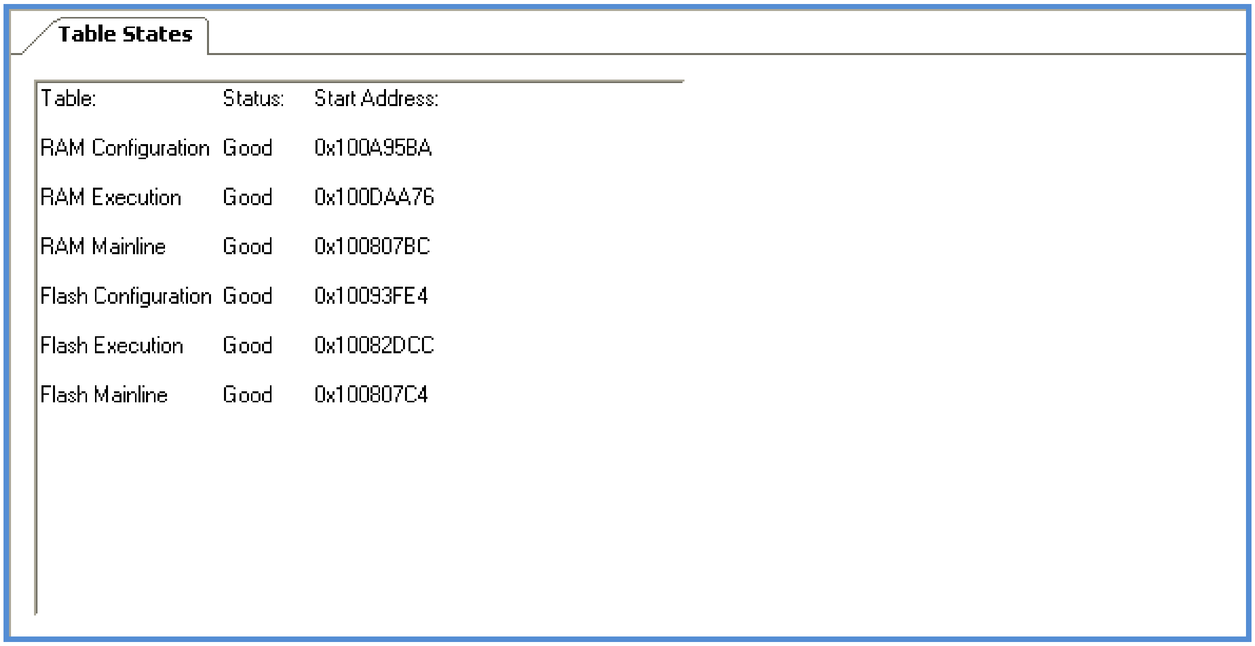


Figure 6-84. Table States Window

Validation

This window contains a function that lists all logic blocks, and their inputs and outputs, the current version of firmware is compatible with. This report can be exported to a text (.txt) file and saved to disk. See Figure 6-85.

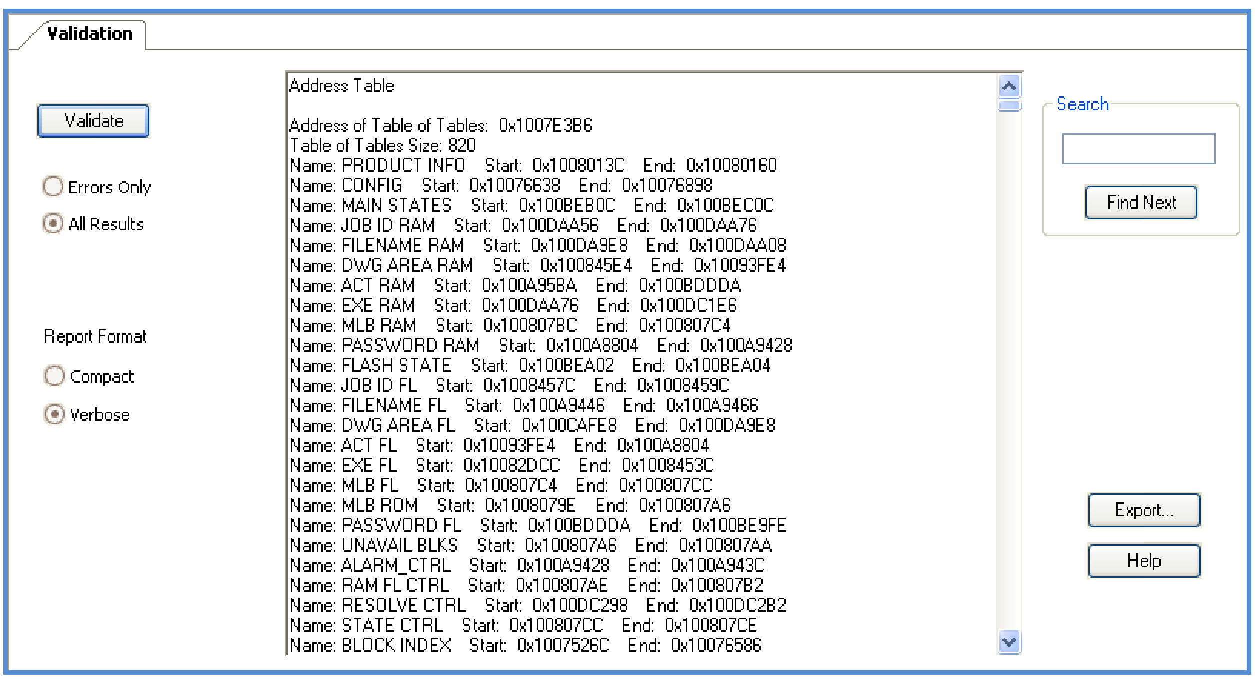


Figure 6-85. Validation Window

Verify/Resolve

This window contains a function that checks the logic configuration for errors and creates a report. This report can be exported to a text (.txt) file and saved to disk. See Figure 6-86.

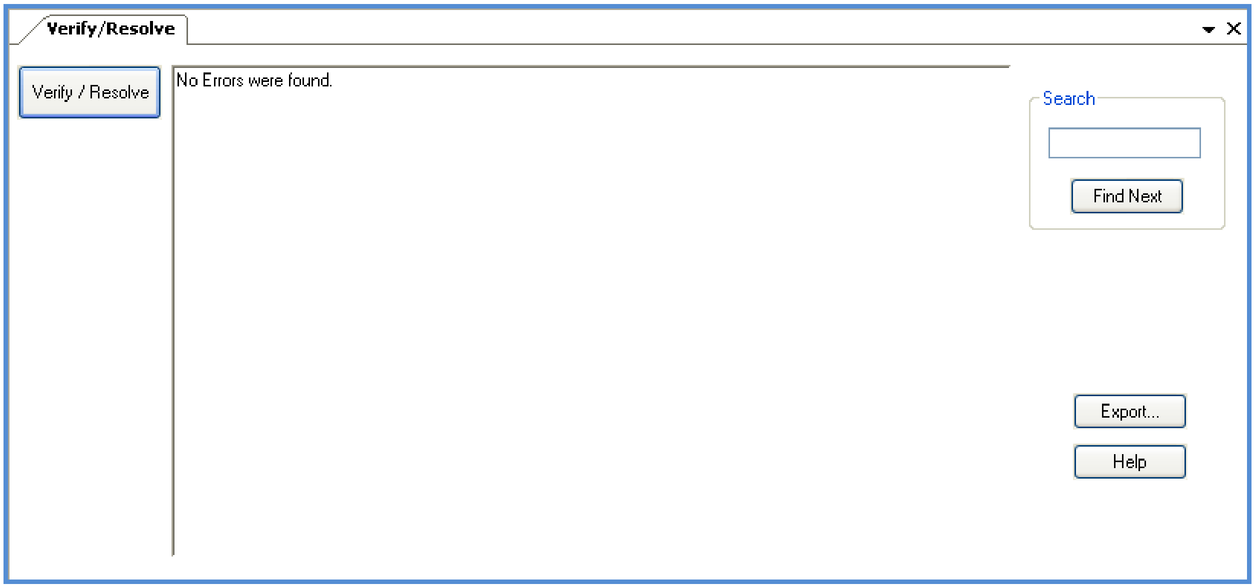


Figure 6-86. Verify/Resolve Window

Configuration Differences

This window displays the differences in the file, RAM, and flash configurations. This report can be exported to a text (.txt) file and saved to disk. See Figure 6-87.

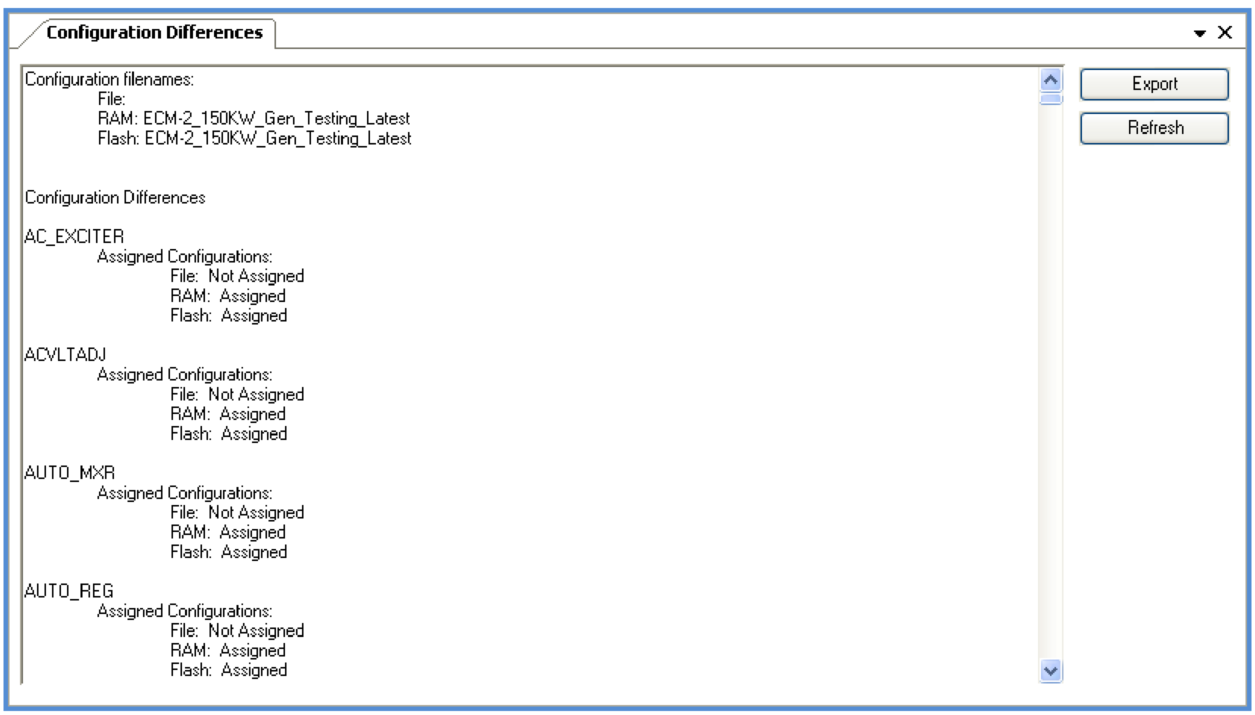


Figure 6-87. Configuration Differences Window

Cross Reference Report

This screen (Figure 6-88)displays a report listing all of the input and output connections of the active logic blocks.

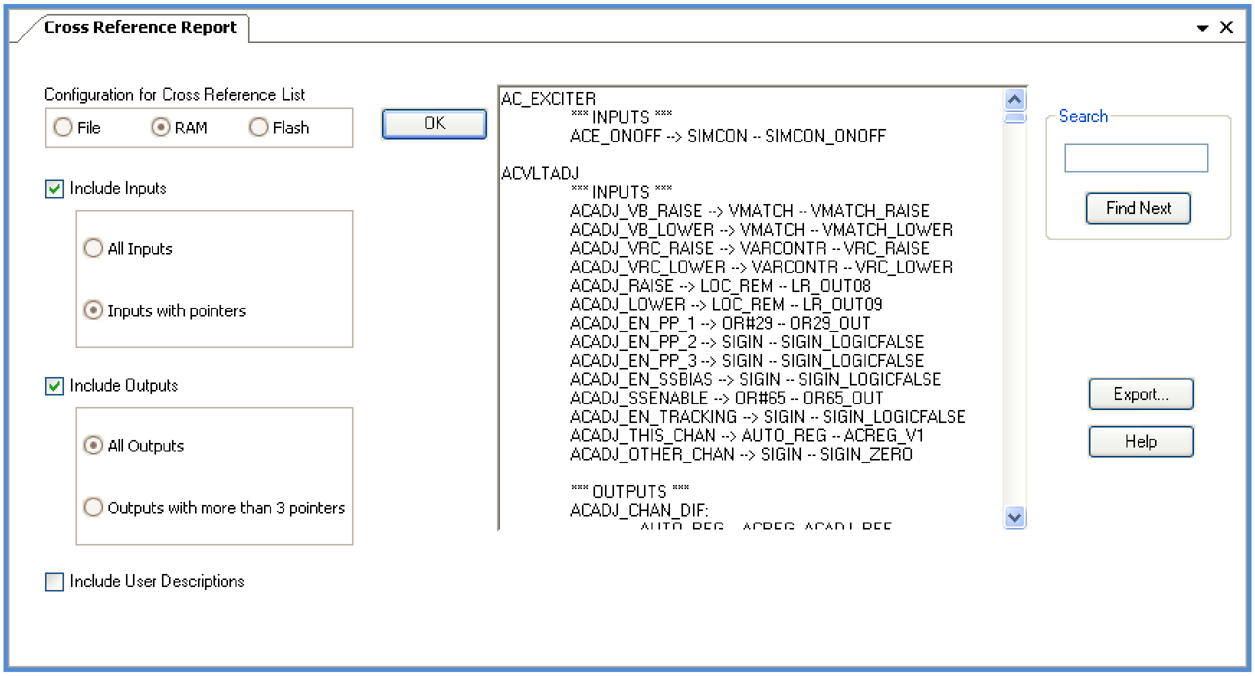


Figure 6-88. Cross Reference Report Window

Alarm History

Displays a history of all alarms. The *Tools* menu provides options to export, refresh, clear history, and show all devices. See Figure 6-89.

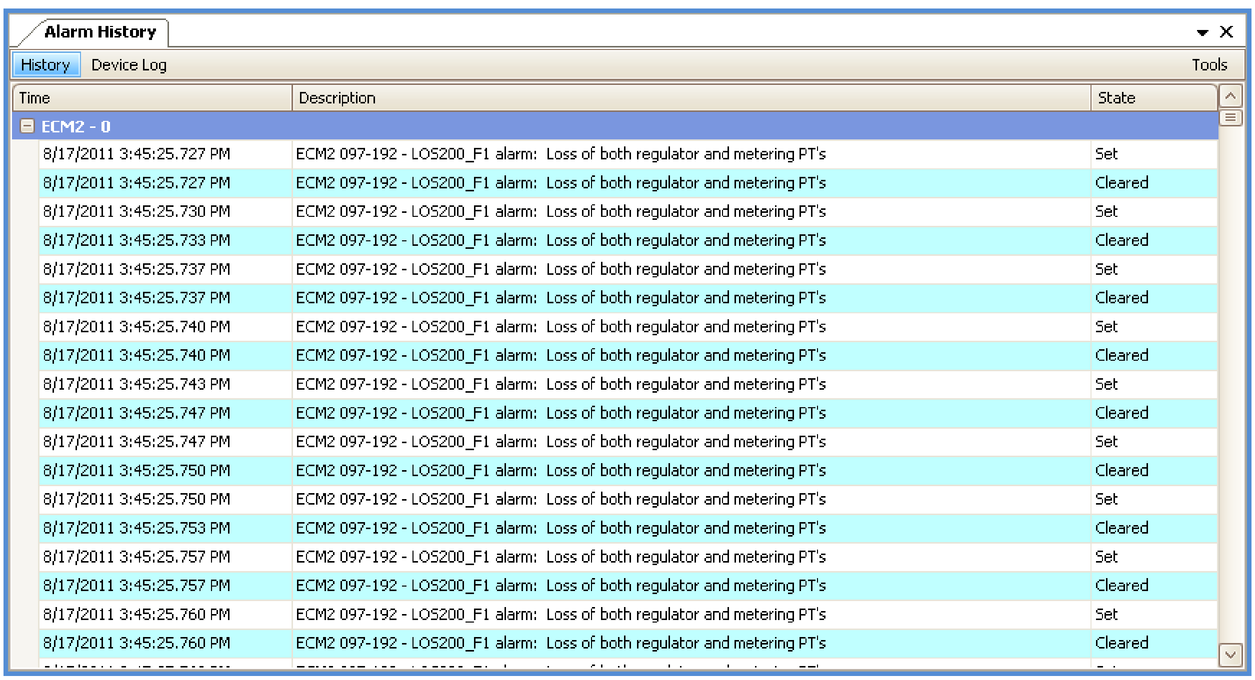


Figure 6-89. Alarm History Window

Settings Explorer

The *Settings Explorer* is a convenient tool within BESTCOMS*Pro* used to navigate through the various settings screens. After you connect to a control module, you can use the *Settings Explorer* to display one or more of the following windows in the working area of the main window. Different window options appear depending on the type of connected control module. Each tab displayed to the right upon clicking the *Settings Explorer* options can be undocked and made into a free floating window. The *Settings Explorer* panel can be hidden via the *View* 

drop down button on the toolbar. The 'x' button hides the *Settings Explorer* and the thumbtack icon allows it to be docked. A docked screen is viewed by hovering the mouse pointer over the docked screen.

Settings Explorer Windows

The window options that are available to an excitation control module (ECM-2) differ from those available to a bridge control module (BCM). Table 6-12 lists the windows available to the specific control modules.

Table 6-12. Control Module Settings Explorer Window Availability

Window	ECM-2	BCM
General Settings		
Controller Settings		
Modbus Settings	●	
Clock Settings	●	●
COMPort Settings	●	●
Ethernet Settings	●	
Device Security Settings		
Password Settings	●	●
Logon Password	●	
Monitor View Setup	●	●
Data Recording Setup	●	
Block Settings (The available logic blocks differ between the ECM-2 and the BCM, see Basler Electric Instruction Manual 9411300991.*)*	●	●
PSS (All)	●	
Alarms Configuration	●	●

Controller Settings

Modbus Settings

View or change Modbus connection settings. (ECM-2 only) See Figure 6-90.

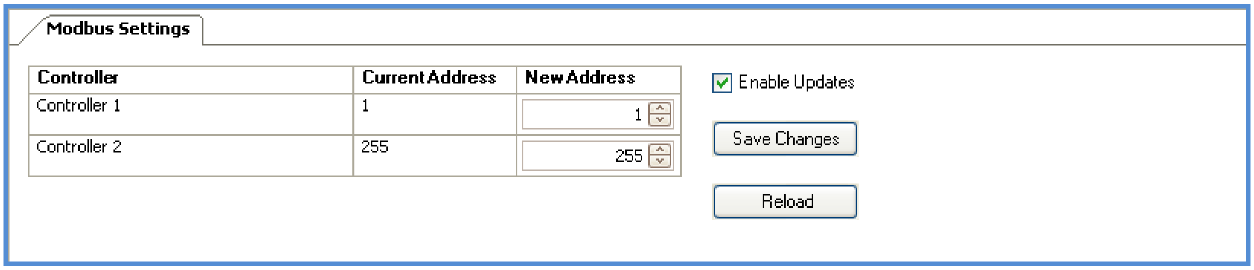


Figure 6-90. Modbus Settings Window

Clock Settings

View and change controller time zone, daylight savings time, and time priority. See Figure 6-91.

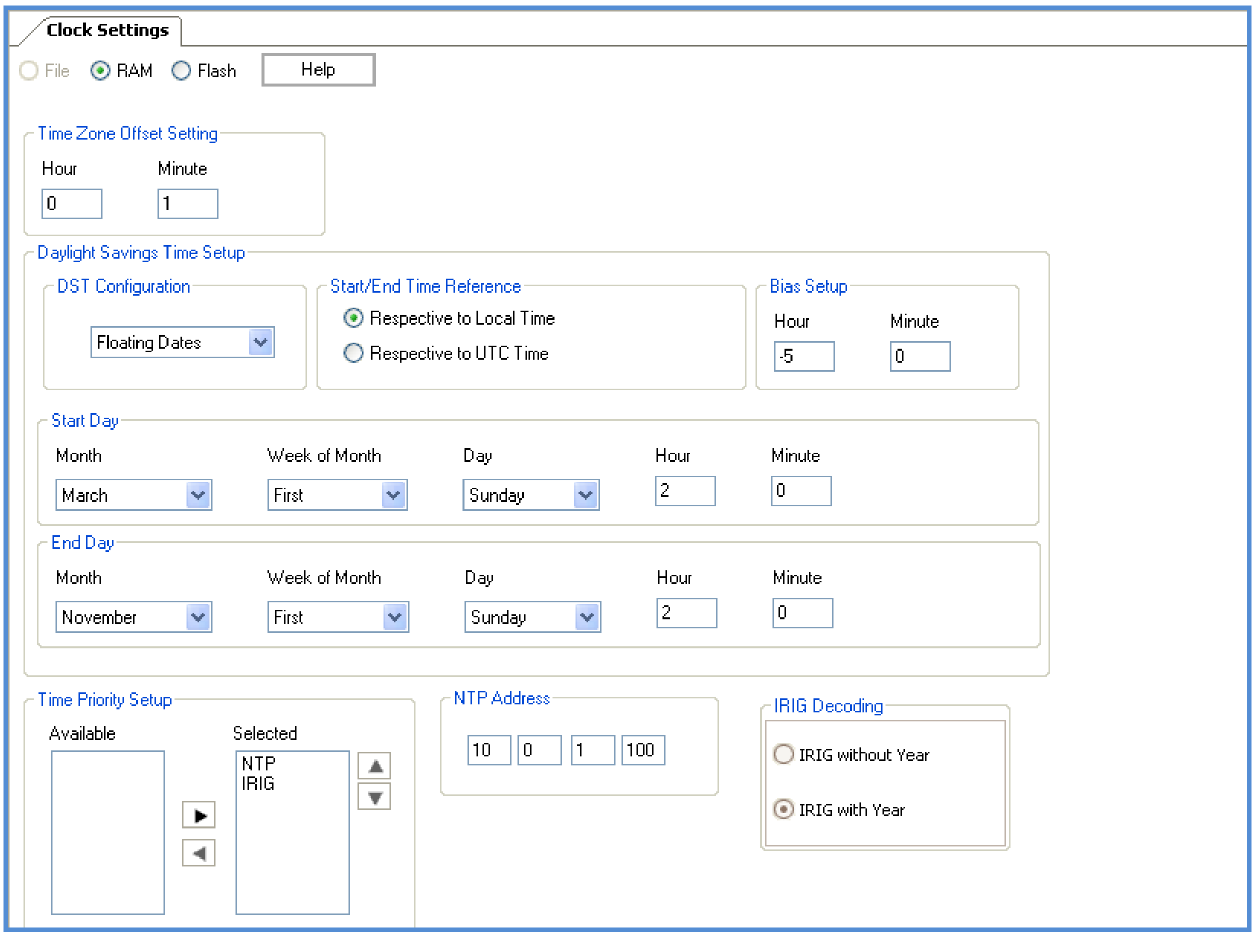


Figure 6-91. Clock Settings

COM Port Settings

View and change COM port baud rate, data bits, parity, stop bits, and mode. See Figure 6-92.

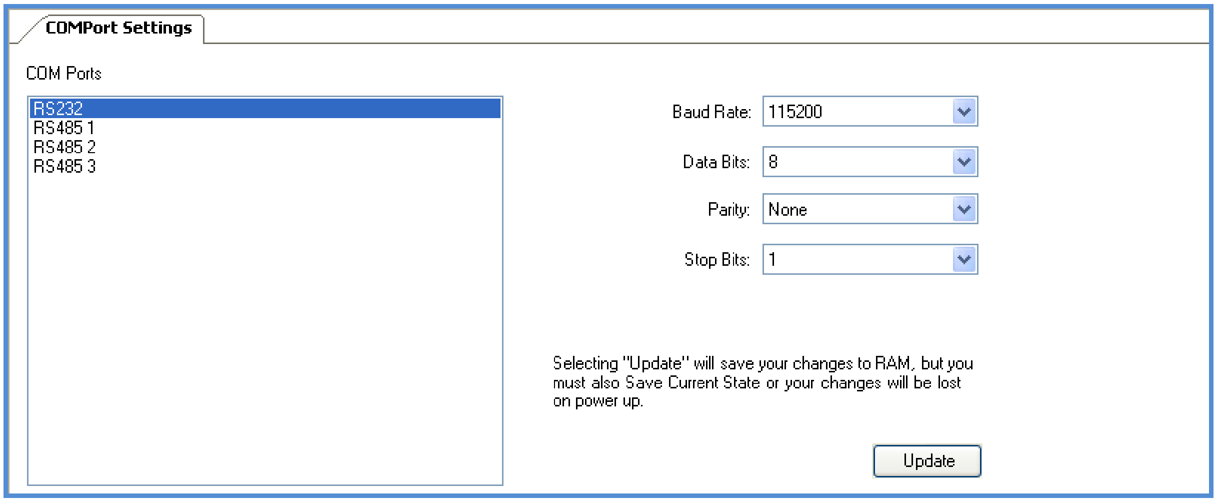


Figure 6-92. COMPort Settings Window

Ethernet Settings

View and change Ethernet connection settings. (ECM-2 only) See Figure 6-93.

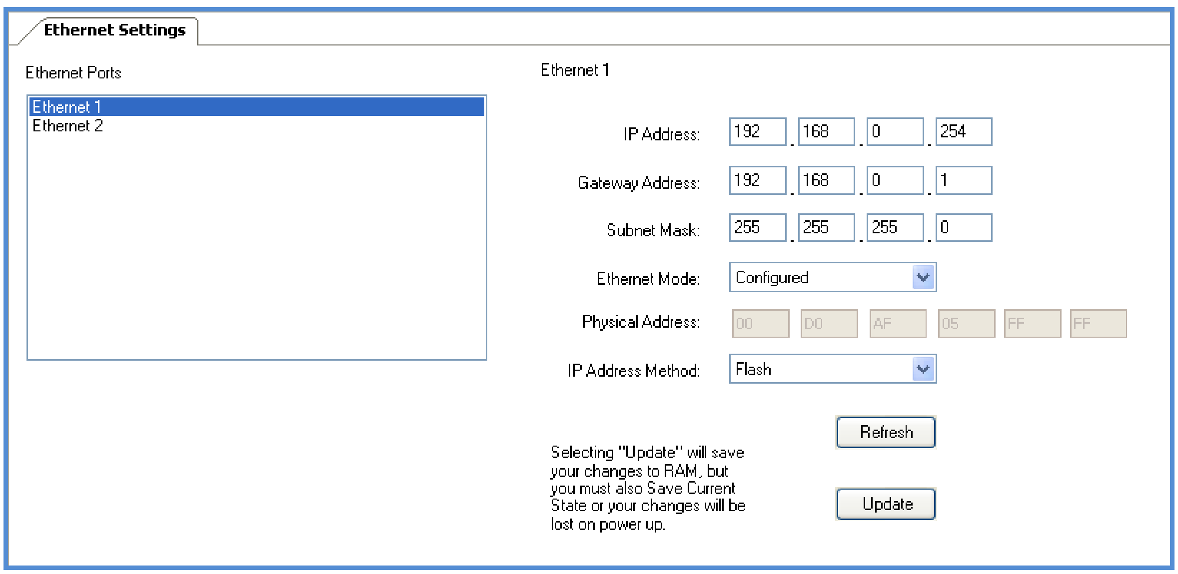


Figure 6-93. Ethernet Settings Window

Device Security Settings

Password Settings

Change the passwords for the different security levels. See Figure 6-94.

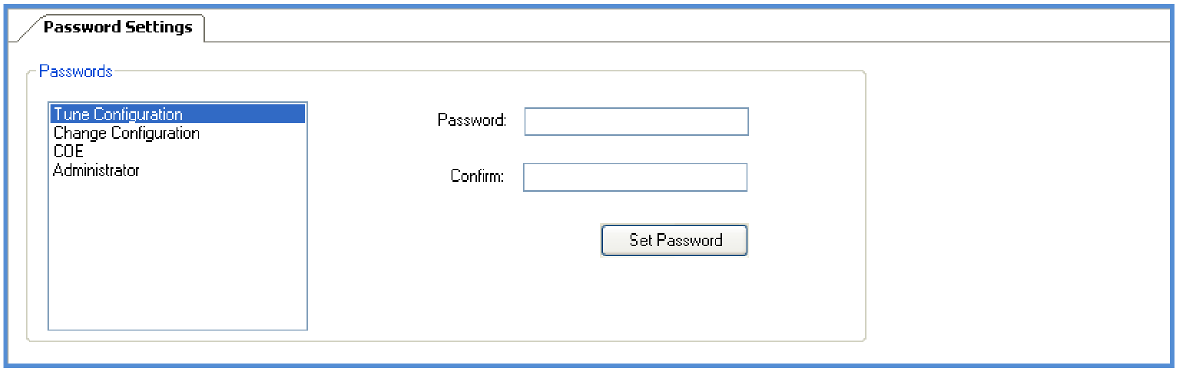


Figure 6-94. Password Settings Window

Logon Password

Set a device password. See Figure 6-95.

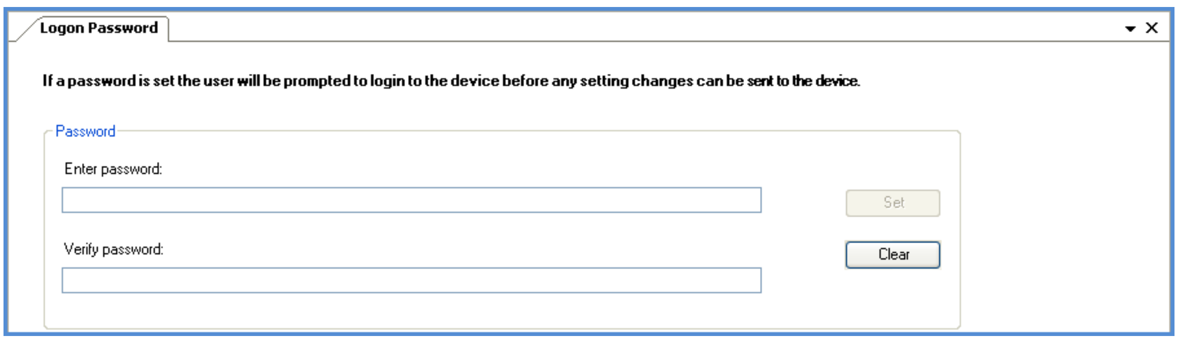


Figure 6-95. Logon Password Window

Monitor View Setup

This screen is used to add or edit memory location monitors. See Figure 6-96. For information on setting up monitor views see *Programmable Logic* in this chapter.

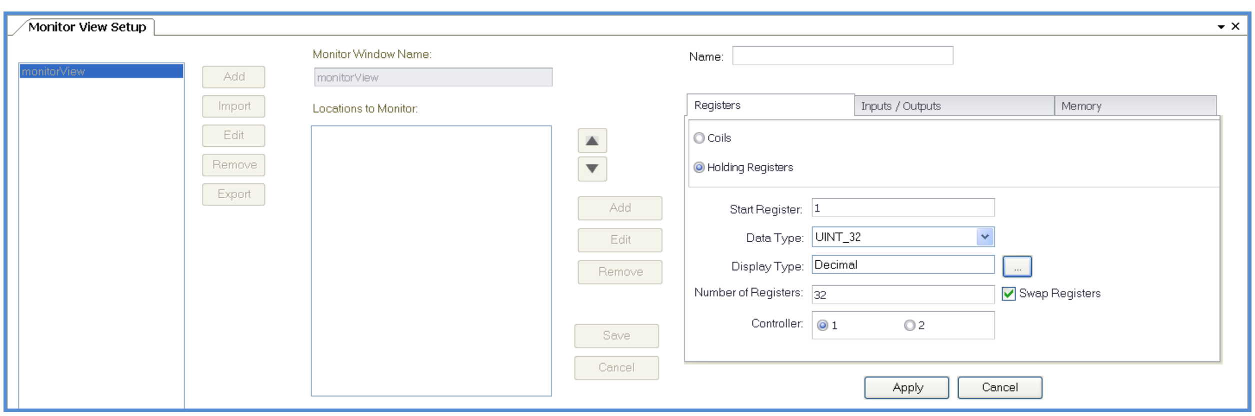


Figure 6-96. Monitor View Setup

Data Recording Setup

Data recording setup is divided between data logging functions (Figure 6-97) and event recorder blocks (Figure 6-98).

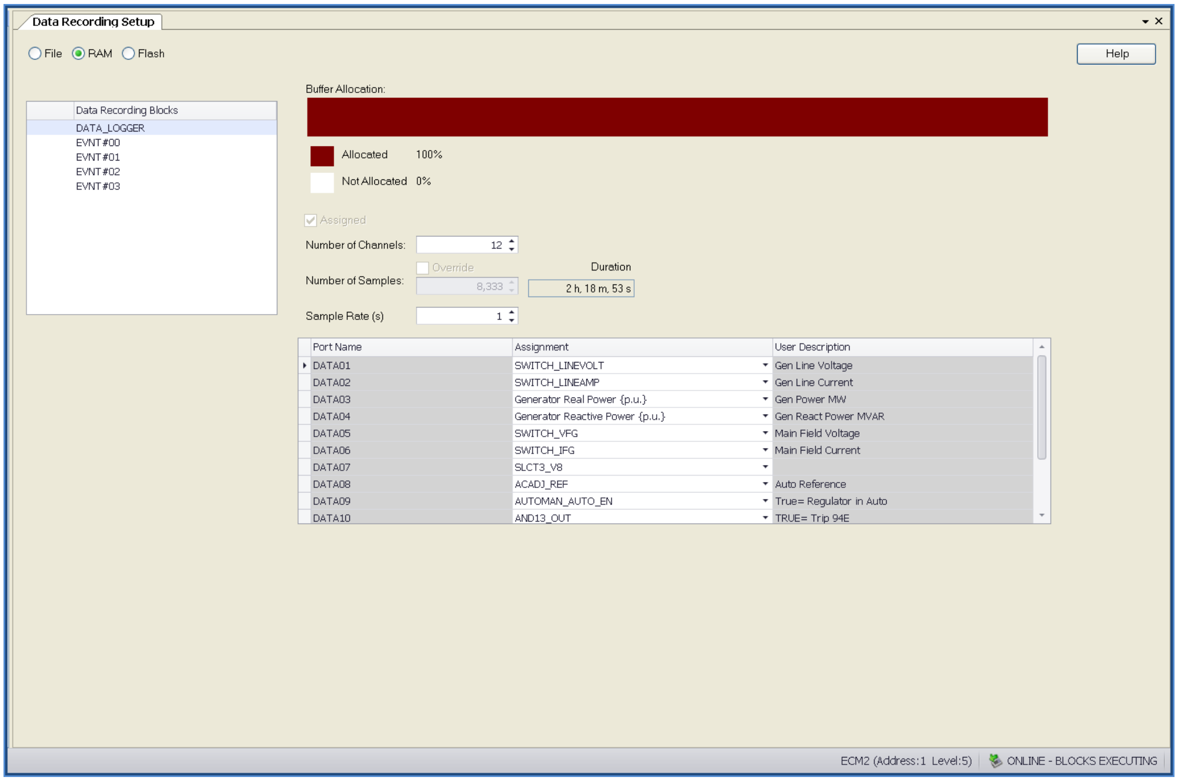


Figure 6-97. Data Recording Setup, Data Logger

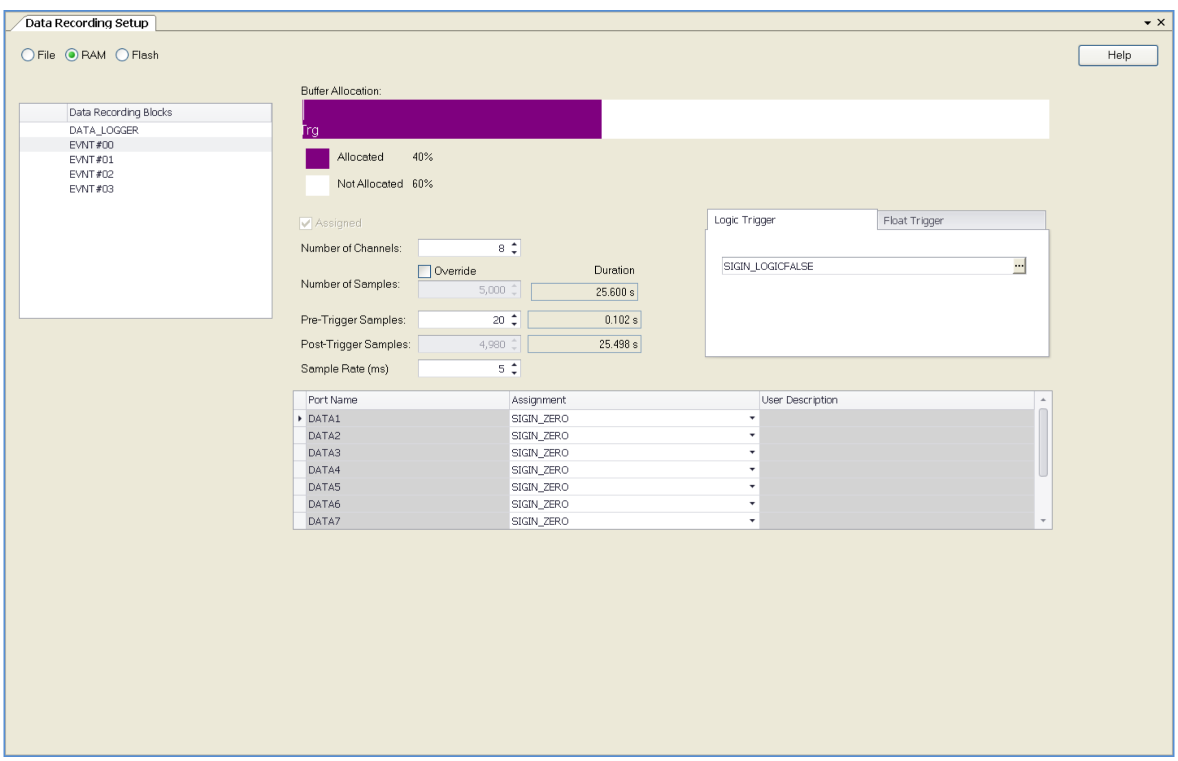


Figure 6-98. Data Recording Setup, Event Recorder

Block Settings

View and change user description, execution cycles, and assignments of a specific active logic block in File and RAM. Block settings for flash are view only. In Figure 6-99, the settings for logic block OR#24 are shown.

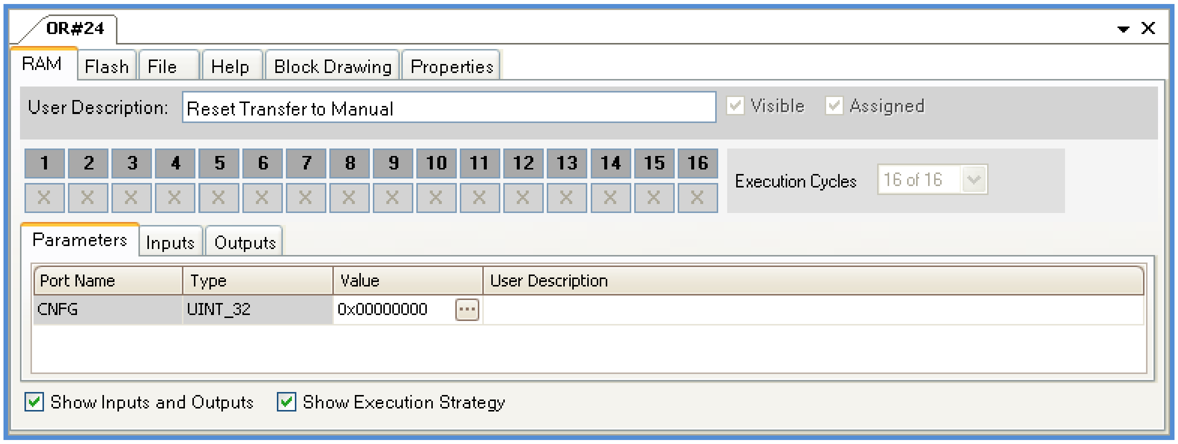


Figure 6-99. Block Settings Window

PSS

Control

Enable/disable control and monitor the PSS supervisory functions in File, RAM, and Flash. See Figure 6-100.

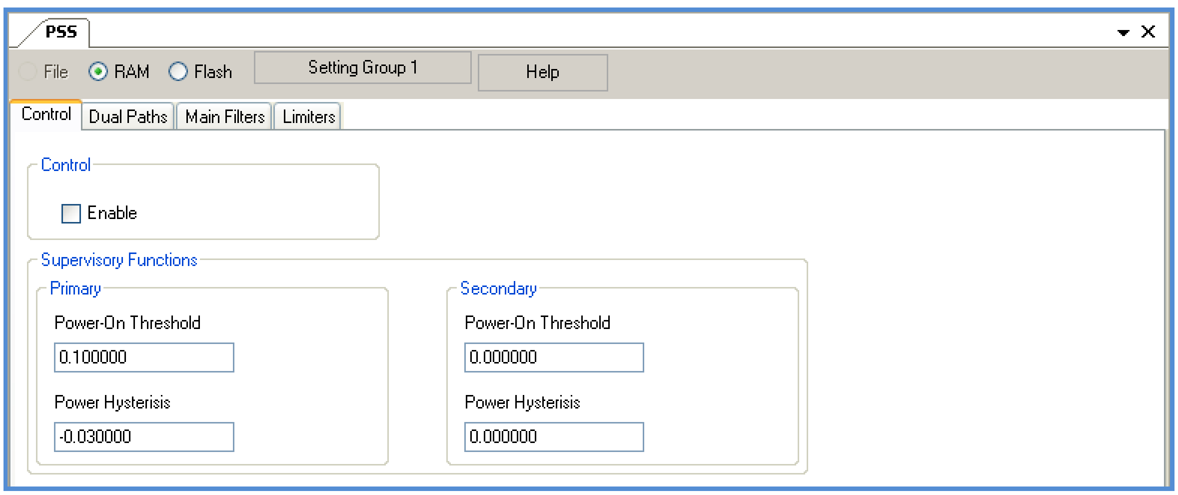


Figure 6-100. PSS, Control Window

Dual Paths

Control the PSS primary and secondary frequency, power washout, low pass, ramp tracking, and intermediate lag in File, RAM, and Flash. See Figure 6-101.

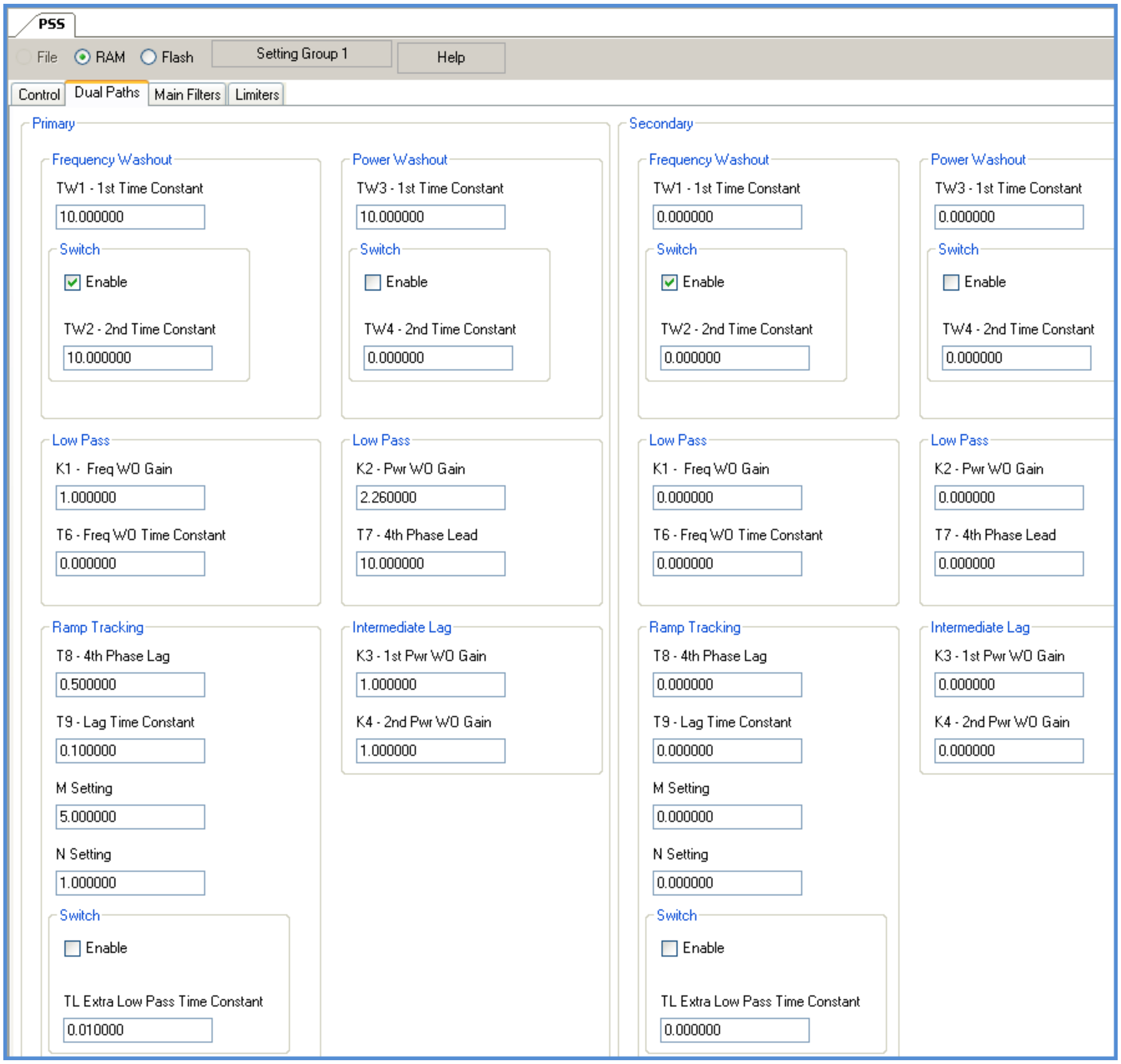


Figure 6-101. PSS, Dual Paths Window

Main Filters

Control the PSS primary and secondary torsional and lead lag filters in File, RAM, and Flash.

See Figure 6-102.

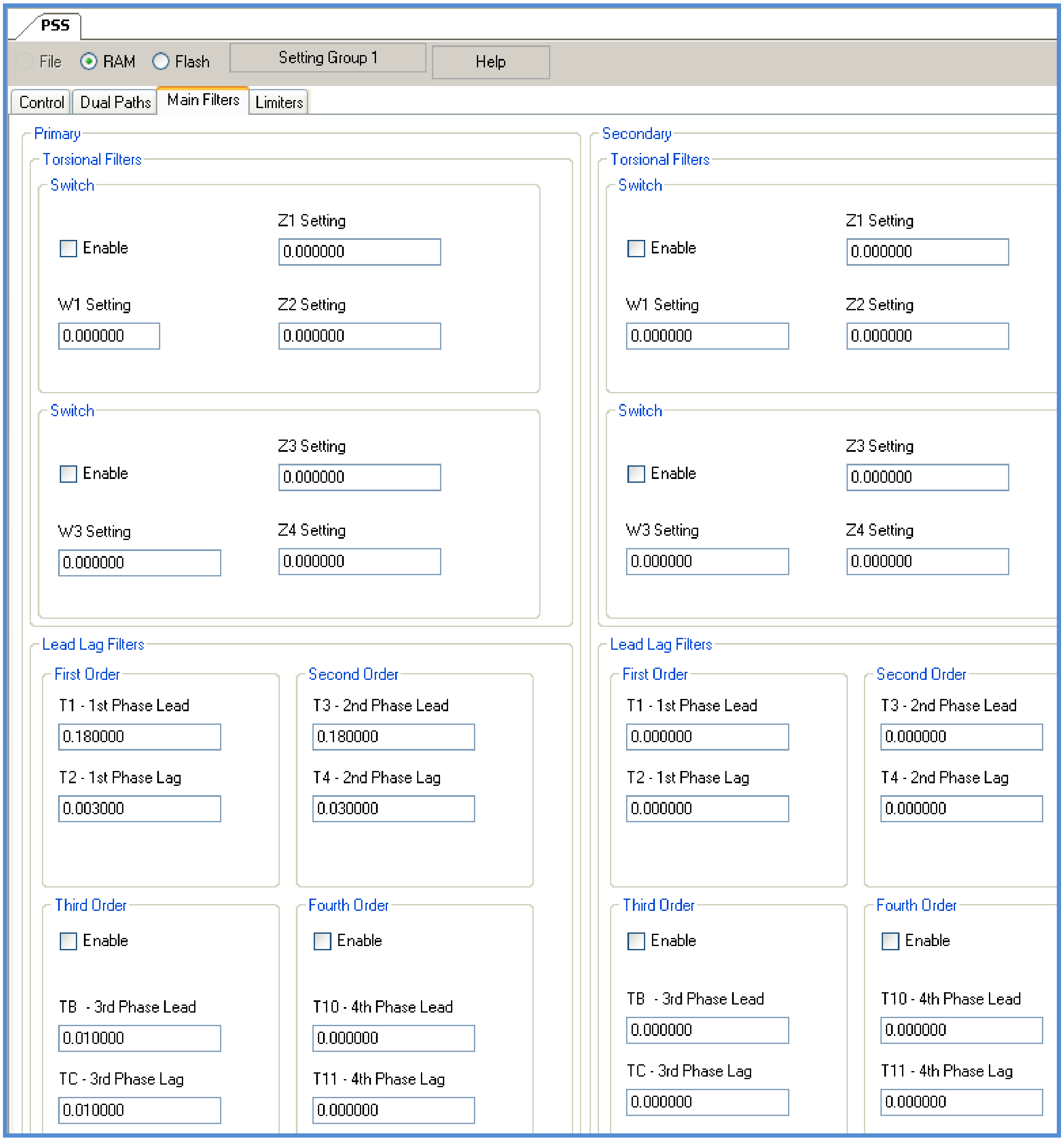


Figure 6-102. PSS, Main Filters Window

Limiters

Control the PSS primary and secondary output limiting, ramp limit, low pass, and stabilizer gain in File, RAM, and Flash. See Figure 6-103.

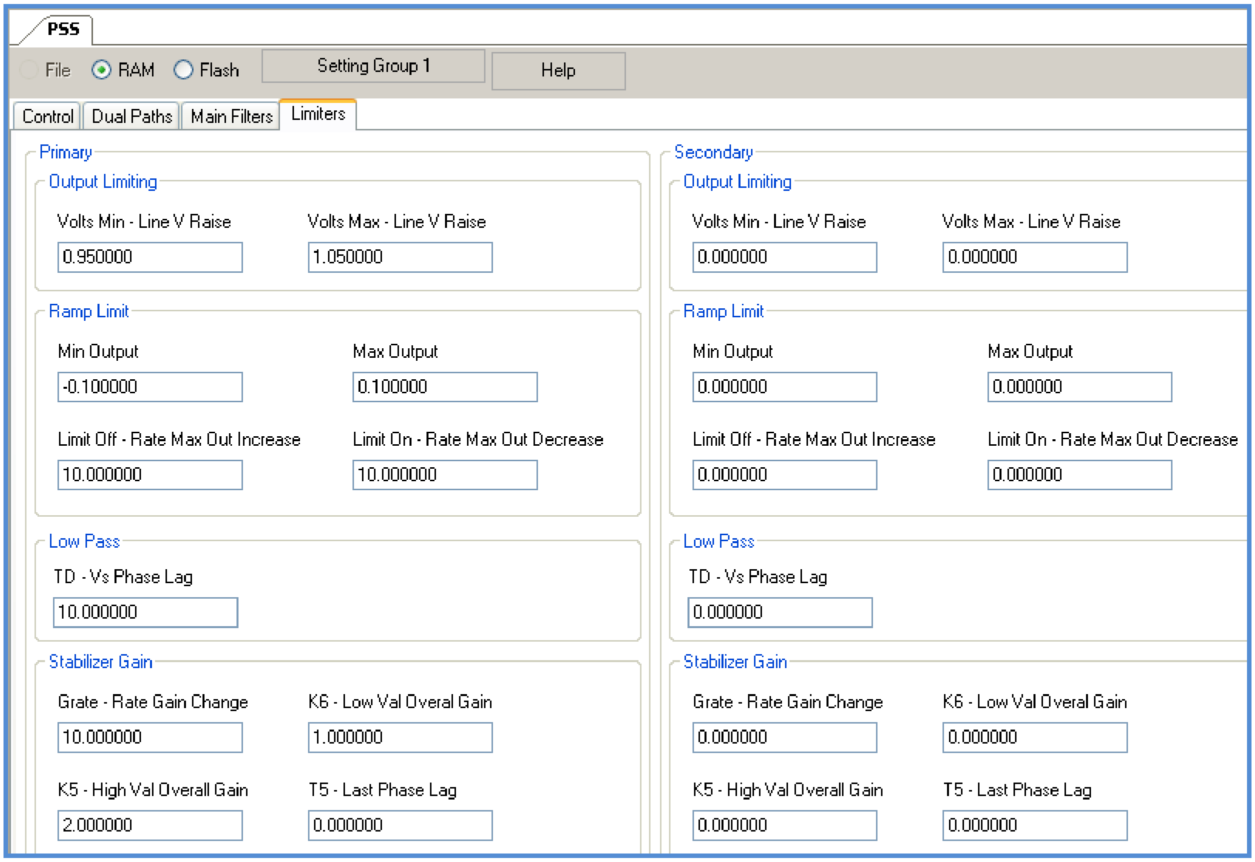


Figure 6-103. PSS, Limiters Window

Alarms Configuration

Enable or disable an alarm's ability to create an alarm notification. The alarm still appears in the alarms window. See Figure 6-104.

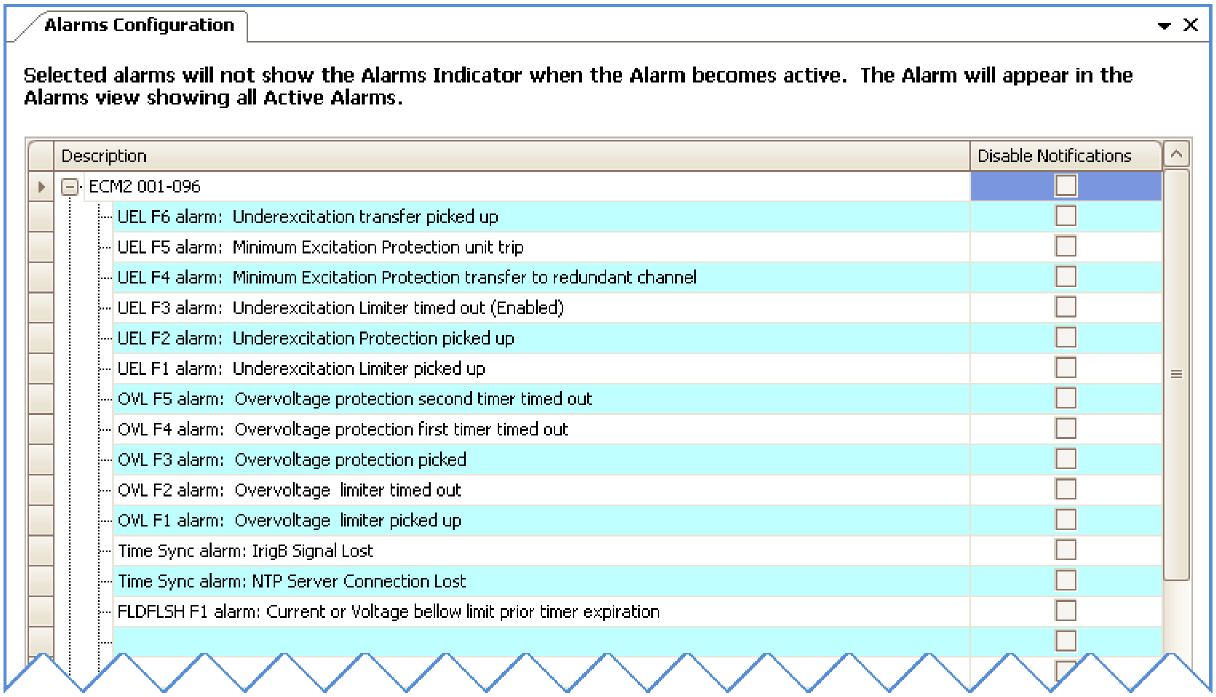


Figure 6-104. Alarms Configuration Window

Menu and Toolbar Commands

Table 6-13 describes all of the main menu and toolbar commands found in BESTCOMS*Pro*.

Table 6-13. Menu and Toolbar Commands

Menu Item	Description	Min. Security Level Required
File		
Connect…	Opens the connections window.	1
Bridge Connect...	Opens the *Bridge Connect* window. Choose from a list of bridges to connect to the controller.	1
Open Configuration…	Opens a saved configuration file.	1
Close	Closes the active configuration file.	1
Save	Saves the active configuration file.	2
Save As...	Saves the active configuration file with a different name.	2
Data Logger	Open *Data Logger File* or *Import Data from Text*.	1
Event Recorder	Open *Event Recorder File* or *Import Event from Text*.	1
SSE Plot	Open *SSE Plot from File* or *Import SSE Plot from Text*.	1
Page Setup	Opens printer settings window.	1
Print Preview	Preview a configuration file printout.	1
Print...	Send a configuration file to a printer.	1

Menu Item	Description	Min. Security Level Required
Preferences	Opens the preferences window.	1
Recent Files	View *Recently Opened Files* or *Clear recent Files* list.	1
Exit	Exit BESTCOMS*Pro*	1
Edit		
Export Config Differences...	Save configuration differences in a text file.	1
View		
Alarms	Opens the alarms window. View all recent alarms.	1
Controller		
Memory I/O…	*Copy to File* or *Insert from File*.	5
Print Controller	Choose any current RAM, flash, or file data to print.	1
Purchase Blocks	Choose logic blocks to be purchased from Basler Electric.	2
Set State…	Opens the *Set Run State* window. Choose the desired state of the controller.	2
Save Current State...	Saves the current state of the controller to be the default state of the controller on power-up.	2
Configurations		
Add Block…	Opens the *Add Block* window. Choose from a list of logic blocks to add.	2
Remove Block…	Opens a *Remove Block* window. Choose from a list of logic blocks to remove.	2
Configure Blocks…	Opens the *Configure Blocks* window. Choose from a list of logic blocks to configure.	2
Copy File to RAM…	Copy data in a configuration file to RAM.	2
Copy RAM to File…	Copy configuration data in RAM to a configuration file.	2
Copy RAM to Flash…	Copy configuration data in RAM to flash memory.	2
Copy Flash to RAM…	Copy configuration data in flash memory to RAM.	1
Copy Flash to File…	Copy configuration data in flash memory to a configuration file.	2
Input Assignments	*Save to File, Import into Existing Config, Import into New Config.*	1
Set Initials	Change user's initials without restarting BESTCOMS*Pro*.	1
User Descriptions	*Export to File, Import form File.*	1
User Definitions	*Add / Edit…, Export to File, Import to File.*	1
Associate File...	Replace the current file configuration with a loaded file configuration.	2
Tools		
Check for Updates	Check for the latest BESTCOMS*Pro* updates via the internet.	1
Select Language	Opens the *Select Language* window.	1

Menu Item	Description	Min. Security Level Required
Set Security Level	Change the current security level. Password required.	1
Firmware Upload	Upload a firmware file to the ECM-2.	4
Compact RAM Diagram	Compacts the RAM Diagram.	2
Window		
Cascade All	Cascade all configuration file windows.	1
Tile	Tile configuration file windows horizontally or vertically.	1
Maximize All	Maximize all configuration file windows.	1
Close All	Close all configuration file windows.	1
Help		
BESTCOMS*Pro* Help	Opens the BESTCOMS*Pro* Help index.	1
About BESTCOMS*Pro*	Displays *General, Detailed Build*, and *System Information*.	1
Activate BESTCOMS*Pro*	Enter or request an activation key.	1
Remove Activation Keys	Removes all activation keys for this product.	1
Block Help	All logic block summaries and drawings.	1
Toolbar Commands		
View Drop down List	Show or hide the view and settings explorers. Open or save workspaces.	1
Connect	Opens the connections window.	1
Open	Opens a saved configuration file.	1
Close	Closes the active configuration file and/or connection.	1
Save	Saves the active configuration file.	1
Preferences	Opens the preferences window.	1
Add Block	Opens the *Add Block* window. Choose from a list of logic blocks to add.	1
Remove Block	Opens the *Remove Block* window. Choose from a list of logic blocks to remove.	1
Set State	Opens the *Set Run State* window. Choose the desired state of the controller.	1
Reload the configuration	Reloads the active configuration.	1
Alarms	Opens the *Alarms* window. Recent alarms are listed.	1

Menu Item	Description	Min. Security Level Required
Compare Configurations	Opens the *Configuration Differences* window.	1

Security Levels

BESTCOMS*Pro* security levels apply to the RAM configuration. You can edit any information in the configuration file regardless of your security level. Your security level is checked when you download from the configuration file to RAM, or when you directly edit RAM.

The security levels are described below in Table 6-14.

Table 6-14. Security Level Definitions

Security Levels	Definition
View Only	Allows viewing of all information in RAM but no ability to save changes. No password is needed and is not shown.
Tune Configuration	Allows changing of input assignments.
Change Configuration	Allows adding and removing blocks, purchasing blocks, and changing the type of input.
COE (Custom Order Engineer)	Enables additional functions for performing system upgrades.
Administrator	Allows access to individual memory locations.

The View Only level does not require a password. All other security levels are password protected.

A default security level is provided when BESTCOMS*Pro* is initially activated. If you know the associated password, you can change your security level after you connect to a controller using the Set Security Level command. Users at a higher level can change the password for their security level or lower. If you forget your password, call Basler Electric to get a temporary activation key with a higher security level which can be used to reset the passwords.

Setting Security Level Passwords

Use the Password Settings window to change the password of one or more security levels for any or all connected controllers. You can change the password of your current security level or a lower security level.

Note: Be careful when changing passwords because the old password cannot be recovered after you set a new one. Also, passwords are not user-specific. The same password applies to all users of the security level.

To set security passwords:

- In the Settings Explorer, choose General Settings, Device Security Settings, Password Settings.
- Your current security level is selected in the list.
- Select a security level to change its password.
- Type the new password for the selected security level in the Password and Confirm fields.
- Click Set Password. A confirmation dialog tells you the password is saved.
- To change the password for another level, repeat Steps 2-6.

Changing Security Levels

Use the Set Security Level command to change your current security level. You must enter the associated password to change to a security level that is higher than your current level.

- Choose *Set Security Level* from the *Tools* menu.
- Select a security level and, if the level is higher than your current level, enter the associated password.
- Click *OK* and BESTCOMS*Pro* changes your security level.

Logic Overview

BESTCOMS*Pro* Programmable Logic is a programming method used for managing the input, output, control, monitoring, and reporting capabilities of Basler Electric's DECS-2100 System. The DECS-2100 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in BESTCOMS*Pro*. Configurations entered and saved in the DECS-2100 system's nonvolatile memory integrate (electronically wire) the selected or enabled control blocks with control inputs and hardware outputs. A group of connected functions, defining the logic of the DECS-2100, is called a logic configuration. Using BESTCOMS*Pro* programmable logic is analogous to physically attaching wire between discrete DECS-2100 terminals. For a detailed explanation of BESTCOMS*Pro* logic see *Programmable Logic* in this chapter.

Logic Block

A logic block is a block of code that represents a component or function in a circuit. Logic blocks can be simple logic gates, latches, and timers or complex function modules. For a full list of available logic blocks for the DECS-2100 with function summaries and diagrams, see Basler Electric Instruction Manual 9411300991.

Execution Strategy

The execution strategy, Figure 6-105, defines when a block executes in relation to all other blocks, the time slots in which the execution takes place, and the executions per cycle. Each cycle consists of 16 divisions. A logic block can execute 1, 2, 4, 8, or 16 times per cycle.

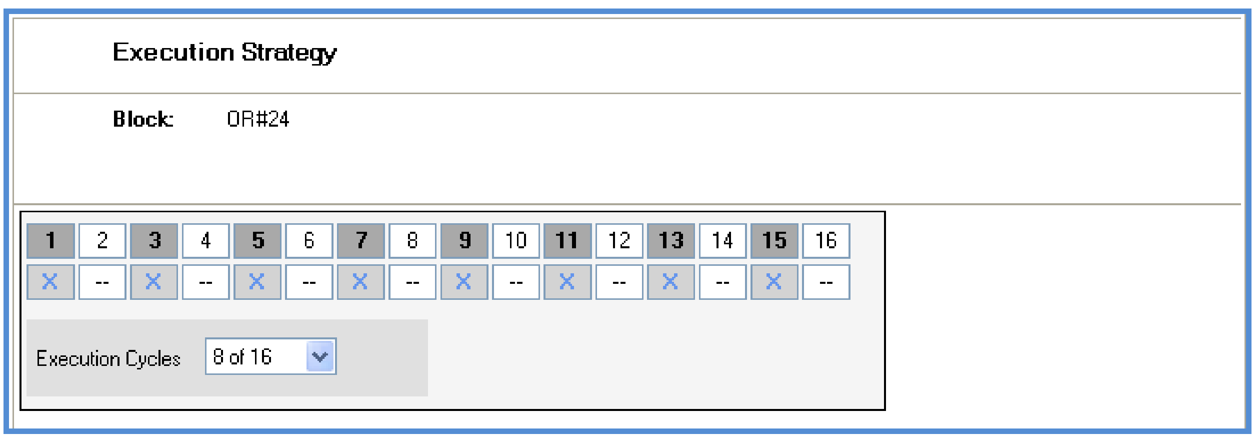


Figure 6-105. Execution Strategy Window

Logic Configuration

A configuration file stores the programmable logic block information and all controller settings. It is used to define new configurations before putting them into operation. When you are ready to put the configuration into operation, download from the configuration file to the RAM of the controller. If the controller is not in the *resolved* state when you try to download, BESTCOMS*Pro* asks if you want to set the state to *resolved*. Your security level is also checked at the time of download. Any level user can edit the configuration file, but only users with the appropriate security level can download the information to RAM.

RAM - This is the configuration information that is to be executed. After you download from the configuration file, the controller state is *resolved*. Set the state to e*xecute blocks* to begin executing the new RAM values. Then monitor and fine tune the configuration as needed.

Flash memory - Flash memory is the permanent memory of the controller. Unlike RAM, Flash memory is not lost if the power goes off. Therefore, you save from RAM to Flash in order to retain information in the event of a power outage or re-cycle. At power-up, the Flash configuration replaces the RAM configuration. You cannot directly edit any information in Flash memory.

To Save Configurations Files

- Click File, Save As…
- Name the file, and click Save.

To Open Configuration Files

- Click File, Open Configuration.
- Select the file to be opened, and click Open.

To copy a configuration to File, RAM, or Flash

Click *Configurations,* and click the appropriate command from the pull down menu.

See Figure 6-106.

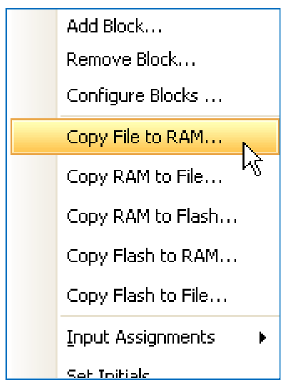


Figure 6-106. Copy Configuration to File, RAM, or Flash

Data Loggers and Event Recorders

This is an overview of data loggers and event recorders. For information on setting up data loggers and event recorders, see *Programmable Logic*.

Data Logger

A data logger is a special function block that takes continuous samples of data. The inputs to this block accept the outputs from other blocks that are to be monitored. The time interval, at which the data logger samples the data, is user-defined. Once a data logger is set up and put into execution, it is always recording data, up to 12 channels of selected parameters. You choose when to view the data. The data logger graph is shown in Figure 6-107.

Event Recorder

An event recorder is a special function block that records the output values related to an event. The trigger that sets off the event and the signals to be recorded are user-defined. When the event recorder is enabled, it starts monitoring for an occurrence of the trigger. When the trigger occurs, the event recorder records the event and automatically displays the attentions indicator in BESTCOMS*Pro* to allow you to upload and view the data.

The two types of triggers are logic and float. For the logic type, you define whether a true or false value for a specific output triggers the event. For the float type, the event is triggered if the value of a specific output falls outside a minimum and maximum value that you define. The event recorder saves both pre-trigger and post-trigger data. You specify a time interval for sampling the data and how many samples you want taken at each interval for pre-trigger and total samples. The sampling rate, total number of samples per channel, number of total samples that are pre-trigger, and number of channels to record (up to 8) are all user-defined for the four available blocks.

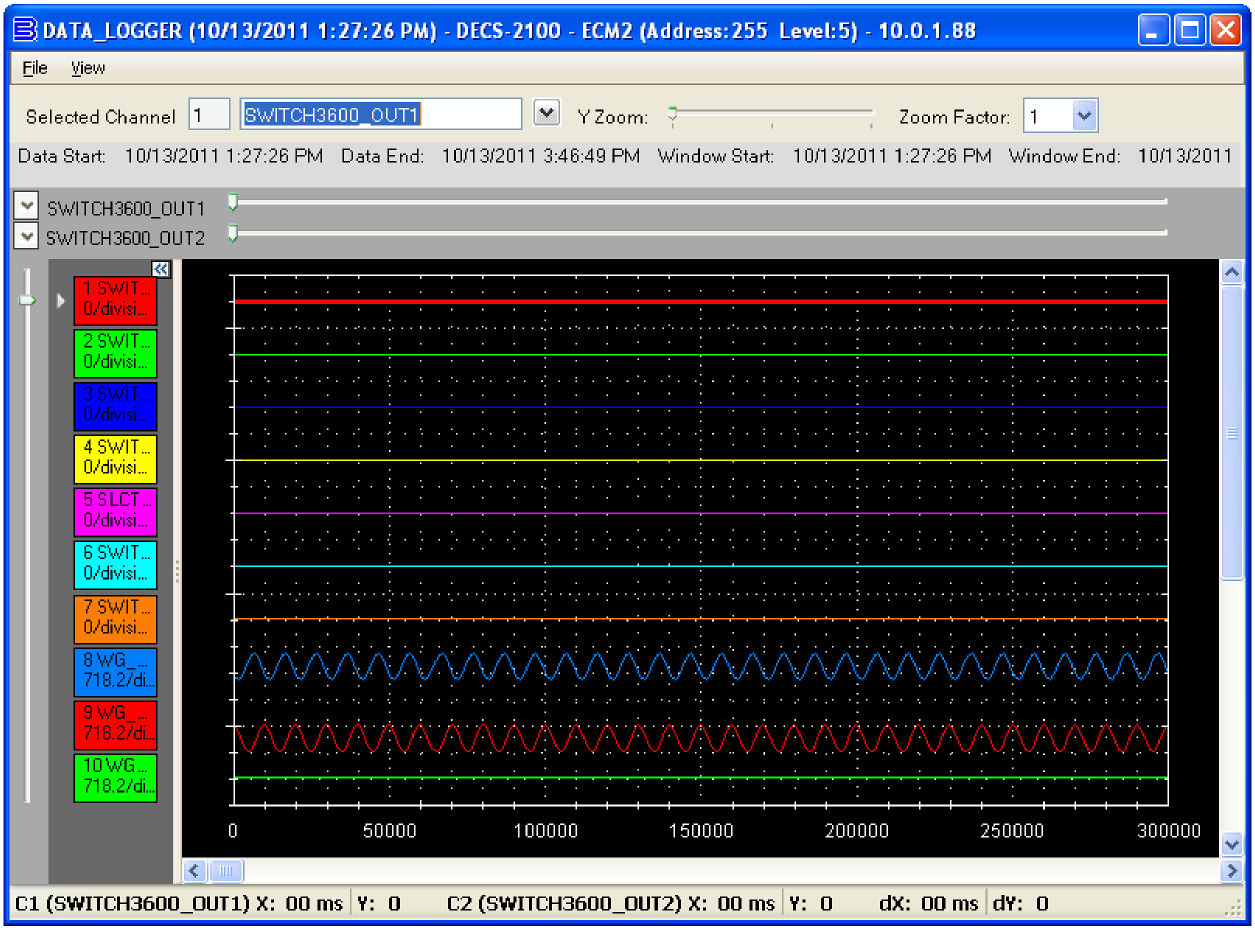


Figure 6-107. Data Logger Graph

Alarms

The controller activates an alarm to alert you to a condition that requires your attention.

Alarm Notifications

When an alarm condition occurs an *Active Alarms* notification appears at the upper right corner of the configuration window as shown in Figure 6-108. Click the *Active Alarms* button to view the alarms window.

Figure 6-108. Alarm Notification

Viewing Alarms

Click the *Alarms* command from the *View* menu or the  button on the toolbar.

The alarms window appears, showing all recent alarms.

Alarms Configuration Window

Alarm notifications may need to be enabled or disabled depending on the current application. A complete list of the alarms can be found in the *Settings explorer*, *Alarms Configurations* window. Each entry has a check box which toggles the enabled or disabled state of the alarm notification. When a disabled alarm notification is triggered it still appears in the alarms window, but there is no notification.

Event and Alarm History Recorder (Sequence of Events)

In *View Explorer*, *Reports*, Click *Alarm History*. A window containing the alarm history and sequence of events is displayed (Figure 6-109). The Alarm History *Tools* menu contains options for refreshing or exporting data. Alarms are only added to the application database when the *Save Alarm History* checkbox is checked in the *General* tab of the *Preferences* dialog.

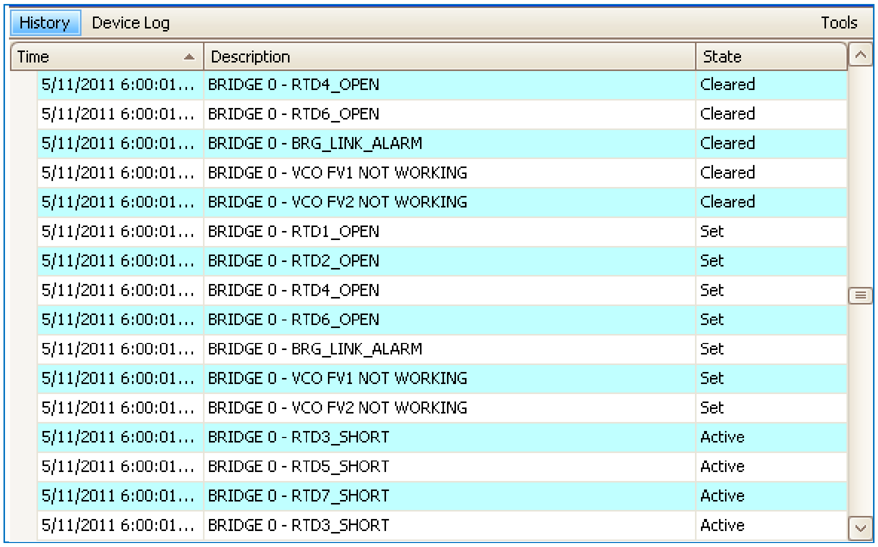


Figure 6-109. Alarm History Window

BESTspace™

BESTspace™ customizable workspaces can be set to fit your specific application needs. Any number of different workspaces can be saved including a default workspace that will load when BESTCOMS™*Pro* is started. (The workspace is the current position, size, and state of all windows that are currently open.) You can save and load workspaces to quickly and easily switch between preferred window layouts and settings. This is especially useful for multiple users of the same PC or for quickly switching between monitoring and configuration tuning tasks. A custom workspace can also be saved as the default workspace that is loaded when a connection is made to the associated controller or its configuration file is loaded.

BESTspace™ controls are accessed through the View button on the lower toolbar.

BESTCOMS™Pro Updates

Over time, enhancements may be added to improve BESTCOMS™*Pro* functionality. Checking for software updates can be done through BESTCOMS™*Pro* on a PC with an internet connection. Checks for updates can be made manually or automatically.

A manual check for updates can be made through the toolbar by selecting *Help, Check for Updates.*

Automatic checks for updates can be enabled and configured through the toolbar by selecting, *Help, Check for Update Settings.* This action accesses the *Check for Updates User Settings* screen (Figure 6-110) which provides selection of enabling automatic updates, the frequency of checking for updates, and whether the update inquiries are anonymous.

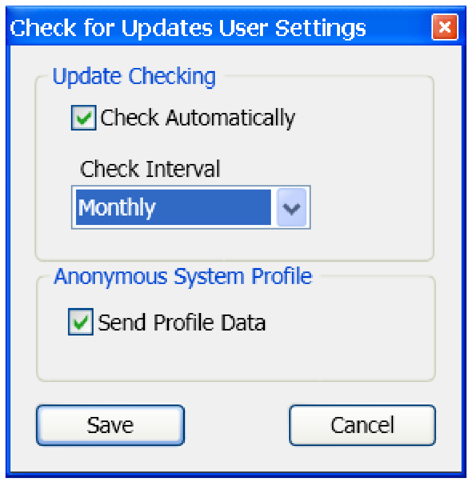


Figure 6-110. Help Menu: Check for Update Settings

Firmware Upgrades

Caution

When ECM-2 firmware is updated, default settings are loaded into the ECM-2, reports and events are cleared, and the ECM-2 reboots. BESTCOMS*Pro* can be used to download configuration settings and save the settings in a file so that they can be restored after updating firmware.

The firmware upgrade option is available only with security level 4 or higher. If you have obtained a package file containing an updated firmware file for your device, you can upload it by selecting *Firmware Upgrade* from the *Tools* pull-down menu on the main screen in BESTCOMS*Pro*. The *Basler Electric Device Package Uploader* screen appears. See Figure 6-111.

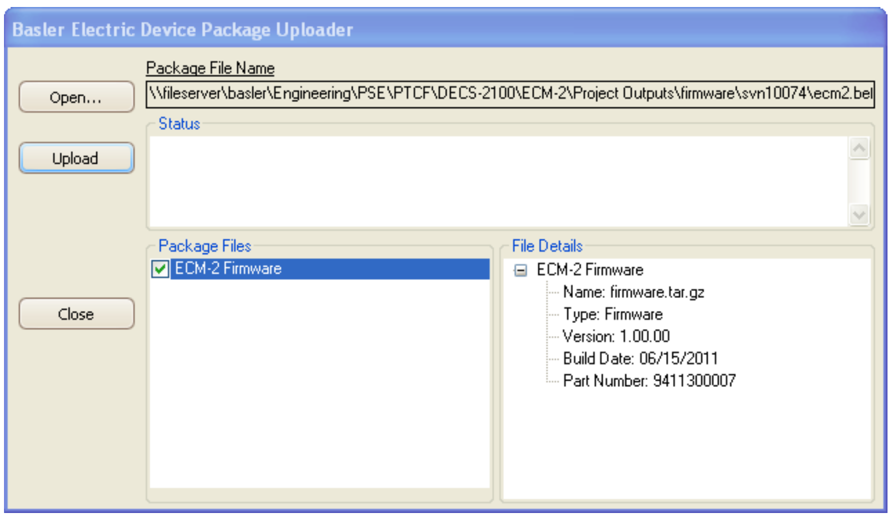


Figure 6-111. Basler Electric Device Package Uploader

Use the *Open* button to browse for the device file that you obtained from Basler Electric. Place a checkmark next to the file you want to upload. Click the *Upload* button. The ECM-2 reboots automatically after the firmware upload is complete.

Plug-Ins for BESTCOMS™Pro

When you connect to a control module, or load a configuration file, the appropriate plug-in loads automatically. The following plug-ins are currently available.

- ECS2100
- DECS-2100

Troubleshooting

BESTCOMS™*Pro* does not support Windows®'s default high DPI scaling behavior. In order to fix this, follow the steps below.

1. Navigate to the installation directory of BESTCOMS™*Pro*.
2. Right click on the BESTCOMS™*Pro* program and select "Properties."
3. Next, select the "Compatibility" tab at the top.
4. Finally, check "Override high DPI scaling behavior." checkbox and then click "Apply."

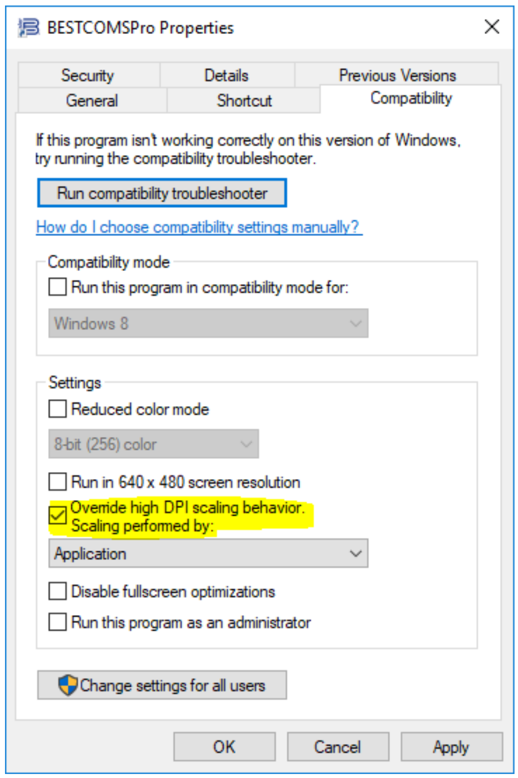


Figure 112. BESTCOMS™*Pro* Properties Menu, Compatibility Tab

7 • Commissioning

This publication serves as a guide for placing a DECS-2100 excitation system into service for the first time. In this publication, references are made to a variety of systems (static, brushless, rotating exciter) with a variety of options. These references are generic and some referenced options may not apply to a particular system. It is essential that the site-specific schematics are obtained and consulted before proceeding with any commissioning procedures.

Safety

Warning!

Components within the excitation system carry lethal levels of voltage. Personal injury or death may result if contact is made with these components. Consulting the system drawings will reveal these hazardous areas/components. All connections should be assumed to be live and dangerous until proven otherwise.

When working with the excitation system, every precaution must be taken to ensure that all high voltages are isolated and avoided by test personnel. High voltages are present within the equipment enclosures; the magnitude of these voltages depends upon the ratings of the particular system. Opening the sources (such as disconnecting the field circuit breaker) does not completely eliminate the possibility of high voltages being present. As long as the machine is physically connected to the system, there is a possibility that a safety hazard exists. In addition to the presence of machine terminal voltage at the excitation transformer, there may be other sources of power entering the enclosure. These power sources include the dc control power and ac station power used to supply various devices. Field voltage will be present at the ground detector power source. The generator field ground detector must be disconnected when servicing the excitation system. Because the ground detector input supply is usually a separate 120 Vac, both the ac power bus and dc field bus may be back fed from this device with 120 Vdc.

Test Equipment

Warning!

Most oscilloscopes have a common connection for all inputs (the oscilloscope case). When making multiple connections to an oscilloscope, ensure that there is no short circuit on the common connection. Isolation transformers may be required. Note that when the oscilloscope case is isolated from ground, potential may be present on the case. Touching the oscilloscope case may result in electrical shock.

The following equipment is required for testing of the excitation equipment as part of the commissioning process.

- Three-phase power source with the proper voltage, frequency, and capacity to energize the power bridge
- Suitable load for the power bridge (an inductive load is highly recommended)
- Two-channel oscilloscope with isolated inputs or isolation amplifier
- Oscilloscope current probe for measurement of SCR gate current
- Oscilloscope differential voltage probe (if inputs are not isolated)
- Multimeter, 20 kΩ/V or better
- Phase angle meter (oscilloscope may be substituted)

- Power sources for transducer calibration:
  - 120 Vac, three-phase, 1 Aac, <0.1% accuracy
  - 20 Vac, three-phase, 7.5 Aac, <0.1% accuracy
  - 200 mVdc, <0.1% accuracy
  - 0–500 Vdc, 1 Adc, <0.1%
- 200 Ω, 1 W potentiometer
- 1 MΩ, 2W potentiometer
- 1 kΩ, ¼ W resistor

Optional Equipment

- Phase sequence meter
- Chart recorder, two element with voltage balancing unit

Procedures Outline

Testing procedures are performed with the machine at rest and running—offline and online.

* These steps must be done or supervised by a service engineer using BESTCOMS™*Pro* software.

† Settings applied in these steps are the responsibility of the user or his hired consultant.

Machine Idle

1. Reconcile all external wiring with the connections shown on the system schematic diagrams.
2. Verify all auxiliary power circuits.
3. If a power potential transformer (PPT) is used, verify the transformer phasing. If a permanent magnet generator (PMG) is used, check the phase rotation on the turning gear.
4. Energize the system modules and circuit boards and verify that the application firmware is the proper version.∗
5. Check the scale and offset of all transducers using simulated sources.∗
6. Verify the operation of all relays, breakers, and control switches.
7. Check the exciter firing control and power bridges.
8. Check all adjusters, followers, regulators, and controllers using simulated sources.†
9. Confirm the operation of all limiting and protection functions using simulated sources. Adjust the pickup and time delay settings according to the site/application requirements.∗†
10. Test the monitoring functions using simulated sources.∗†
11. Reconnect PPT or PMG (if original source was not used to check power bridge function).

Machine Running at Rated Speed, Generator Breaker Open

1. If a PMG is used, verify the PMG voltage magnitude and phase rotation.
2. Check the excitation system control offline.
3. Check system stability offline (bump test).

Machine Running at Rated Speed, Generator Breaker Closed

1. Ensure that the polarity and phase angle of the machine current signals are correct
2. If var or power factor control is used, check the system with controller enabled.
3. Check for correct setting and stability of various limiters using actual machine signals. Test settings or software-injected test offsets may be used if necessary.∗†

4. Verify power system stabilizer setup and operation.∗†
5. Check the final configuration of the system as it operates on the electrical system.†

Commissioning Procedures

Preparation

All service personnel should familiarize themselves with all site requirements and the associated equipment before performing any testing.

Safety

For safety, the ground detector should be disabled and power should be removed from the enclosure heaters while working in the unit. The field leads should be lifted when connected to a dummy load. When supplying the power bridge from a test power source, the PPT or PMG leads should be lifted. Connections between the shunt and field current transducer should be removed when a test source is used. Remember to reconnect all circuits prior to spinning the generator.

Tracking Your Progress

A copy of the system schematic diagrams should be used as a checklist for tested circuits. As circuits are tested, they can be crossed off. A system may contain circuits not covered here. Consult with the service engineer for the proper procedures for testing these circuits.

Multiple Channels

Calibration must be performed on all channels of a system. Values obtained for a channel must be as close as possible to the corresponding values for the other channels. A procedure should be conducted simultaneously for all channels.

Preventing Trips

Disable all trip commands to avoid undesired trips. Remember to enable the trip commands prior to spinning the generator.

External Wiring

A point-to-point check of all wiring connections, for continuity and proper polarity, should be performed. Improper wiring or phasing can cause incorrect operation of the limiters and protection functions.

Auxiliary Power Circuits

Verify proper operation of all enclosure lights receptacles, thermostats, and heaters.

Power Source Phasing

Caution
Failure to verify the PPT connections, winding polarity, and the phase sequence of all voltages may result in equipment malfunction and damage.

Inspect the PPT connections and polarity. Confirm that the PPT primary connections provide a positive phase sequence. Table 7-1 lists the typical terminal designations for the PPT and power bridge along with the connections needed for positive, in-phase, sequence rotation.

Table 7-1. Typical Terminal Designations

	A-Phase	B-Phase	C-Phase
PPT Primary	H1	H2	H3
PPT Secondary	X1	X2	X3
Power Bridge Input	PS1	PS2	PS3

The actual terminal nomenclature may vary according to the equipment used and site-specific conventions. The key consideration for these connections is that the phase sequence of the three-phase supply to ac isolation transducers and power bridge is positive when the 41 device is closed. If the machine phase sequence is different from that shown on the excitation schematic, the cause must be determined and corrected before the equipment is energized.

Firmware Verification

Verify that the output of the black-start power supply (fed by 125 Vdc control power) is 24 Vdc, ±3Vdc.

With a PC operating BESTCOMS*Pro* software, connect to the ECM-2 and note the firmware version of the module. Also note the version of the display panel.

Each step in the following procedure should be performed on all channels before continuing to the next step. This practice will yield results with minimal differences between channels.

Establish communication between the ECM-2 and a PC operating BESTCOMSPro before calibrating the input transducers.

Transducer Scale and Offset

Note

Each step in the following procedure should be performed on all channels before continuing to the next step. This practice will yield results with minimal differences between channels.

Establish communication between the ECM-2 and a PC operating BESTCOMSPro before calibrating the input transducers.

Set the PT and CT inputs to zero by shorting the inputs at their respective input switches. Set the scales of the SIGIN block corresponding to the PT and CT inputs to 1. Verify that the associated outputs of the SIGIN block indicate that each PT and CT signal is close to zero (±0.0018). If they are not, use the appropriate offset constant to make the output of each input close to zero. (Increase/decrease the offset in increments of 0.5.) Remove all short-circuits from the PT and CT inputs.

1. Connect the regulator PT switches to a three-phase voltage source with a magnitude, frequency, and phase sequence equal to the PT secondary voltage when the generator output is at its rated value. Verify that the MAGNITUDE1 output of the PTCTTRN block is 1.000, ±0.0009. If it is not, use the appropriate SIGIN block SIGIN_CH##_SCALE constants to make the output of the block equal to 1.000, ±0.0009. Set all three SIGIN block input constants (SIGIN_CH##_SCALE) to the same value for a three-phase input.
2. Run a transfer curve with the input voltages of 90%, 110%, and 130% of the generator line voltage. The results should be linear.
3. Connect the metering PT switches to a three-phase voltage with a magnitude, frequency, and phase sequence equal to the PT secondary voltage when the generator output is at its rated value. Verify that the MAGNITUDE2 output of the PTCTTRN block is 1.000, ±0.009. If it is not, use the appropriate SIGIN block SIGIN_CH##_SCALE constants to make the output of the block equal to 1.000, ±0.0009.

Set all three SIGIN block input constants (SIGIN_CH##_SCALE) to the same value for a three-phase input.

4. Run a transfer curve with the input voltage set to simulate 90%, 110%, and 130% of the generator line voltage. The results should be linear.
5. Temporarily adjust the CONFIG parameter of the PTCTTRN block by adding 8 hex to the present value (configures the PTCTTRN for operation with a single CT input). Connect each CT switch to a source of ac current equal in magnitude, frequency, phase sequence, and polarity to the CT secondary currents when the generator output is at its rated value, verify that the CTMAGNITUDE output of the PTCTTRN block is 1.000, ±0.005. If it not use the appropriate SIGIN block SIGIN_CH##_SCALE constant associated with the phase-A CT input to make the output of the block equal to 1.000, ±0.05. (Typically, phase-A CT constant is SIGIN_CH04_SCALE.)
6. Temporarily connect the CTPHASEA input of the PTCTTRN block to the SIGIN channel associated with the phase-B CT. With the source still connected to each CT switch set equal in magnitude, frequency, phase sequence, and polarity to the CT secondary currents when the generator output is at its rated value, verify that the CTMAGNITUDE output of the PTCTTRN block is 1.000, ±0.005. If it not use the appropriate SIGIN block SIGIN_CH##_SCALE constant associated with the phase-B CT input to make the output of the block equal to 1.000, ±0.05. (Typically, phase-B CT constant is SIGIN_CH05_SCALE.)
7. Temporarily connect the CTPHASEA input of the PTCTTRN block to the SIGIN channel associated with the phase-C CT. With the source still connected to each CT switch set equal in magnitude, frequency, phase sequence, and polarity to the CT secondary currents when the generator output is at its rated value, verify that the CTMAGNITUDE output of the PTCTTRN block is 1.000, ±0.005. If it not use the appropriate SIGIN block SIGIN_CH##_SCALE constant associated with the phase-C CT input to make the output of the block equal to 1.000, ±0.05. (Typically, phase-C CT constant is SIGIN_CH06_SCALE.)
8. Return the CTPHASEA input of the PTCTTRN block to its original value (the SIGIN channel associated with the phase-A CT). Return the CONFIG parameter of the PTCTTRN block to its original value. With the source still connected to each CT switch set equal in magnitude, frequency, phase sequence, and polarity to the CT secondary currents when the generator output is at its rated value, verify that the CTMAGNITUDE output of the PTCTTRN block is 1.000, ±0.005. If it not use the appropriate SIGIN block SIGIN_CH##_SCALE constants to make the output of the block equal to 1.000, ±0.05. (Typically, these constants are SIGIN_CH04_SCALE, SIGIN_CH05_SCALE, and SIGIN_CH06_SCALE.) Scale all three SIGIN_CH##_SCALE proportionally for a three-phase input.
9. Run a transfer curve with the CT input current at 1 Aac, 2 Aac, 3 Aac, and 4 Aac. The results should be linear.
10. Apply values to the PT and CT inputs that simulate the generator at rated conditions. Use BESTCOMS*Pro* to capture an event that records the instantaneous voltage and current inputs. Verify that the phasing is correct. Confirm on the display panel that the line voltage, line current, megawatts, megavars, and power factor read correctly on all screens.
11. If the LOS2_SENS block is utilized, verify proper assignment of the CH_MET_VA thru CH_IC parameters. With the appropriate values of PT and CT inputs to simulate the generator at rated conditions applied, verify that the SEQ_V1 and SEQ_I1 outputs of the LOS2_SENS block are 1.00±.009 and that the SEQ_V2 and SEQ_I2 outputs are less than 0.100.

Note
For IT transducers, pin 19 is positive with respect to pin 20 and pin 21 is positive with respect to pin 22.

12. Remove the appropriate fuse and short the connections to the Phase AB line transducer (ALXDM). Set the PPT_SCALEA parameter of the FLDSCALE block to 1. Verify that PPT_PTA output of the

FLDSCALE block is 0 counts, ±2 counts. If it is not, adjust the PPT_OFFSETA parameter so that the output is at 0, ±2 counts.

Connect the ac line transducer input (pins J19 and J20) to a dc voltage equal to the peak value of the line-to-line voltage applied to the power bridges (√2 * Vrms). Verify that the PPT_PTA output is 1.000, ±0.0009. If it is not, adjust the PPT_SCALEA parameter of the FLDSCALE block until the PPT_PPA output is 1.000, ±0.0009.

13. Remove the appropriate fuse and short the connections to the Phase BC line transducer (ALXDM). Set the PPT_SCALEB parameter of the FLDSCALE block to 1. Verify that PPT_PTB output of the FLDSCALE block is 0 counts, ±2 counts. If it is not, adjust the PPT_OFFSETB parameter so that the output is at 0, ±2 counts.

    Connect the ac line transducer input (pins J21 and J22) to a dc voltage equal to the peak value of the line-to-line voltage applied to the power bridges (√2 * Vrms). Verify that the PPT_PTB output is 1.000, ±0.0009. If it is not, adjust the PPT_SCALEB parameter of the FLDSCALE block until the PPT_PPB output is 1.000, ±0.0009.

14. Re-establish all connections and replace all fuses previously removed.
15. Remove the appropriate fuse and short the connection to the field voltage transducer (pins J21 and J22 of DCXDM). Set the VG_SCALE parameter of the FLDSCALE block to 1. Verify that the GEN_FLD_VLT output of the FLDSCALE block is at 0, ±2 counts. If it is not, adjust VG_OFFSET parameter so that the output is at 0, ±2 counts.
16. Remove the short-circuit across the input of the field voltage transducer and apply a dc input equal to the field voltage at full load. (The full-load field voltage can be calculated by multiplying the full-load field current by the field resistance at rated operation field temperature, typically 70°C for hydro and 100°C for steam.) Verify that the GEN_FLD_VLT output of the FLDSCALE block is at 1.000, ±0.0009. If it is not, adjust VG_SCALE so that the output is at 1.000, ±0.0009.
17. Run a transfer curve with the input voltage set to simulate 50%, 100%, and 150% of full-load field voltage (if possible). All results should be linear.
18. Check the display panel to verify that the field voltage is displayed correctly on all screens.
19. Restore all DCXDM connections and replace the fuse removed in step 15.
20. Disconnect the leads from the output current shunt and short the connections of the field current transducer (pins J19 and J20 of DCXDM). Set the IG_SCALE parameter of the FLD_SCALE block to 1 and IG_FILTER to 0.00. Verify that the GEN_FLD_CUR output of the FLD_SCALE block is 0, ±2. If it is not, adjust IG_OFFSET so that the output is 0, ±2.
21. Remove the short circuit across the input of the field current transducer. Connect a millivolts-level source to the input for the field current transducer (DCXDM). Apply an input that corresponds to the shunt signal when field current is at full load. Verify that the GEN_FLD_CUR output of the FLD_SCALE block is 1.000, ±0.0009. If it is not, adjust IG_SCALE so that the output is 1.000, ±0.0009.
22. Run a transfer curve with the input signal set to simulate 50%, 100%, and 200% of full-load field current. All results should be linear.
23. Check the display panel to verify that the field current is displayed correctly on all screens.
24. Restore all DCXDM connections.
25. If the system contains both generator and exciter field transducers, repeat steps 15 thru 21 substituting EXC_FLD_VLT for GEN_FLD_VLT; EXC_FLD_CUR for GEN_FLD_CUR, VE_### for VG_###; and IE_### for IG_### in each step.
26. If 4–20mAdc analog inputs are used to measure current, confirm that load resistors are present. Verify that AD_OFFSET_3 and AD_GAIN_3 of the ALOGDIG block are properly set for channel 1 (per the system drawings and site transducers).

    Confirm that AD_OFFSET_4 and AD_GAIN_4 of the ALOGDIG block are properly set for channel 2 (per the system drawings and site transducers).

If a ground detector is used, channel 3 typically measures leakage to ground and can be configured later as part of ground detector calibration.

27. If RTD inputs are used, check for proper setting of the following ALOGDIG block parameters: AD_OFFSET_1, AD_GAIN_1, AD_OFFSET_2, AD_GAIN_2, AD_RTD_KSCALE, and AD_RTD_RZ. Connect a test resistance in place of an RTD. For a 100 ohm input, the output of ALOGDIG should indicate 0°C. for a 110 ohm input, the output of ALOGDIG should indicate 25.9°C. If this output supplies a remote meter, inject signals and verify proper meter indications.
28. If analog outputs are used, refer to the system drawings and check the DIGALOG and DAC_OB blocks for properly set offsets and scales. If this output supplies a remote meter inject signals and verify proper meter indications.

Relays, Breakers, and Control Switches

Check the operation of all relays, contactors, cooling fans, circuit breakers, and adjusters. The various control switches, located locally at system enclosure and remotely at the station operator’s control board, should be checked also. Operation of all these devices must be in agreement with the system drawings. Initial checks should be made with the local display panel followed by the control room switches, and then the distributed control system screens.

For dual-channel systems, this portion of the procedure should be performed first with the main channel in control. Then, all steps should be repeated with the redundant channel in control.

Connect a three-phase ac voltage source to the regulator PT switches. This source should have the same magnitude and phase sequence as the PT secondary voltage when the generator output is at the rated value.

The following steps serve as checks for the more typically used components.

1. Verify operation of a local/remote transfer. With local control, the system enclosure display panel controls are enabled. With remote control, the control room switches are enabled and the display panel screen switches on the system enclosure are disabled. Steps 2 through 10 should be performed in local control and then repeated in remote control. Verify the operation of any local and remote indicator lights.
2. Verify all aspects of field circuit breaker (41) operation: the 41A-CS close and trip commands, 41AX relays, and interlocks. When the local 41CS is switch to the trip position, the lockout (86) device operates immediately, initiating phase back. The 41A device trips about 5 seconds later (after a software timer expires). Upon a site-supplied emergency trip, the 41A device operates immediately. Check all 41A, 41AX, and 86 status indicator lights and contacts.
3. Verify operation of automatic/manual mode selections. Verify that the system can be transferred between automatic and manual modes. Check for proper auto and manual indicator light operation.
4. Check the system for a proper response to a loss of sensing. Confirm that a transfer to manual mode occurs when the regulator PT and metering PT (if used) voltage decreases below the selected value.

   Normally, the system is started in auto mode. Since the PT voltage is low initially, the controls are defaulted by the loss of sensing function to manual mode. When the PT voltage crosses the selectable level in a predetermined time, the system transfers back into auto mode.

   If metering PTs are used, the system transfers from one set of PTs to the other set when only one set of PTs is low. Transfer to manual mode occurs when both sets of PTs go low. These scenarios can be simulated in two ways. The first test simulates a blown fuse by disconnecting a single PT input. The second test simulates a high-resistance fuse/connection by lowering the PT inputs.
5. While disconnected from the field, test operation of the field flashing circuitry. If included, set 31TD according to the site requirements (typically 10 seconds). Check the 31 and 31X contacts in the alarm and annunciator circuits. Ensure that field flashing is terminated when the field current builds up or when regulator PT voltage is applied.
6. Verify operation of the automatic adjuster. Confirm that the traverse range and pre-position setting meet the requirements of the application. With the 41A device tripped, the adjuster output is at the

ACVLTADJ block soft start bias value (ACADJ_SS_BIAS) and cannot be moved under normal operation. With 41A closed, the adjuster output can be moved.

To verify the traverse range, set the adjuster at minimum, and apply a PT signal until the ac error signal reads zero. (A balance meter can be used if dc error is kept at zero.) This is the minimum setting of the adjuster. With the adjuster set at maximum, apply a PT signal until the ac error signal reads zero. Both of these settings (ACADJ_MAX and ACADJ_MIN) are selectable with BESTCOMS*Pro* software. The traverse time is set using ACADJ_SLEW.

7. Verify operation of the manual adjuster. Confirm that the traverse range and pre-position setting meet the requirements of the application. With the 41A device tripped, the adjuster output is at the MANADJ block soft start bias value (MANADJ_SS_BIAS) and cannot be moved under normal operation. With the 41A device closed, the adjuster output can be moved.

   To verify the traverse range, set the adjuster at minimum, and vary a simulated current shunt signal until the dc error reads zero. (A balance meter can be used if ac error is kept at zero.) This is the minimum setting of the adjuster. With the adjuster set at maximum, apply a simulated current shunt signal until the dc error signal reads zero. Both of these settings (MANADJ_MAX and MANADJ_MIN) are selectable with BESTCOMS*Pro* software. The traverse time is set using MANADJ_SLEW.

8. Verify operation of the var control adjuster. Confirm that the traverse range and pre-position setting meet the requirements of the application. With the 41A device tripped, the adjuster output is at the VARCONTR block pre-position value (VRC_PP_1) and cannot be moved under normal operation. With the 41A device closed, the adjuster output can be moved.

   To verify the traverse range, set the adjuster at minimum, apply PT and CT signals, and adjust simulated vars until the var balance signal reads zero. This is the minimum setting of the adjuster. With the adjuster set at maximum, apply PT and CT signals and adjust the simulated vars until the var balance signal reads zero. Both of these settings (VRC_MAX and VRC_MIN) are selectable with BESTCOMS*Pro* software. The traverse time is settable using VRC_SLEW.

9. If used, check operation of the 64 switch and field ground fault detector. Confirm that the ground fault detector is disabled during field flashing.
10. If used, check operation of the cooling fans and their associated controls
11. Repeat steps 2 through 10 with the remote controls selected.
12. Check any other control features as indicated by the system drawings.

Firing Control and Power Bridges—Generator Not Spinning

Caution

If the excitation transformer is not used and a separate source is connected to the 41A device, the excitation transformer secondary connections to the 41A device must be disconnected, taped, and tagged. Do not energize the excitation transformer secondary with the test source.

Although starting resistors may be used as a load for this test, a higher current load (preferably inductive) is preferred. If the rotor field will be used as part of the load, an additional load resistor should be added in series with the generator or exciter field. This resistor must be sized to prevent any damage to the exciter or generator rotor and prevent overloading of the test power source when the unit is not rotating. (Current values less than no-load field current can damage the generator or brushes.) Check with the customer to determine the safe level of current for the stationary machine.

An idle, powered field must be closely supervised to prevent thermal damage. Damage to brushes may also occur.

In the following steps bridge operation, under control of the REG_SLCT3 block SLCT3_BASE signal, is checked. Three-phase, 60 hertz power is required for this test and may be obtained from the excitation transformer secondary if the transformer can be energized. If a separate source must be used, it should be sized to give sufficient static exciter load and provide a reasonable operating test. The test supply can have a closed, three-phase delta configuration or a three-phase, wye configuration. Do not use an open-delta source for this test. Confirm that the phase sequence of the supply voltage agrees with the system drawings. The three-test voltage should be connected at the input of the 41A device.

1. To simulate an open-loop condition, enable control of the power bridge output by setting SLCT3_BASE. With the DECS-2100 out of service (41A open), set variable SLCT3_K1 at zero in all channels. Set variable SLCT3_BASEFC to 1.0 in all channels.
2. If the system has only one power bridge, proceed to step 3. For a system with more than one bridge, enable only one bridge by placing all other bridges in maintenance mode. This is accomplished with the maintenance logic block. It is crucial that the ECM-2 being accessed corresponds to the channel in control.
3. With a suitable load connected, connect an oscilloscope to view the SCR firing pulses at the power amplifier modules. Close the 41A device and observe that the power amplifier output voltage is near the level of no-load field voltage if test source is less than normal ac input voltage level, the field voltage output will be reduced proportionally to the ratio of test voltage to nominal voltage. The observed exciter output waveform should be similar to the waveforms shown in Figure 7-1. Note that six SCR firings per cycle are indicated by the six “bumps” per cycle in the output waveform.

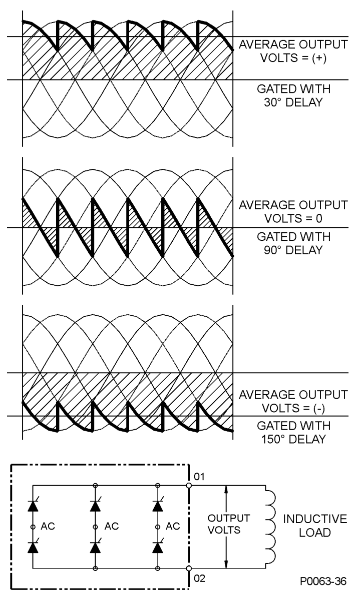


Figure 7-1. Typical Power Bridge Output Waveforms

Note

In order for the firing pulses to be properly displayed on the oscilloscope, the oscilloscope must be synchronized to the firing circuit supply voltage. If the ac line isolation transducer receives its voltage from the same 60 hertz test source, then the oscilloscope can be set to line synchronization. If the excitation transformer is serving as the test supply and the oscilloscope is connected to 60 hertz station power, a separate synchronization signal should be supplied to the external synchronization terminal of the oscilloscope and the oscilloscope should be set for external synchronization. An oscilloscope current probe is highly recommended for measuring SCR firing pulses.

4. Verify that each firing pulse consists of a number of individual pickets, typically four pickets for each firing pulse.

> **Caution**
>
> Do not dwell at ceiling voltage levels any longer than 60 seconds unless the load is sized to handle continuous ceiling voltage. Load resistors may become excessively hot during application of continuous ceiling voltage. Allow sufficient cooling time (60 seconds) before repeating the application of ceiling voltage.

5. Vary the SLCT3_BASE setting and observe that the firing pulses move from right to left on the oscilloscope screen as the SLCT3_BASE setting increases (raise direction of the base adjuster). Large values of SLCT3_BASE cause the unit to go to ceiling. Values of SLCT3_BASE near zero cause the output voltage to approach zero. (Actual low-end voltage depends on whether or not the simulated load is inductive.) Note that the negative output voltage—seen when the power bridge is phased back to between 90 and 180 degrees of delay—is a momentary transient that appears only with an inductive load.

   The exciter output, in response to the SLCT3_BASE setting control, must be smooth and, with an inductive load, approximately linear between the start of SCR conduction and near saturation voltage (exciter ceiling voltage, where the ceiling voltage is 1.25 × test source voltage). Note that with a resistive load, only the upper portion of the curve will be linear. Voltage will not decay to zero with zero input.

6. Check the polarity of the field voltmeter in the control room.
7. Using the display panel, set the just-tested power bridge into maintenance mode and activate one of the bridges previously set in maintenance mode. Repeat steps 3 through 6.
8. For a dual-channel system, when all bridges have been tested, transfer to the redundant channel and repeat steps 3 through 7.

After completion of these power component tests, the logic circuitry should be tested. Leave the exciter test load in series with the machine field and the test source ready for combination tests with the regulator logic.

Adjusters, Followers, Regulators, & Controllers—Generator Not Spinning

> **Caution**
>
> Do not use the same 60 hertz test source simultaneously for the logic modules and power *modules. Test source power regulation may cause unstable operation*.

The following procedures provide methods for checking the more commonly used regulators, adjusters, and controllers. For dual-channel systems, the following procedures should be performed first with the main channel in control. Then, each step should be repeated with the redundant channel in control.

1. Check the setup of the automatic adjuster control (software block ACVLTADJ). With 41A closed use the operator control to move the adjuster output from maximum to minimum. Observe ACADJ_TRAVEL for the percent travel from 0 to 100. Verify that the maximum (ACADJ_REF), minimum, and traverse time meet the operational requirements for the application.

Open the 41A device and verify that the output returns to the soft start bias level. Check that this will meet the site startup requirements. If used, check for correct operation of the adjuster position meter or the minimum/maximum position indicator lights/contacts.

2. Check the setup of the manual adjuster control (software block MANADJ). Observe MANADJ_TRAVEL for the percent of travel from 0 to 100. With the 41A device closed, use the operator's control to move the adjuster from maximum (MANADJ_REF) to minimum. Check that the maximum, minimum, and traverse times are suited for the application requirements.

   Open the 41A device and verify that the output returns to the soft start bias level. Check that this will meet the site startup requirements. If used, check for correct operation of the adjuster position meter or the minimum/maximum position indicator lights/contacts.

3. Check operation of the balance meter. With the 41A device open, disable the followers and var/power factor controllers. Set RCOMP_XC and RCOMP_RC to zero in the REAC_COMP block. Set LDR_XD and LDR_RC to zero in the LINEDROP block (if used). Set the PT and CT test sources to correspond to rated values. Set the simulated field current to represent full-load field current. Verify that the POWERTRN#00 block indicates the correct MW and Mvar readings. Close the 41A device. Set the manual and auto adjuster outputs at 1.0. Confirm that the output of AUTO_MXR, as seen at the REG_SLCT3 (SLCT3_ACR) and MAN_MXR (SLCT3_DCR), both read zero. Confirm that the balance meter reads zero. Raise the auto adjuster and verify that the balance meter reads negative. Raise the manual adjuster and verify that the balance meter returns to zero.

4. Check the manual adjuster followers. With the unit in auto mode and the followers disabled, lower the PT test source to 98% of the rated value. Enable the followers. Check that the manual adjuster (MANADJ_REF) output increases and the balance meter heads toward zero. The adjuster output should stop moving when minimum is reached or when the balance meter approaches zero (within the bandwidth of the manual follower).

5. Check the automatic adjuster followers. With the unit in manual mode and the followers disabled, increase the PT test source to 100% of the rated value. Use the auto adjuster switch to return the balance meter to zero. Set the simulated field current to 90% of full load and enable the followers. Verify that the automatic adjuster (ACADJ_REF) output increases and the balance meter heads toward zero. (The balance meter may cross zero and go positive.) The adjuster output should stop moving when minimum is reached or when the balance meter approaches zero (within the bandwidth of the automatic follower).

6. Return RCOMP_XC and RCOM_RC to their original values in the REAC_COMP block. Set the PT and CT test signals to simulate 0 power factor, overexcited (lagging generator vars). For droop compensation, ACREG_V2 should become more negative by the amount of droop compensation. For rise compensation, ACREG_V2 should become more positive by the amount of droop compensation.

7. If line drop compensation is used, return the LINEDROP LDR_XCL and LDR_RCL parameters to their original values. Apply PT and CT test signals that simulate 0 power factor, overexcited (lagging generator vars). For droop compensation, ACREG_V2 should become more negative by the amount of droop compensation. For rise compensation, ACREG_V2 should become more positive by the amount of droop compensation.

8. If var control is used, check its setup through software block VARCONTR. With var control disabled, set the PT and CT test signals to simulate rated load at unity power factor. Use the var control raise/lower switches to set VRC_ERROR at zero. Reduce the PT test signal to below VRC_VMIN. Adjust the CT test signal to simulate an overexcited generator (approximately 0.8 power factor, lagging). Enable var control. Check the adjuster position and confirm that the ac adjuster output remains unchanged. Return the PT test signal to the rated voltage. Verify that the output of the ac adjuster decreases. Adjust the CT test signal to simulate an underexcited generator (approximately 0.8 power factor, leading). Confirm that the ac adjuster output increases.

9. If power factor control is used, check its setup through software block PFCONTR. With power factor control disabled, set the PT and CT test signals to simulate rated load at unity power factor. Use the power factor control raise/lower switches to set PFC_ERROR at zero. Reduce the PT test signal to below PFC_VMIN. Adjust the CT test signal to simulate an overexcited generator (approximately 0.8 power factor, lagging). Enable power factor control. Check the adjuster position and confirm that the ac adjuster output remains unchanged. Restore the PT test signal to the rated voltage and verify that

the output of the ac adjuster decreases. Adjust the CT test signal to simulate an underexcited generator (approximately 0.8 power factor, leading). Confirm that the ac adjuster output increases.

10. For a dual-channel system, set the PT and CT test signals to the rated values and adjust the field current source to represent full-load field current. With the main channel in control, access the display panel screen dedicated to the transfer of channel control. Verify that the tracker window reads 0, ±0.1.
11. Transfer control to the redundant channel and repeat step 10.

Limiters and Protective Functions

The following procedures cover the more common limiter and protection features and provide methods for checking each function. The event recorder in BESTCOMS*Pro* can be used to check short time delays as needed. For a dual-channel system, block calibration should be performed at the same time for both channels to obtain matched results.

Note
If desired, after each pickup point is verified, the operation of each limiter can be viewed by monitoring the power bridge output voltage. The firing circuit must be brought to a reasonable level prior to application of the pickup test signal. The firing signal can be adjusted with the auto/manual adjusters. The tracking circuit (adjuster followers) should be disabled to prevent interference with limiter operation during testing.

Maximum Excitation Limiter

Check the operation of the overexcitation limiter (OEL {MXL} time delay). Check all contact outputs, indicator lights, and annunciations associated with the OEL (MXL).

Note
When a step change is performed, any instability of the signal source will cause false operation of the pickup point and affect the timing. The signal can be monitored with the data logging function.

1. Verify that the recal inputs do not affect the output. Raise the field current sensing input until the OEL (OEL00_F1) picks up and record this value as the limiter pickup. (The OEL output remains at OEL00_OFF while the OEL is timing.)
2. Raise the field current sensing input until the OEL (OEL00_F3) picks up and record this value as the protection pickup.
3. Set the field current sensing source at 4% over the limiter pickup threshold. De-energize the field current sensing source and wait for the inverse timer to expire. Switch the field current sensing source on and measure the time until the OEL times out. Record this time. OEL00_F2 becomes TRUE when the inverse timer expires. Verify that the measured time is consistent with the A, B, and C settings and that the timing is coordinated with the generator thermal capability (ANSI C50.10, C50.12-C50.14). Remove the field current sensing source.
4. Set the field current sensing source at 30% over the limiter pickup threshold. De-energize the source and wait for the inverse timer to expire. Switch the field current sensing source on and measure the time until the limiter and protective functions time out. Record this time. Verify that the measured time is consistent with the A, B, and C settings and that the timing is coordinated with the generator thermal capability.

5. Check for correct operation of flags to transfer channels, disable followers, and initiate a unit trip per the application requirements.
6. If used, check the temperature recalibration.
7. If used check the pressure recalibration.
8. If dual setting groups are used, repeat Steps 1 through 7 for Setting Group 1.

Instantaneous Current Limiter

Check the operation of the instantaneous current limiter. Check all contact outputs, indicator lights, and annunciations associated with the limiter.

1. Configure the system to simulate an open 52 breaker. Raise the field current test source input until instantaneous limiter INS_F1 picks up and record this value as the offline limiter pickup.
2. Raise the field current test source until instantaneous limiter INS_F4 picks up and record this value as the offline protection pickup. Remove the test source.
3. Set the test source at 4% over the offline protection pickup (INS_SP4). Switch the test source on and measure the time until the INST_CUR timer expires. Record this value.
4. Configure the system to simulate a closed 52 breaker. Raise the level of the test source until instantaneous limiter INS_F1 picks up. Record this value as the online limiter pickup.
5. Raise the field current test source until instantaneous limiter INS_F4 picks up. Record this value as the online protection pickup. Remove the test source.
6. Adjust the test source to be 4% over online protection pickup INS_SP3 and remove the source. Switch the source on and measure the time until all instantaneous current timers expire. Verify that this value is coordinated with the generator thermal capability.
7. If dual setting groups are used, repeat Steps 1 through 6 for Setting Group 1.

Volts per Hertz Limiter

Check the operation of the volts per hertz limiter (HXL). Check all contact outputs, indicator lights, and annunciations associated with the limiter.

1. Increase the PT test source until HXL_F1 picks up. Record this value as the limiter pickup. Increase the test source until HXL_F3 picks up. Record this value as the protection pickup.
2. Reduce the PT test source 15%. Suddenly increase the signal to 4% over the limiter pickup. Measure the time until HXL times out. HXL_F2 becomes TRUE after the inverse timer expires. Confirm that this timing is consistent with the settings and that the timing is coordinated with the generator voltage/thermal capability (ANSI C37.XX).
3. Reduce the test source to 10% of nominal. Suddenly increase the signal to 10% over the limiter pickup. Measure the time until HXL times out. HXL_F2 becomes TRUE when the inverse timer expires. Confirm that the time obtained is consistent with the settings and is coordinated with the voltage/thermal capability of the generator.
4. If dual setting groups are used, repeat Steps 1 through 3 for Setting Group 1.

Overvoltage Limiter

Check the operation of the overvoltage limiter (OVL). Check all contact outputs, indicator lights, and annunciations associated with the limiter.

1. Increase the PT test source voltage until OVL_F1 picks up. Record this value as the limiter pickup. Increase the test source until OVL_F3 picks up and record this value as the protection pickup.
2. Reduce the PT test source to 10% of nominal. Suddenly increase the test source to 4% over the limiter pickup. Measure the time until OVL times out. Verify that this timing is consistent per the settings and that the timing is coordinated with the generator voltage capability.
3. If dual setting groups are used, repeat Steps 1 and 2 for Setting Group 1.

Minimum Excitation limiter

Check the operation of the minimum excitation limiter (MEL). Check all contact outputs, indicator lights, and annunciations associated with the limiter.

1. Set the PT test source voltage at the rated value, the balance meter at zero, and the CT test source at 0.5 Aac, 0 power factor. Simulate a closed 52 breaker. The MEL output should be negative and equal to MEL_OFF. Increase the CT test source until the MEL picks up and record the value. Increase the test source signal until MEL_F2 picks up and record the value.
2. Reduce the CT test source to 0.5 Aac. Then, increase the signal to 5% above the MEL_F2 pickup and measure the time until the MEL_P timer expires. Record this timing.
3. Shift the phase angle 60 degrees to simulate 26 degrees (0.9 power factor, underexcited). Increase the CT signal until the MEL picks up again and record the value. Typically, this value will be greater than the CT signal at full-load, unity power factor. Verify that this value is coordinated with any loss of field protection.
4. If dual setting groups are used, repeat Steps 1 through 3 for Setting Group 1.

Underexcitation Limiter

Check the operation of the underexcitation limiter (UEL). Check all contact outputs, indicator lights, and annunciations associated with the limiter.

1. Verify that the re-cal inputs are not affecting the outputs. Set the PT test source at the rated value, zero the balance meter, and set the CT test source at 0.5 Aac, 0 power factor, lead). Simulate a closed 52 breaker. The UEL output should be negative and equal to UEL_OFF. Raise the CT test signal until the UEL picks up and record the value. Increase the CT signal again until UEL_F2 picks up. Record this value.
2. Reduce the CT signal to 0.5 Aac. Then, increase the CT signal to 5% above MEL_F2 pickup and measure the time until the UEL_P timer expires. Record this value.
3. Shift the phase angle 60 degrees to simulate 26 degrees (0.9 power factor, underexcited). Increase the CT test source until the UEL picks up again. Record this value. Typically, this value will be greater than the CT signal at full-load, unity power factor. Verify that this value is coordinated with any loss of field protection.
4. If used, check the temperature recalibration.
5. If used check the pressure recalibration.
6. If dual setting groups are used, repeat Steps 1 through 5 for Setting Group 1.

Loss of Sensing and Other Limiter and Protection Settings

1. Check the loss of sensing. Verify operation of all relay outputs, indicator lights, and other annunciations associated with loss of sensing. Remove one fuse to simulate a failed fuse.
2. Check the operation of any other limiter and protective features.
3. Set all limiters and protection elements according to the site requirements. Settings are the responsibility of the end-user.

Monitoring Functions

Test the operation of all protective circuits, using test sources as required.

Generator Ground Detector

Check the operation of the generator ground detector and all associated relay outputs, indicator lights, and annunciators. A typical test procedure is provided as follows. Use BESTCOMS*Pro* to access the FLDGND block.

1. Disconnect pin 5 of the ground detector from the field.

2. Apply 120 Vac, 60 Hz to pins 6 and 7. Remove the resistor connected at pins 10 and 12. Verify that there is not voltage across pins 1 and 2. Verify that output AD00_IN_A is a least +0.01. (This offset voltage must always be positive.) Adjust parameter AD00_OFFSET_3, as needed, to obtain at least +0.01 at output AD00_IN_A.
3. Force the appropriate relay on to apply 120 Vac across pins 8 and 9. Connect a 1 MΩ resistor (RT) at pins 10 and 12. Measure the voltage output across RT (120 Vdc, ±20 Vdc). Confirm that parameter FLDGND)SOURCEVOLTS equals that voltage. Disconnect RT from pins 10 and 11.
4. Connect a 1 kΩ resistor between the –125 V output (pin 5) and ground. Measure the voltage across the resistor. Also measure the voltage across pins 1 and 2. Verify that output AD00_IN_A is the same as the voltage measured across pins 1 and 2 (±0.001). If it is not, set AD00_RTDGAIN_3 to make it match. Check that output FLDGND_GROUNDCURRENT equals the voltage across the 1 kΩ resistor. If it does not adjust FLDGND_ITSCALE to make it match.
5. With the 1 kΩ resistor still connected across pins 4 and 5, FLDGND_RMIN should equal 1 k, ±0.3 k. If it does not, adjust FLDGND_SOURCEOHMS to make it match. Verify that the field ground alarm indications signify that a field ground has occurred.
6. Verify that FLDGND_VFSCALE equals the field voltage that was used to set the transducers.
7. Remove the 1 kΩ resistor from pins 4 and 5. Connect the 1 MΩ resistor (RT) across pins 10 and 12. Verify that FLDGND_RMIN equals 1000 K, ±300 K. Verify that all field ground alarm indications have cleared.

Field Overtemperature Alarms

If used, test the function of the field overtemperature alarms and all associated relay outputs, indicator lights, and annunciators.

1. With the field voltage and current test source set at 1.0 per unit, check that FLDTEMP00_RBASE equals the base load resistance and FLDTEMP00_TBASE equals the field temperature at which the base load resistance was calculated. Check the metering outputs.
2. Reduce the simulated field current to 10% of nominal and check the alarms.

Reconnection to PPT or PMG

At this point, the entire DECS-2100 system has been checked and the system can be reconnected to the machine in preparation for startup. All test voltage and sources should be removed and all system components should be restored to the normal, in-service state. All test jumpers should be removed, all protection functions restored, and all lifted leads re-landed.

Caution
Be sure that all external connections and settings are correct before proceeding.

1. Enable the following circuits:
    a. Minimum excitation limiter
    b. Volts per hertz limiter
    c. Maximum excitation limiter
    d. Instantaneous limiter
    e. Unit trip
2. Before startup of the generator:

a. Check that all limiter and protection settings have been made. (Settings are the responsibility of the end-user.)

b. Verify that the generator circuit breaker (52), device 41A, and flashing contactor 31 (if used) are open.

c. Check that the manual adjuster (MANADJ_PP1) is set to give 70% no-load field current.

d. Verify that auto mode is selected and var or power factor control is disabled.

e. Check that the followers are disabled.

f. Check that all droop or rise compensators are disabled.

g. Close the three-pole, potential switch for the regulator PTs and the CT input switch. If used, close the three-pole potential switch for the metering PTs.

h. Confirm that the connections to the generator field have been reconnected.

i. Confirm that the connections to the PPT or PMG have been reconnected.

j. Confirm that the space heaters have been reconnected.

k. Verify that the field ground detector connections have been reestablished.

l. Verify that all unit trip circuit connections have been made.

m. Check that all connections between the shunt and transducer have been remade.

3. Using BESTCOMS*Pro,* establish an event recorder block to measure terminal voltage, firing commands, field current, 41A close commands, 41A status, and 41A trip commands (both instantaneous and time delayed) when the breaker is closed the first time. Set an event to be triggered by the 41A close command. If field flashing is used, the 31 close command should also be recorded. Other inputs may be recorded as desired.

4. Verify that the correct phase sequence exists at both the input terminals of device 41A and the regulator input panel terminals. On shunt-powered systems, this can be done using an oscilloscope looking at the residual generator voltage.

5. If a PMG is used, before closing the 41A device, verify that the magnitude of the PMG voltage complies with the value listed on the system drawings.

Offline Excitation Control

1. With the generator operating at rated speed, close device 41A. Review the event to verify correct operation of the equipment during the start.

Caution
Verify immediately that the generator field current corresponds to the value set by PP#1 in the MANADJ block if the unit remains in manual mode. If the unit is in auto mode, verify that the generator terminal voltage corresponds to the value set by PP#1 in the AUTOADJ block. Trip device 41A if the terminal voltage is excessive or if the field current measured is radically higher than the machine field data specifications.

Note
If the manual adjuster is set too low, the unit will not transfer into auto mode. Raise the manual adjuster to enable a transfer into auto mode.

2. If the unit is operating in manual mode, use the manual adjuster to make the terminal voltage equal to 1.0 per unit. (If the field current instantaneous limiter prevents raising voltage, increase the offline trip setting first and then the offline limiter setting.) Enable the adjusters and verify that the balance meter indicates nearly zero. Transfer the unit to auto mode. The terminal voltage bump should be small.

Caution

Do not exceed the machine voltage rating during any of these tests. Exceeding the **voltage ratings may result in personal injury and equipment damage**.

3. If the unit is operating in auto mode, use the auto adjuster to make the terminal voltage equal to 1.0 per unit. (If the field current instantaneous limiter prevents raising voltage, increase the offline trip setting first and then the offline limiter setting.) Enable the adjuster followers and verify that the balance meter indicates nearly zero. Transfer the unit to manual mode, and then back to auto mode. The bump in terminal voltage should be small.
4. If the output field temperature monitor is being used, check that FLDTEMP00_FIELDTEMP equals the temperature of the cold rotor field. (This should be checked before the field has had a chance to warm up.) If the values do not match, adjust FLDTEMP00_TBASE.
5. Holding the machine at rated speed and rated, no-load terminal voltage, check the three-phase voltage present at regulator input panel terminals 7-8-9. This voltage should be approximately 120 V_{L-L} and have a phase sequence of 7-8-9. The metered value should agree with the regulator Pt ratio on the system drawings. If the values disagree, determine the cause before proceeding.
6. Verify that the output of the terminal voltage transducers reads 1.00. (Check both channels for a dual-channel system.) If the output is incorrect, adjust the scale factors in the SIGIN block of each channel.
7. Verify that SLCT3_V8 reads between 1.0 and 1.15. (A precise value for V8 should be based on the generator saturation curve and be equal to the actual field current at no load divided by the air gap field current at rated voltage (read from the saturation curve).) Adjust SLCT3_KFC to correct the SLCT3_V8 reading as needed. For a dual-channel system, change SLCT3_KFC in the redundant channel to the adjusted value.
8. Confirm operation of the manual regulator (unit is in auto mode) in both the raise and lower directions. This is accomplished by moving the manual voltage adjuster to cause the regulator balance meter to indicate one side of zero and then the other side of zero. This action by the voltage adjuster should not affect the machine terminal voltage.
9. Move the voltage adjuster in the lower direction. This action should reduce the machine terminal voltage. The balance meter should return to near zero. Move the voltage adjuster in the raise direction, causing the machine terminal voltage to return to normal. Adjust ACADJ_SLEW as needed for smooth voltage control.
10. Transfer the unit to manual mode and move the manual adjuster in the lower direction. This action should reduce the machine terminal voltage. The balance meter should return to near zero. Move the voltage adjuster in the raise direction, causing the machine terminal voltage to return to normal. Adjust MANADJ_SLEW as needed for smooth voltage control.
11. Return the unit to auto mode.
12. For a dual-channel system, verify the tracker and that “transfer possible” is enabled. Verify that the tracker value is close to 0, ±0.1. Transfer control to the redundant channel and repeat steps 8 through 11.

    If desired, the unit can be switched to the redundant channel with the 41A device open. The generator field can be flashed again and the steps in this chapter repeated.

Offline Stability and Damping

Note
The offline instantaneous limiter must be set high enough so as not to impact the bump test. Positive voltage bumps with a rotating exciter can cause the limiter to effectively reduce the generator ceiling voltage and make the response look like that of an over- or critically-damped regulator. See Figure 7-2.

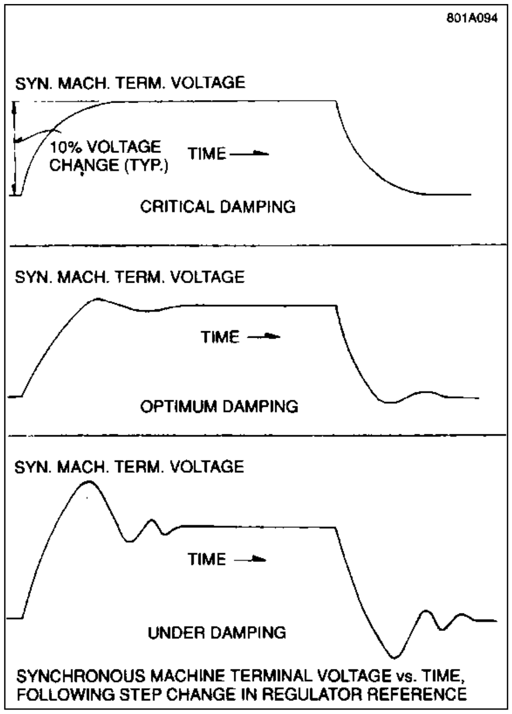


Figure 7-2. Generator Output Responses

Stability and damping adjustments of the system are usually made with the synchronous machine offline (except for synchronous condensers that must be connected to the system to operate). If settings have been determined by stability studies, those values should be set before performing bump testing.

Caution
Exercise care when performing these tests to avoid subjecting the machine to terminal voltages that exceed its rating.

1. Using BESTCOMS*Pro* set up an event recorder to measure the bump input signal (EXC_SIG output of the SSE block), terminal voltage, field voltage, firing command, and field current during the offline bump tests. Configure the event to trigger on application of the bump signal. Configure the duration of the event recorder to capture both the application and removal of the bump input signal. Other inputs may be recorded as desired.
2. With the generator operating at rated speed and offline, adjust the terminal voltage to rated value by means of the auto adjuster.

3. Using the Time Response window of BESTCOMS*Pro* configure a test signal type of “Step” with a magnitude of -0.010, and step duration of 10 seconds. Configure the test signal injection location to “Auto Error”. Initiate a voltage bump test by pressing “Start”. Gradually increase voltage bumps to 5% changes first in the lower direction (negative magnitude) and then in the raise direction (positive magnitude) for various damping adjustments. By observing the response action on the data record, optimum damping adjustments can be made. See Figure 7-2 for suggested optimum response conditions. Exercise care so that the unit is not under damped when offline. This can cause oscillations when the unit is operating online.

Machine PT and CT Signal Polarity and Phase Angle

1. Use BESTCOMS*Pro* to configure an event recorder block to measure the regulator PT inputs, CT inputs, and terminal voltage. If metering PTs are used, they should also be recorded. Synchronize the machine with the power grid. Load the machine to approximately 10% rated MW load (or higher if required by turbine conditions).
2. With the generator connected to the power system (breaker 52 closed) and the machine operating at unity power factor, check the phase angle between the current and voltage. At unity power factor, the B-phase line current should lag the A-B line voltage by approximately 150 degrees. If needed, adjust POWERTRN00_PHASE (for all channels) to make POWERTRN00_MVAR read 0.00 at unity power factor. This compensates for phase shifts between the regulator PTs and CTs from the ideal 150 degree phase shift.
3. Enable all reactive compensation functions. Verify the required settings with the end-user. For satisfactory parallel operation, there should be a 4 to 6% reactance between the machine terminals and the system. This reactance can be in the generator step-up transformer (GSU) or the regulator can be biased by the droop compensator. In this case, a setting of 4 to 6% reactive droop will achieve the desired result.
4. Using auto control, raise the level of excitation slightly. That is, set the generator to supply vars to the system. For droop compensation, verify that the adjuster reference moves slightly more than the terminal voltage increase. Verify that for rise compensation, the adjuster reference moves slightly less than the terminal voltage increase.
5. After verifying that the regulator balance meter is near zero, transfer from auto to manual control mode. Carefully operate the manual adjuster slightly in the lower and raise directions. Observe that the machine reactive loading decreases in response to lowering the adjuster and increases in response to raising the manual adjuster. Transfer the system back to automatic control.
6. For a dual-channel system, verify that tracker is reading close to zero and then transfer from the main channel to the redundant channel. The oscillations in voltage should be very small. Repeat step 5. Transfer control of the system back to the main channel.
7. If desired, a bump test can be performed at this time. When performing an online bump, care should be taken to avoid excessive var swings. Use the adjuster to determine how much voltage change corresponds to a 10% var change. Typically, the magnitude of the bump should cause no more than a 10% var change. Check with the end-user to determine a desired or expected value. An event recording for an online bump should include terminal voltage, firing command, field current, and machine Mvar and MW.
8. If possible, increase the machine load to rated MW and power factor. Field current transducer scaling should be checked at full load. At full load, the field current transducer should read 1.00. Note that if the field current transducer scaling is changed, the offline settings must also be adjusted.

Var/Power Factor Control

Caution

If any raise or lower operations cause system disturbances, quickly transfer control from auto to manual mode.

Verify that the var controller error is near zero. Place the system in var mode. Raise and lower the var level using the var controls. Adjust VRC_SLEW (VARCONTR block) or PFC_SLEW (PFCONTR block) as needed for smooth control.

Power System Stabilizer

Configuration and testing of the PSS should be performed only by a person experienced in power system stabilizer operation.

Limiters

If a PSS is used, the PSS should be tuned and in service while doing any limiter tests. As required, each limiter should be tested to take control of the excitation system online. An offset may be put into the limiter setpoint to recalibrate the pickup to occur in a safe region of operation.

Final Check of System Operation

Upon completion of all testing, final checks of system operation should be made with the machine connected to the system. A final check of the ground detector should also be made.

Module Setup Summary

Table 7-2 and Table 7-3 are provided as aids in configuring the ECM-2 and isolation transducers.

Table 7-2. Summary of PPT or PMG Transducer Setup

INPUT CONNECTION	INPUT VALUE	BLOCK	SET INPUT PARAMETER	TO MAKE OUTPUT READ
J19 to J20	ZERO (Short)	FLDSCALE	PPT_OFFSETA	PPT_PTA = 0±2 counts
	DC Voltage equal to PPT Secondary Peak (√2 * rms)		PPT_SCALEA	PPT_PTA = 1.000±.0009
J21 to J22	ZERO (Short)	FLDSCALE	PPT_OFFSETB	PPT_PTB=0±2 counts
	DC Voltage equal to PPT Secondary Peak (√2 * rms)		PPT_SCALEB	PPT_PTB = 1.000±.0009

Table 7-3. Summary of Field Current and Voltage Transducer Setup

INPUT CONNECTION	INPUT VALUE	BLOCK (in ECM)	SET INPUT PARAMETER	TO MAKE OUTPUT READ
J21 to J22	ZERO (Short)	FLDSCALE	VG_OFFSET	GEN_FLD_VLT = 0±2 counts
	DC Volts = 100% of GENERATOR RATED FULL LOAD at 75 DEG. C		VG_SCALE	GEN_FLD_VLT = 1.000±.0009
J19 to J20	ZERO (Short)	FLDSCALE	IG_OFFSET	GEN_FLD_CUR = 0±2 counts
	DC mV = 100% of GENERATOR RATED FULL LOAD		IG_SCALE	GEN_FLD_CUR = 1.000±.0009
J21 to J22	ZERO (Short)	FLDSCALE	VE_OFFSET	EXC_FLD_VLT = 0±2 counts
	DC Volts = 100% of EXCITER RATED FULL LOAD at 75 DEG. C		VE_SCALE	EXC_FLD_VLT = 1.000±.0009
J19 to J20	ZERO (Short)	FLDSCALE	IE_OFFSET	EXC_FLD_CUR = 0±2 counts
	DC mV = 100% of EXCITER RATED FULL LOAD		IE_SCALE	EXC_FLD_CUR = 1.000±.0009

Auto Tuning

Caution

PID values calculated by the Auto Tuning function are to be implemented only after their suitability for the application has been verified by the user. Incorrect PID numbers can result in poor system performance or equipment damage.

During commissioning, excitation system parameters are not known. These unknown variables traditionally cause the commissioning process to consume a large amount of time and fuel. With the development of auto tuning the excitation system parameters are automatically identified and the PID gains are calculated using well-developed algorithms. Automatically tuning the PID controller greatly reduces commissioning time and cost. The auto tuning function is accessed by clicking the *Auto Tune* option under *View Explorer, Commissioning*. BESTCOMS*Pro* must be connected to an ECM-2 in order to begin the auto tuning process. The auto tune window provides options for choosing Design Method for PID, Exciter Type, and Power Input Type. When the desired settings are selected, the *Start* button is clicked to start the process. See Figure 7-3.

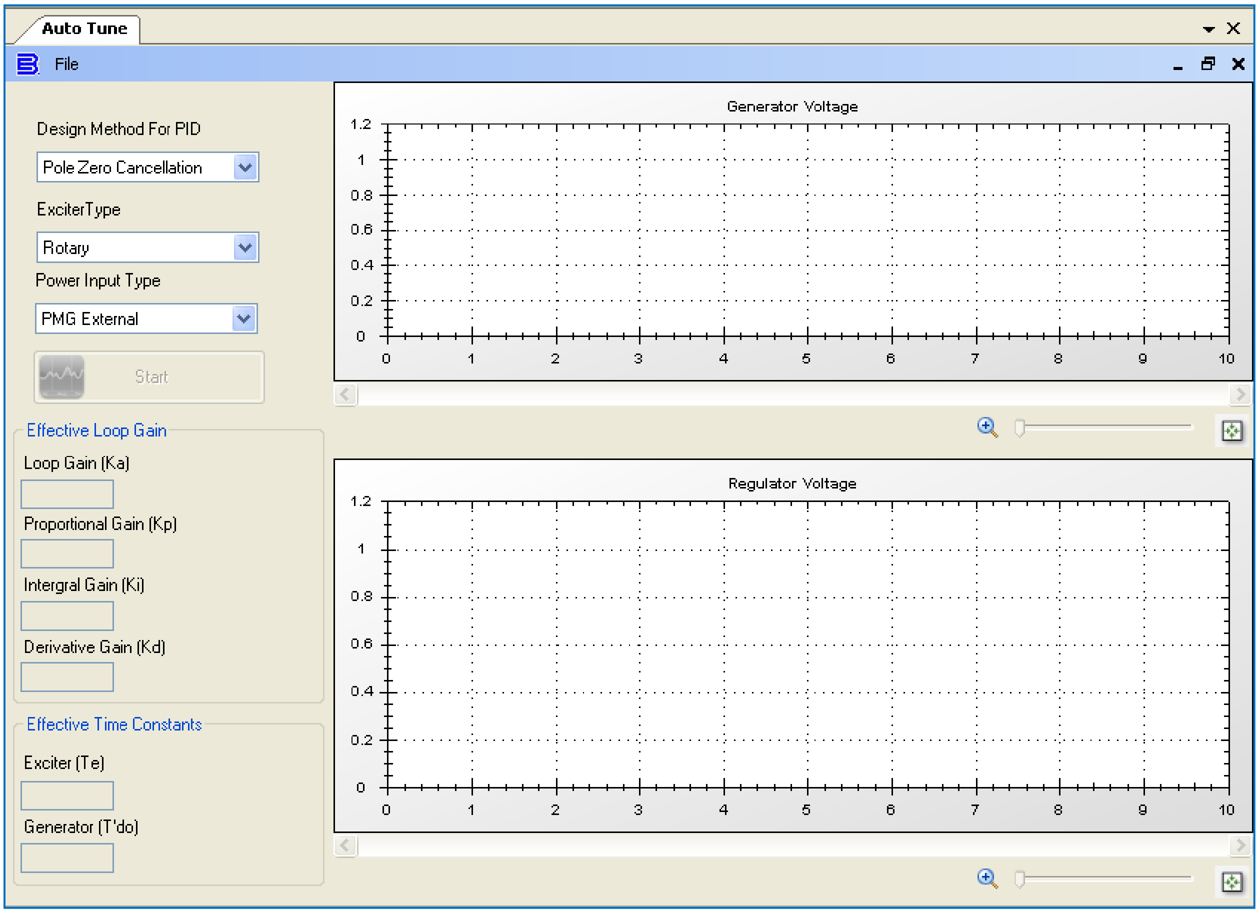


Figure 7-3. Auto Tune Window

Design Method for PID: Set to either Pole Zero Cancellation or Pole Placement.
Exciter Type: Set to either Rotary or Static.
Power Input Type: Set to either PMG External or Shunt.
Start: Begins the auto tuning process.

The *File* menu contains the following selections:

Options: The options window is displayed.
Stop Test: The current test is stopped.
Run Loop Gain: Runs loop gain.
Run Step Only: Runs step only.
Synch Graph Scrolling: When the checkbox is checked, the graphs are all set to the same position on the X-axis and they scroll simultaneously when one of the graphs is scrolled.

The options window contains the following four tabs, illustrated in Figure 7-4, Figure 7-6, Figure 7-5, and Figure 7-7:

Steady State: Set the delay, time, threshold, bias, and PP.
Steady State Controller: Set Kp, Ki, and K1.
Step: Set the step magnitude, time, and Kp.
Misc.: Set the sample rate.

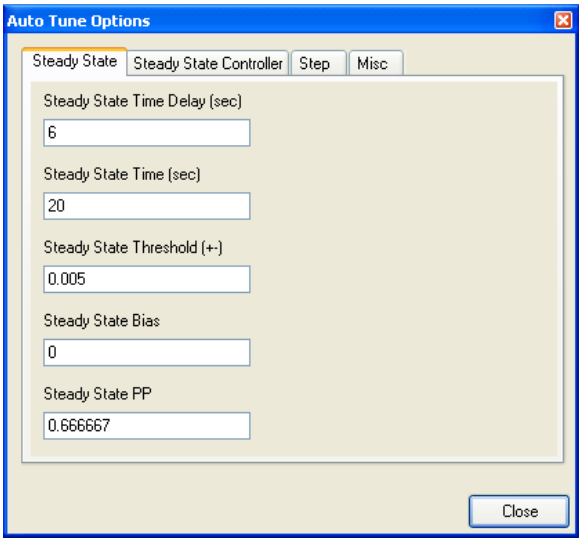


Figure 7-4. Steady State Tab

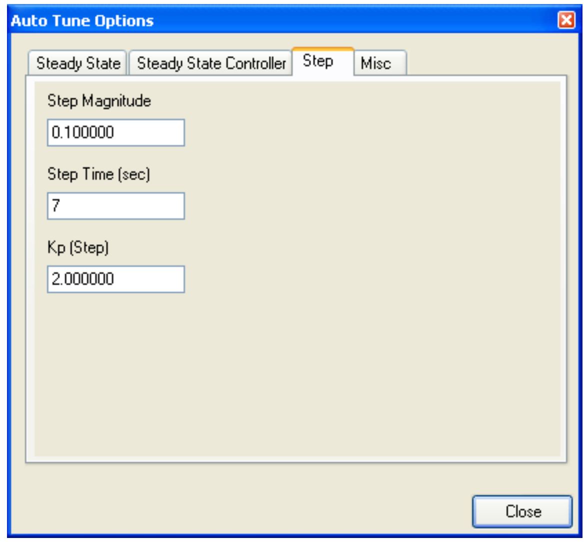


Figure 7-5. Step Tab

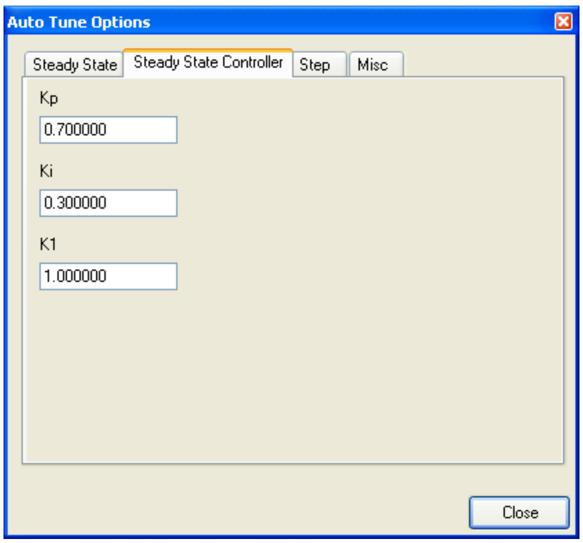


Figure 7-6. Steady State Controller Tab

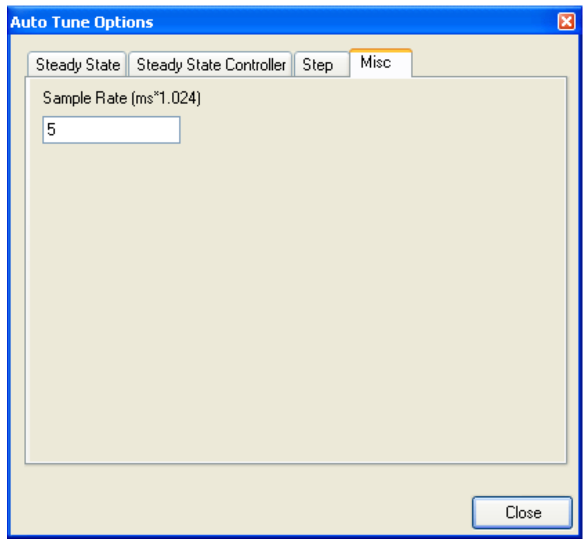


Figure 7-7. Misc Tab

Right-clicking on the graph areas displays the following options. See Figure 7-9.

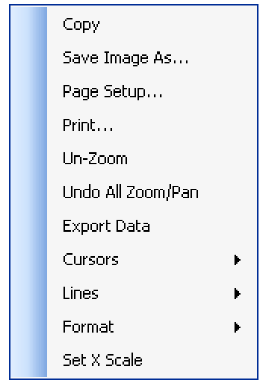


Figure 7-8. Right-Click Menu

Copy: Copy the image of the graph to the clipboard.
Save Image As: Save the image of the graph as a .emf, .png, .gif, .jpg, .tif, .bmp.
Page Setup: Set up the printing options.
Print: Print the graph.
Un-Zoom: Reset the zoom.
Undo All Zoom/Pan: Reset the zoom and pan position to the original state.
Export Data: Export the graph data as a .txt file.
Cursors: Contains options for Goto Cursor X and Move Cursor X into View.
Lines: Display Data Points, Show Point Values, Interpolated, Smooth, Step.
Format: Toggle Background Color, Show Grid Lines, X Axis Autofit.
Set X Scale: Scaling Options, Manual or Automatic, Minimum, Maximum.

Rolling the mouse wheel up or down when the cursor is hovering over the graph area causes the view to zoom in or out.

Auto Tune Screen Functions

The Auto Tune screen functions are described below.

- Parameters are selected for Design Method for PID, Exciter Type, and Power Input Type.
- With the generator running and offline (no load, not tied to grid), the Start button is clicked to start auto tune. Generator voltage drops and a softstart begins.
- A step response is performed after softstart completes and the voltage is stable to within the THRESH input parameter.
- The PID value is calculated after the step response is complete.
- The number of iterations during calculation is displayed above the graph window. (Maximum iteration count = 100).
- Calculated gain and time constant parameters are displayed which must be applied appropriately to the system.

AUTOTUNE Logic Inputs/Outputs

Table 7-4 describes the AUTOTUNE logic inputs and outputs.

Table 7-4. AUTOTUNE Logic Inputs and Outputs

Input Name	Description
REG_FIR_CMD	Regulator normal firing command.
GEN_VOLTS	Generator voltage input.
ENABLE	Permissive enable logic input.
CONFIG	Config word Set bit 0 to “1” when shunt excited
MODE	Autotune mode. Set automatically by BESTCOMS*Pro* during the auto tuning process. 0 – Disabled 1 – PI Control 2 – P Control 3 – Step response
SSTIME	Soft Start Time
SSBIAS	Soft Start Bias

Input Name	Description
PP	Soft Start Preposition. Set automatically by BESTCOMS*Pro* during the auto tuning process.
THRESH	Steady State Threshold
TD	Steady State Time Delay
STEP_KP	Proportional gain for step response. Set automatically by BESTCOMS*Pro* during the auto tuning process.
STEP_MAG	Step input magnitude for step response
STEP_TIME	Step input time for step response
KI	Integral gain for PI control
KP	Proportional gain for PI control
K1	FIRING_CMD output gain. Set by BESTCOMS*Pro* to the calculated system loop gain when AUTOTUNE_MODE is 2 or 3.
RATE	Buffering rate limit. Used by BESTCOMS*Pro* to control rate at which data samples are collected and plotted during auto tuning process. Set automatically by BESTCOMS*Pro* during the auto tuning process.
MIN_FIR_CMD	Minimum firing command output during the auto tuning process
Output Name	**Description**
STATUS	Bit 0 is set to “1” when the PI controller reaches steady state.
ACTIVE	TRUE when AUTOTUNE block is not inhibited by ENABLE input and BESTCOMS*Pro* starts the auto tuning process
FIRING_CMD	Output signal of active controller

8 • Modbus™ Communication

Caution
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Controller #1 Modbus® Coil Map

Table 8-1 through Table 8-4 list the Modbus Coil Map for Controller #1. The same coil map is used for Controllers #3 and #5 (when present).

Table 8-1. Local HMI Inputs (Controller #1 Modbus Coil Map)

Coil	Variable	Description
001	PMIN_COIL01	State written to Modbus coil address 001
002	PMIN_COIL02	State written to Modbus coil address 002
003	PMIN_COIL03	State written to Modbus coil address 003
004	PMIN_COIL04	State written to Modbus coil address 004
005	PMIN_COIL05	State written to Modbus coil address 005
006	PMIN_COIL06	State written to Modbus coil address 006
007	PMIN_COIL07	State written to Modbus coil address 007
008	PMIN_COIL08	State written to Modbus coil address 008
009	PMIN_COIL09	State written to Modbus coil address 009
010	PMIN_COIL10	State written to Modbus coil address 010
011	PMIN_COIL11	State written to Modbus coil address 011
012	PMIN_COIL12	State written to Modbus coil address 012
013	PMIN_COIL13	State written to Modbus coil address 013
014	PMIN_COIL14	State written to Modbus coil address 014
015	PMIN_COIL15	State written to Modbus coil address 015
016	PMIN_COIL16	State written to Modbus coil address 016
017	PMIN_COIL17	State written to Modbus coil address 017
018	PMIN_COIL18	State written to Modbus coil address 018
019	PMIN_COIL19	State written to Modbus coil address 019
020	PMIN_COIL20	State written to Modbus coil address 020
021	PMIN_COIL21	State written to Modbus coil address 021
022	PMIN_COIL22	State written to Modbus coil address 022
023	PMIN_COIL23	State written to Modbus coil address 023
024	PMIN_COIL24	State written to Modbus coil address 024

Coil	Variable	Description
025	PMIN_COIL25	State written to Modbus coil address 025
026	PMIN_COIL26	State written to Modbus coil address 026
027	PMIN_COIL27	State written to Modbus coil address 027
028	PMIN_COIL28	State written to Modbus coil address 028
029	PMIN_COIL29	State written to Modbus coil address 029
030	PMIN_COIL30	State written to Modbus coil address 030
031	PMIN_COIL31	State written to Modbus coil address 031
032	PMIN_COIL32	State written to Modbus coil address 032
033	PMIN_COIL33	State written to Modbus coil address 033
034	PMIN_COIL34	State written to Modbus coil address 034
035	PMIN_COIL35	State written to Modbus coil address 035
036	PMIN_COIL36	State written to Modbus coil address 036
037	PMIN_COIL37	State written to Modbus coil address 037
038	PMIN_COIL38	State written to Modbus coil address 048
039	PMIN_COIL39	State written to Modbus coil address 039
040	PMIN_COIL40	State written to Modbus coil address 040
041	PMIN_COIL41	State written to Modbus coil address 041
042	PMIN_COIL42	State written to Modbus coil address 042
043	PMIN_COIL43	State written to Modbus coil address 043
044	PMIN_COIL44	State written to Modbus coil address 044
045	PMIN_COIL45	State written to Modbus coil address 045
046	PMIN_COIL46	State written to Modbus coil address 046
047	PMIN_COIL47	State written to Modbus coil address 047
048	PMIN_COIL48	State written to Modbus coil address 048

Table 8-2. Remote HMI Inputs (Controller #1 Modbus Coil Map)

Coil	Variable	Description
049	PMIN_COIL49	State written to Modbus coil address 049
050	PMIN_COIL50	State written to Modbus coil address 050
051	PMIN_COIL51	State written to Modbus coil address 051
052	PMIN_COIL52	State written to Modbus coil address 052
053	PMIN_COIL53	State written to Modbus coil address 053
054	PMIN_COIL54	State written to Modbus coil address 054
055	PMIN_COIL55	State written to Modbus coil address 055
056	PMIN_COIL56	State written to Modbus coil address 056
057	PMIN_COIL57	State written to Modbus coil address 057
058	PMIN_COIL58	State written to Modbus coil address 058
059	PMIN_COIL59	State written to Modbus coil address 059
060	PMIN_COIL60	State written to Modbus coil address 060
061	PMIN_COIL61	State written to Modbus coil address 061
062	PMIN_COIL62	State written to Modbus coil address 062
063	PMIN_COIL63	State written to Modbus coil address 063
064	PMIN_COIL64	State written to Modbus coil address 064

Table 8-3. Digital Outputs (Controller #1 Modbus Coil Map)

Coil	Variable	Description
097	PMOUT_PCOIL97	State available to Modbus coil address 097
098	PMOUT_PCOIL98	State available to Modbus coil address 098
099	PMOUT_PCOIL99	State available to Modbus coil address 099
100	PMOUT_PCOIL100	State available to Modbus coil address 100
101	PMOUT_PCOIL101	State available to Modbus coil address 101
102	PMOUT_PCOIL102	State available to Modbus coil address 102
103	PMOUT_PCOIL103	State available to Modbus coil address 103
104	PMOUT_PCOIL104	State available to Modbus coil address 104
105	PMOUT_PCOIL105	State available to Modbus coil address 105
106	PMOUT_PCOIL106	State available to Modbus coil address 106
107	PMOUT_PCOIL107	State available to Modbus coil address 107
108	PMOUT_PCOIL108	State available to Modbus coil address 108
109	PMOUT_PCOIL109	State available to Modbus coil address 109
110	PMOUT_PCOIL110	State available to Modbus coil address 110
111	PMOUT_PCOIL111	State available to Modbus coil address 111
112	PMOUT_PCOIL112	State available to Modbus coil address 112
113	PMOUT_PCOIL113	State available to Modbus coil address 113
114	PMOUT_PCOIL114	State available to Modbus coil address 114
115	PMOUT_PCOIL115	State available to Modbus coil address 115
116	PMOUT_PCOIL116	State available to Modbus coil address 116
117	PMOUT_PCOIL117	State available to Modbus coil address 117
118	PMOUT_PCOIL118	State available to Modbus coil address 118
119	PMOUT_PCOIL119	State available to Modbus coil address 119
120	PMOUT_PCOIL120	State available to Modbus coil address 120
121	PMOUT_PCOIL121	State available to Modbus coil address 121
122	PMOUT_PCOIL122	State available to Modbus coil address 122
123	PMOUT_PCOIL123	State available to Modbus coil address 123
124	PMOUT_PCOIL124	State available to Modbus coil address 124
125	PMOUT_PCOIL125	State available to Modbus coil address 125
126	PMOUT_PCOIL126	State available to Modbus coil address 126
127	PMOUT_PCOIL127	State available to Modbus coil address 127
128	PMOUT_PCOIL128	State available to Modbus coil address 128
129	PMOUT_PCOIL129	State available to Modbus coil address 129
130	PMOUT_PCOIL130	State available to Modbus coil address 100
131	PMOUT_PCOIL131	State available to Modbus coil address 131
132	PMOUT_PCOIL132	State available to Modbus coil address 132
133	PMOUT_PCOIL133	State available to Modbus coil address 133
134	PMOUT_PCOIL134	State available to Modbus coil address 134
135	PMOUT_PCOIL135	State available to Modbus coil address 135
136	PMOUT_PCOIL136	State available to Modbus coil address 136
137	PMOUT_PCOIL137	State available to Modbus coil address 137
138	PMOUT_PCOIL138	State available to Modbus coil address 138

Coil	Variable	Description
139	PMOUT_PCOIL139	State available to Modbus coil address 139
140	PMOUT_PCOIL140	State available to Modbus coil address 140
141	PMOUT_PCOIL141	State available to Modbus coil address 141
142	PMOUT_PCOIL142	State available to Modbus coil address 142
143	PMOUT_PCOIL143	State available to Modbus coil address 143
144	PMOUT_PCOIL144	State available to Modbus coil address 144
145	PMOUT_PCOIL145	State available to Modbus coil address 145
146	PMOUT_PCOIL146	State available to Modbus coil address 146
147	PMOUT_PCOIL147	State available to Modbus coil address 147
148	PMOUT_PCOIL148	State available to Modbus coil address 148
149	PMOUT_PCOIL149	State available to Modbus coil address 149
150	PMOUT_PCOIL150	State available to Modbus coil address 150
151	PMOUT_PCOIL151	State available to Modbus coil address 151
152	PMOUT_PCOIL152	State available to Modbus coil address 152
153	PMOUT_PCOIL153	State available to Modbus coil address 153
154	PMOUT_PCOIL154	State available to Modbus coil address 154
155	PMOUT_PCOIL155	State available to Modbus coil address 155
156	PMOUT_PCOIL156	State available to Modbus coil address 156
157	PMOUT_PCOIL157	State available to Modbus coil address 157
158	PMOUT_PCOIL158	State available to Modbus coil address 158
159	PMOUT_PCOIL159	State available to Modbus coil address 159
160	PMOUT_PCOIL160	State available to Modbus coil address 160

Table 8-4. Status Blocks (Controller #1 Modbus Coil Map)

Coil	Variable	Description
161	STATSYS_41A_CLOSED	41A excitation breaker closed when TRUE
162	STATSYS_52G_CLOSED	52G generator breaker closed when TRUE
163	STATSYS_AUTO	Exciter in AUTO control mode when TRUE
164	STATSYS_MANUAL	Exciter in MANUAL control mode when TRUE
165	STATSYS_REMOTE	Exciter in REMOTE control when TRUE
166	STATSYS_CHN_CNTL	TRUE when this control channel is in control
167	STATSYS_PSS_EN	PSS is enabled when TRUE
168	STATSYS_PSS_CNTL	PSS is active when TRUE
169	STATSYS_VM_EN	Voltage matching feature in enabled when TRUE
170	STATSYS_VM_CMPLT	Voltage matching is complete when TRUE
171	STATSYS_SYNC_EN	Automatic synchronizer is enabled when TRUE
172	STATSYS_SYNC_ACT	Automatic synchronizer is active when TRUE
173	STATSYS_SYNC_VOLT_MATCH	Automatic synchronizer has matched voltage within threshold when TRUE
174	STATSYS_SYNC_FREQ_MATCH	Automatic synchronizer has matched frequency within threshold when TRUE
175	STATSYS_VAR_EN	VAR controller (or regulator) is enabled when TRUE
176	STATSYS_VAR_CNTL	VAR controller (or regulator) is active when TRUE
177	STATSYS_PF_EN	PF controller (or regulator) is enabled when TRUE

Coil	Variable	Description
178	STATSYS_PF_CNTL	VAR controller (or regulator) is active when TRUE
179	STATSYS_SIM_ON	Simulation mode is active when TRUE
180	STATSYS_USB_RDY	USB port is ready when TRUE
181	STATSYS_USB_DONE	USB port activity is complete when TRUE
182	STATSYS_USB_DISCON	USB flash drive safe to remove when TRUE
183	Spare1	
184	Spare2	
185	Spare3	
186	Spare4	
187	Spare5	
188	Spare6	
189	Spare7	
190	Spare8	
191	Spare9	
192	Spare10	
193	STATLIM_OELG_PU	Generator field OEL picked-up/timing
194	STATLIM_OELG_TIMOUT	Generator field OEL timed out
195	STATLIM_OELG_CNTL	Generator field OEL in control
196	STATLIM_OELE_PU	Exciter field OEL picked-up/timing
197	STATLIM_OELE_TIMOUT	Exciter field OEL timed out
198	STATLIM_OELE_CNTL	Exciter field OEL in control
199	STATLIM_INST_PU	INST limiter picked-up/timing
200	STATLIM_INST_TIMOUT	INST limiter timed-out
201	STATLIM_INST_CNTL	INST limiter in control
202	STATLIM_MFEL_PU	MFEL picked-up/timing
203	STATLIM_MFEL_TIMOUT	MFEL timed out
204	STATLIM_MFEL_CNTL	MFEL in control
205	STATLIM_OVL_PU	OVL picked-up/timing
206	STATLIM_OVL_TIMOUT	OVL timed out
207	STATLIM_OVL_CNTL	OVL in control
208	STATLIM_UVL_PU	UVL picked-up/timing
209	STATLIM_UVL_TIMOUT	UVL timed out
210	STATLIM_UVL_CNTL	UVL in control
211	STATLIM_HXL_PU	HXL picked-up/timing
212	STATLIM_HXL_TIMOUT	HXL timed out
213	STATLIM_HXL_CNTL	HXL in control
214	STATLIM_VRL_PU	VRL picked-up/timing
215	STATLIM_VRL_TIMOUT	VRL timed out
216	STATLIM_VRL_CNTL	VRL in control
217	STATLIM_MEL_PU	MEL picked-up/timing
218	STATLIM_MEL_TIMOUT	MEL timed out
219	STATLIM_MEL_CNTL	MEL in control

Coil	Variable	Description
220	STATLIM_UEL_PU	UEL picked-up/timing
221	STATLIM_UEL_TIMOUT	UEL timed out
222	STATLIM_UEL_CNTL	UEL in control
223	STATLIM_GCL_PU	GCL picked-up/timing
224	STATLIM_GCL_TIMOUT	GCL timed out
225	STATLIM_GCL_CNTL	GCL in control
226	STATLIM_RECAL_CLIP	Limiter recalibration input(s) clipped
227	Spare1	
228	Spare2	
229	Spare3	
230	Spare4	
231	Spare5	
232	Spare6	
233	Spare7	
234	Spare8	
235	Spare9	
236	Spare10	
237	Spare11	
238	Spare12	
239	Spare13	
240	Spare14	
241	STATXFER_OELG_RED	Generator field OEL transfer to redundant
242	STATXFER_OELG_MAN	Generator field OEL transfer to manual
243	STATXFER_OELE_RED	Exciter field OEL transfer to redundant
244	STATXFER_OELE_MAN	Exciter field OEL transfer to manual
245	STATXFER_INST_RED	INST limiter transfer to redundant
246	STATXFER_INST_MAN	INST limiter transfer to manual
247	STATXFER_MFEL_RED	MFEL transfer to redundant
248	STATXFER_MFEL_MAN	MFEL transfer to manual
249	STATXFER_OVL_RED	OVL transfer to redundant
250	STATXFER_OVL_MAN	OVL transfer to manual
251	STATXFER_UVL_RED	UVL transfer to redundant
252	STATXFER_UVL_MAN	UVL transfer to manual
253	STATXFER_HXL_RED	HXL transfer to redundant
254	STATXFER_HXL_MAN	HXL transfer to manual
255	STATXFER_VRL_RED	VRL transfer to redundant
256	STATXFER_VRL_MAN	VRL transfer to manual
257	STATXFER_MEL_RED	MEL transfer to redundant
258	STATXFER_MEL_MAN	MEL transfer to manual
259	STATXFER_UEL_RED	UEL transfer to redundant
260	STATXFER_UEL_MAN	UEL transfer to manual
261	STATXFER_GCL_RED	GCL transfer to redundant

Coil	Variable	Description
262	STATXFER_GCL_MAN	GCL transfer to manual
263	STATXFER_LOS_RED	Loss of sensing transfer to redundant
264	STATXFER_LOS_MAN	Loss of sensing transfer to manual
265	STATXFER_XFERDISABLE	Transfer to redundant disabled
266	STATXFER_HMIXFERDIS	Transfer to redundant via HMI disabled
267	STATXFER_REDNOTRDY	Channel not ready for transfer (not ready to accept control)
268	Spare1	
269	Spare2	
270	Spare3	
271	Spare4	
272	Spare5	
273	STATALRM_41A_FLCLS	41A failed to close alarm
274	STATALRM_41A_FLOPN	41A failed to open alarm
275	STATALRM_FLD_FLSH	Failed to field flash alarm
276	STATALRM_LOS	Loss of voltage sensing alarm
277	STATALRM_REGPTFL	Loss of regulator PT
278	STATALRM_METPTFL	Loss of metering PT
279	STATALRM_VOLT_UNBAL	Phase unbalance voltage
280	STATALRM_CUR_UNBAL	Phase unbalance of current
281	STATALRM_PSSCLP	PSS output clipped at either minimum and maximum limit alarm
282	STATALRM_PSAC	Loss of AC powered power supply
283	STATALRM_PSDC	Loss of DC powered power supply
284	STATALRM_MNFLDGND	Main field, field to ground alarm
285	STATALRM_EXFLDGND	Exciter field, field to ground alarm
286	STATALRM_PPT_TEMP	PPT low-level over-temperature alarm
287	STATLARM_PPT_HITEMP	PPT high-level over-temperature alarm
288	STATALRM_BRDGALM	Bridge alarm (any)
289	STATALRM_BRDGTEMP	Bridge over-temperature alarm
290	STATALRM_LBF	Loss of both bridge cooling fans
291	STATALRM_USER1	User defined alarm status bit
292	STATARLM_USER2	User defined alarm status bit
293	STATARLM_USER3	User defined alarm status bit
294	Spare1	
295	Spare2	
296	Spare3	
297	Spare4	
298	Spare5	
299	Spare6	
300	Spare7	
301	Spare8	
302	Spare9	

Coil	Variable	Description
303	Spare10	
304	Spare11	
305	STATTRIP_OELG	Generator field OEL tripped
306	STATTRIP_OELE	Exciter field OEL tripped
307	STATTRIP_INST	INST limiter tripped
308	STATTRIP_MFEL	MFEL tripped
309	STATTRIP_OVL	OVL tripped
310	STATTRIP_UVL	UVL tripped
311	STATTRIP_HXL	HXL tripped
312	STATTRIP_VRL	VRL tripped
313	STATTRIP_MEL	MEL tripped
314	STATTRIP_UEL	UEL tripped
315	STATTRIP_GCL	GCL tripped
316	STATTRIP_FLDCUR_XDCR	Loss of field current transducer while in manual trip
317	STATTRIP_DX	De-excitation module operated on fault trip
318	STATTRIP_CB	Crowbar module operated trip
319	STATTRIP_OTEMP	PPT over-temperature trip
320	STATTRIP_ESTOP	Emergency stop (86) trip
321	STATTRIP_USER1	User defined trip
322	STATTRIP_USER2	User defined trip
323	STATTRIP_USER3	User defined trip
324	Spare1	
325	Spare2	
326	Spare3	
327	Spare4	
328	Spare5	
329	Spare6	
330	Spare7	
331	Spare8	
332	Spare9	
333	Spare10	
334	Spare11	
335	Spare12	
336	Spare13	
1001	MBIN_COIL1001	State written to Modbus coil address 1001
1002	MBIN_COIL1002	State written to Modbus coil address 1002
1003	MBIN_COIL1003	State written to Modbus coil address 1003
1004	MBIN_COIL1004	State written to Modbus coil address 1004
1005	MBIN_COIL1005	State written to Modbus coil address 1005
1006	MBIN_COIL1006	State written to Modbus coil address 1006
1007	MBIN_COIL1007	State written to Modbus coil address 1007
1008	MBIN_COIL1008	State written to Modbus coil address 1008

Coil	Variable	Description
1009	MBIN_COIL1009	State written to Modbus coil address 1009
1010	MBIN_COIL1010	State written to Modbus coil address 1010
1011	MBIN_COIL1011	State written to Modbus coil address 1011
1012	MBIN_COIL1012	State written to Modbus coil address 1012
1013	MBIN_COIL1013	State written to Modbus coil address 1013
1014	MBIN_COIL1014	State written to Modbus coil address 1014
1015	MBIN_COIL1015	State written to Modbus coil address 1015
1016	MBIN_COIL1016	State written to Modbus coil address 1016
1017	MBIN_COIL1017	State written to Modbus coil address 1017
1018	MBIN_COIL1018	State written to Modbus coil address 1018
1019	MBIN_COIL1019	State written to Modbus coil address 1019
1020	MBIN_COIL1020	State written to Modbus coil address 1020
1021	MBIN_COIL1021	State written to Modbus coil address 1021
1022	MBIN_COIL1022	State written to Modbus coil address 1022
1023	MBIN_COIL1023	State written to Modbus coil address 1023
1024	MBIN_COIL1024	State written to Modbus coil address 1024
1025	MBIN_COIL1025	State written to Modbus coil address 1025
1026	MBIN_COIL1026	State written to Modbus coil address 1026
1027	MBIN_COIL1027	State written to Modbus coil address 1027
1028	MBIN_COIL1028	State written to Modbus coil address 1028
1029	MBIN_COIL1029	State written to Modbus coil address 1029
1030	MBIN_COIL1030	State written to Modbus coil address 1030
1031	MBIN_COIL1031	State written to Modbus coil address 1031
1032	MBIN_COIL1032	State written to Modbus coil address 1032
1033	MBIN_COIL1033	State written to Modbus coil address 1033
1034	MBIN_COIL1034	State written to Modbus coil address 1034
1035	MBIN_COIL1035	State written to Modbus coil address 1035
1036	MBIN_COIL1036	State written to Modbus coil address 1036
1037	MBIN_COIL1037	State written to Modbus coil address 1037
1038	MBIN_COIL1038	State written to Modbus coil address 1038
1039	MBIN_COIL1039	State written to Modbus coil address 1039
1040	MBIN_COIL1040	State written to Modbus coil address 1040
1041	MBIN_COIL1041	State written to Modbus coil address 1041
1042	MBIN_COIL1042	State written to Modbus coil address 1042
1043	MBIN_COIL1043	State written to Modbus coil address 1043
1044	MBIN_COIL1044	State written to Modbus coil address 1044
1045	MBIN_COIL1045	State written to Modbus coil address 1045
1046	MBIN_COIL1046	State written to Modbus coil address 1046
1047	MBIN_COIL1047	State written to Modbus coil address 1047
1048	MBIN_COIL1048	State written to Modbus coil address 1048
1049	MBIN_COIL1049	State written to Modbus coil address 1049
1050	MBIN_COIL1050	State written to Modbus coil address 1050

Coil	Variable	Description
1051	MBIN_COIL1051	State written to Modbus coil address 1051
1052	MBIN_COIL1052	State written to Modbus coil address 1052
1053	MBIN_COIL1053	State written to Modbus coil address 1053
1054	MBIN_COIL1054	State written to Modbus coil address 1054
1055	MBIN_COIL1055	State written to Modbus coil address 1055
1056	MBIN_COIL1056	State written to Modbus coil address 1056
1057	MBIN_COIL1057	State written to Modbus coil address 1057
1058	MBIN_COIL1058	State written to Modbus coil address 1058
1059	MBIN_COIL1059	State written to Modbus coil address 1059
1060	MBIN_COIL1060	State written to Modbus coil address 1060
1061	MBIN_COIL1061	State written to Modbus coil address 1061
1062	MBIN_COIL1062	State written to Modbus coil address 1062
1063	MBIN_COIL1063	State written to Modbus coil address 1063
1064	MBIN_COIL1064	State written to Modbus coil address 1064

Controller #1 Modbus™ Holding Registers

Table 8-5 through Table 8-7 list the Modbus holding registers for Controller #1. The same holding registers are used for Controllers #3 and #5 (when present).

Table 8-5. Analog Inputs (Controller #1 Modbus Holding Registers)

Register	Variable	Description
40001 40002	PMIN_01	Value written to Modbus holding registers 40001 and 40002
40003 40004	PMIN_02	Value written to Modbus holding registers 40003 and 40004
40005 40006	PMIN_03	Value written to Modbus holding registers 40005 and 40006
40007 40008	PMIN_04	Value written to Modbus holding registers 40007 and 40008
40009 40010	PMIN_05	Value written to Modbus holding registers 40009 and 40010
40011 40012	PMIN_06	Value written to Modbus holding registers 40011 and 40012
40013 40014	PMIN_07	Value written to Modbus holding registers 40013 and 40014
40015 40016	PMIN_08	Value written to Modbus holding registers 40015 and 40016
40017 40018	PMIN_09	Value written to Modbus holding registers 40017 and 40018
40019 40020	PMIN_10	Value written to Modbus holding registers 40019 and 40020
40021 40022	PMIN_11	Value written to Modbus holding registers 40021 and 40022
40023 40024	PMIN_12	Value written to Modbus holding registers 40023 and 40024
40025 40026	PMIN_13	Value written to Modbus holding registers 40025 and 40026

Register	Variable	Description
40027 40028	PMIN_14	Value written to Modbus holding registers 40027 and 40028
40029 40030	PMIN_15	Value written to Modbus holding registers 40029 and 40030
40031 40032	PMIN_16	Value written to Modbus holding registers 40031 and 40032
40033 40034	PMIN_17	Value written to Modbus holding registers 40033 and 40034
40035 40036	PMIN_18	Value written to Modbus holding registers 40035 and 40036
40037 40038	PMIN_19	Value written to Modbus holding registers 40037 and 40038
40039 40040	PMIN_20	Value written to Modbus holding registers 40039 and 40040

Table 8-6. Analog Outputs (Controller #1 Modbus Holding Registers)

Register	Variable	Description
40041 40042	PMOUT_P21	Value available at Modbus holding registers 40041 and 40042
40043 40044	PMOUT_P22	Value available at Modbus holding registers 40043 and 40044
40045 40046	PMOUT_P23	Value available at Modbus holding registers 40045 and 40046
40047 40048	PMOUT_P24	Value available at Modbus holding registers 40047 and 40048
40049 40050	PMOUT_P25	Value available at Modbus holding registers 40049 and 40050
40051 40052	PMOUT_P26	Value available at Modbus holding registers 40051 and 40052
40053 40054	PMOUT_P27	Value available at Modbus holding registers 40053 and 40054
40055 40056	PMOUT_P28	Value available at Modbus holding registers 40055 and 40056
40057 40058	PMOUT_P29	Value available at Modbus holding registers 40057 and 40058
40059 40060	PMOUT_P30	Value available at Modbus holding registers 40059 and 40060
40061 40062	PMOUT_P31	Value available at Modbus holding registers 40061 and 40062
40063 40064	PMOUT_P32	Value available at Modbus holding registers 40063 and 40064
40065 40066	PMOUT_P33	Value available at Modbus holding registers 40065 and 40066
40067 40068	PMOUT_P34	Value available at Modbus holding registers 40067 and 40068
40069 40070	PMOUT_P35	Value available at Modbus holding registers 40069 and 40070
40071 40072	PMOUT_P36	Value available at Modbus holding registers 40071 and 40072
40073 40074	PMOUT_P37	Value available at Modbus holding registers 40073 and 40074

Register	Variable	Description
40075 40076	PMOUT_P38	Value available at Modbus holding registers 40075 and 40076
40077 40078	PMOUT_P39	Value available at Modbus holding registers 40077 and 40078
40079 40080	PMOUT_P40	Value available at Modbus holding registers 40079 and 40080
40081 40082	PMOUT_P41	Value available at Modbus holding registers 40081 and 40082
40083 40084	PMOUT_P42	Value available at Modbus holding registers 40083 and 40084
40085 40086	PMOUT_P43	Value available at Modbus holding registers 40085 and 40086
40087 40088	PMOUT_P44	Value available at Modbus holding registers 40087 and 40088
40089 40090	PMOUT_P45	Value available at Modbus holding registers 40089 and 40090
40091 40092	PMOUT_P46	Value available at Modbus holding registers 40091 and 40092
40093 40094	PMOUT_P47	Value available at Modbus holding registers 40093 and 40094
40095 40096	PMOUT_P48	Value available at Modbus holding registers 40095 and 40096
40097 40098	PMOUT_P49	Value available at Modbus holding registers 40097 and 40098
40099 40100	PMOUT_P50	Value available at Modbus holding registers 40099 and 40100
40101 40102	PMOUT_P51	Value available at Modbus holding registers 40101 and 40102
40103 40104	PMOUT_P52	Value available at Modbus holding registers 40103 and 40104
40105 40106	PMOUT_P53	Value available at Modbus holding registers 40105 and 40106
40107 40108	PMOUT_P54	Value available at Modbus holding registers 40107 and 40108
40109 40110	PMOUT_P55	Value available at Modbus holding registers 40109 and 40110
40111 40112	PMOUT_P56	Value available at Modbus holding registers 40111 and 40112
40113 40114	PMOUT_P57	Value available at Modbus holding registers 40113 and 40114
40115 40116	PMOUT_P58	Value available at Modbus holding registers 40115 and 40116
40117 40118	PMOUT_P59	Value available at Modbus holding registers 40117 and 40118
40119 40120	PMOUT_P60	Value available at Modbus holding registers 40119 and 40120
40121 40122	PMOUT_P61	Value available at Modbus holding registers 40121 and 40122
40123 40124	PMOUT_P62	Value available at Modbus holding registers 40123 and 40124

Register	Variable	Description
40125 40126	PMOUT_P63	Value available at Modbus holding registers 40125 and 40126
40127 40128	PMOUT_P64	Value available at Modbus holding registers 40127 and 40128
40129 40130	PMOUT_P65	Value available at Modbus holding registers 40129 and 40130
40131 40132	PMOUT_P66	Value available at Modbus holding registers 40131 and 40132
40133 40134	PMOUT_P67	Value available at Modbus holding registers 40133 and 40134
40135 40136	PMOUT_P68	Value available at Modbus holding registers 40135 and 40136
40137 40138	PMOUT_P69	Value available at Modbus holding registers 40137 and 40138
40139 40140	PMOUT_P70	Value available at Modbus holding registers 40139 and 40140

Table 8-7. Metering Blocks (Controller #1 Modbus Holding Registers)

Register	Variable	Description
40141 40142	METGEN_VOLTAGE	Per unit generator voltage magnitude
40143 40144	METGEN_CURRENT	Per unit generator current magnitude
40145 40146	METGEN_MW	Generator mega-Watt magnitude
40147 40148	METGEN_MVAR	Generator mega-VAR magnitude
40149 40150	METGEN_MVA	Generator mega-VA magnitude
40151 40152	METGEN_PF	Generator power factor
40153 40154	METGEN_FREQ	Generator frequency
40155 40156	METGEN_BASEVOLT	Generator per-unit base voltage
40157 40158	METGEN_BASECUR	Generator per-unit base current
40159 40160	METGEN_BASEMVA	Generator pre-unit base MVA
40161 40162	Spare1	
40163 40164	Spare2	
40165 40166	Spare3	
40167 40168	Spare4	
40169 40170	Spare5	
40171 40172	Spare6	

Register	Variable	Description
40173 40174	METMNFLD_VOLT	Per unit main field voltage magnitude
40175 40176	METMNFLD_CURRENT	Per unit main field current magnitude
40177 40178	METMNFLD_TEMP	Main field temperature
40179 40180	METMNFLD_RES	Calculated main field resistance
40181 40182	METMNFLD_GNDRESMIN	Calculated maximum main field to ground resistance
40183 40184	METMNFLD_GNDREDMAX	Calculated minimum main field to ground resistance
40185 40186	METMNFLD_BASEVOLT	Main field per-unit base voltage
40187 40188	METMNFLD_BASECUR	Main field per-unit base current
40189 40190	METEXFLD_VOLT	Per unit exciter field voltage magnitude
40191 40192	METEXFLD_CURRENT	Per unit exciter field current magnitude
40193 40194	METEXFLD_TEMP	Exciter field temperature
40195 40196	METEXFLD_RES	Calculated exciter field resistance
40197 40198	METEXFLD_GNDRESMIN	Calculated maximum exciter field to ground resistance
40199 40200	METEXFLD_GNDREDMAX	Calculated minimum exciter field to ground resistance
40201 40202	METEXFLD_BASEVOLT	Exciter field per-unit base voltage
40203 40204	METEXFLD_BASECUR	Exciter field per-unit base current
40205 40206	METADJ_ACREF	Reference level of AC voltage adjuster
40207 40208	METADJ_ACPOS	Travel (position) indication of AC voltage adjuster
40209 40210	METADJ_ACERR	Error signal of AC voltage regulator
40211 40212	METADJ_MANREF	Reference level of Manual adjuster
40213 40214	METADJ_MANPOS	Travel (position) indication of manual adjuster
40215 40216	METADJ_MANERR	Error signal of manual regulator
40217 40218	METADJ_VARREF	Reference level of VAR adjuster
40219 40220	METADJ_VARPOS	Travel (position) indication of VAR adjuster
40221 40222	METADJ_VARERR	Error signal of VAR controller (or regulator)

Register	Variable	Description
40223 40224	METADJ_PFREF	Reference level of PF adjuster
40225 40226	METADJ_PFPOS	Travel (position) indication of PR adjuster
40227 40228	METADJ_PFERR	Error signal of PR controller (or regulator)
40229 40230	METADJ_AMBAL	Difference between operating points of Manual and Auto control modes
40231 40232	METADJ_TRKERR	Difference between operating points of Main and Redundant control channels
40233 40234	Spare1	
40235 40236	Spare2	
40237 40238	METLIM_OEL1_OUT	Per unit output of exciter field OEL block
40239 40240	METLIM_OEL2_OUT	Per unit output of generator field OEL block
40241 40242	METLIM_INS_OUT	Per unit output of INS block
40243 40244	METLIM_MFEL_OUT	Per unit output of MFEL block
40245 40246	METLIM_HXL_OUT	Per unit output of HXL block
40247 40248	METLIM_OVL_OUT	Per unit output of OVL block
40249 40250	METLIMT_UVL_OUT	Per unit output of UVL block
40251 40252	METLIM_UEL_OUT	Per unit output of UEL block
40253 40254	METLIM_MEL_OUT	Per unit output of MEL block
40255 40256	METLIM_GCL_OUT	Per unit output of GCL block
40257 40258	METLIM_VRL_OUT	Per unit output of VRL block
40259 40260	METLIM_PSS_OUT	Per unit output of PSS block
40261 40262	METLIM_PSS_DELTA_SPD	Delta speed input to PSS
40263 40264	METLIM_PSS_COMP_SPD	Compensated speed signal for PSS
40265 40266	METLIM_COMPTEMP	Cooling air temperature used to compensate various limiters
40267 40268	METLIM_COMPPRES	Hydrogen pressure level used to compensate various limiters
40269 40270	METSYNC_GENVOLT	Per unit generator voltage magnitude
40271 40272	METSYNC_GENFREQ	Generator frequency

Register	Variable	Description
40273 40274	METSYNC_BUSVOLT	Per unit bus voltage magnitude
40275 40276	METSYNC_BUSFREQ	Bus frequency
40277 40278	METSYNC_VOLTDIF	Difference between bus and generator voltage (= BUSVOLT-GENVOLT)
40279 40280	METSYNC_SPDDIF	Difference between generator and bus frequency (= BUSFREQ-GENFREQ)
40281 40282	METSYNC_PHSDIF	Difference between generator and bus voltage phase angle (=BUS_angle-GEN_ angle)
40283 40284	Spare1	
40285 40286	METPPT_VOLT	Per unit PPT secondary voltage magnitude
40287 40288	METPPT_PRICUR	Per unit PPT primary current magnitude
40289 40290	METPPT_SECCUR	Per unit PPT secondary current magnitude
40291 40292	METPPT_AVGTEMP	PPT average winding temperature
40293 40294	METPPT_PHATEMP	PPT phase-A winding temperature
40295 40296	METPPT_PHBTEMP	PPT phase-B winding temperature
40297 40298	METPPT_PHCTEMP	PPT phase-C winding temperature
40299 40300	METPPT_BASEVOLT	Exciter PPT per-unit base voltage
40301 40302	METPPT_BASEPRICUR	Exciter PPT per-unit base primary current
40303 40304	METPPT_BASESECCUR	Exciter PPT per-unit base secondary current
40305 40306	Spare1	
40307 40308	Spare2	
40309 40310	Spare3	
40311 40312	Spare4	
40313 40314	Spare5	
40315 40316	Spare6	
40317 40318	METGSU_VOLT	Per unit generator step-up transformer voltage magnitude
40319 40320	METGSU_CUR	Per unit generator step-up transformer current magnitude
40321 40322	METGSU_MW	Generator step-up transformer mega-Watt magnitude

Register	Variable	Description
40323 40324	METGSU_MVAR	Generator step-up transformer mega-VAR magnitude
40325 40326	METGSU_MVA	Generator step-up transformer mega-VA magnitude
40327 40328	METGSU_PF	Generator step-up transformer power factor
40329 40330	METGSU_FREQ	Generator step-up transformer frequency
40331 40332	METGSU_BASEVOLT	Generator step-up transformer per-unit base voltage
40333 40334	METGSU_BASECUR	Generator step-up transformer per-unit base current
40335 40336	METGSU_BASEMVA	Generator step-up transformer pre-unit base MVA
40337 40338	Spare1	
40339 40340	Spare2	
40341 40342	Spare3	
40343 40344	Spare4	
40345 40346	Spare5	
40347 40348	Spare6	
40349 40350	METOTHER_REGPTMAG	Per unit voltage magnitude of "regulator" PT inputs
40351 40352	METOTHER_METPTMAG	Per unit voltage magnitude of "metering" PT inputs
40353 40354	METOTHER_REGOUT	Control signal of active regulator mode
40355 40356	METOTHER_PIDINPUT	Error signal applied to input of main PID control loop
40357 40358	METOTHER_FIRCMD	Firing command
40359 40360	METOTHER_PHAPTDIF	Difference between phase-A voltage input and average voltage signal
40361 40362	METOTHER_PHBPTDIF	Difference between phase-B voltage input and average voltage signal
40363 40364	METOTHER_PHCPTDIF	Difference between phase-C voltage input and average voltage signal
40365 40366	METOTHER_PHACTDIF	Difference between phase-A current input and average current signal
40367 40368	METOTHER_PHBCTDIF	Difference between phase-B current input and average current signal
40369 40370	METOTHER_PHCCTDIF	Difference between phase-C current input and average current signal
40371 40372	METOTHER_USER1	User defined metering signal

Register	Variable	Description
40373 40374	METOTHER_USER2	User defined metering signal
40375 40376	METOTHER_USER3	User defined metering signal
40377 40378	Spare1	
40379 40380	Spare2	
41001 41002	MBIN_1001	Value written to Modbus holding registers 41001 and 41002
41001 41002	MBIN_1001	Value written to Modbus holding registers 41001 and 41002
41003 41004	MBIN_1002	Value written to Modbus holding registers 41003 and 41004
41005 41006	MBIN_1003	Value written to Modbus holding registers 41005 and 41006
41007 41008	MBIN_1004	Value written to Modbus holding registers 41007 and 41008
41009 41010	MBIN_1005	Value written to Modbus holding registers 41009 and 41010
41011 41012	MBIN_1006	Value written to Modbus holding registers 41011 and 41012
41013 41014	MBIN_1007	Value written to Modbus holding registers 41013 and 41014
41015 41016	MBIN_1008	Value written to Modbus holding registers 41015 and 41016
41017 41018	MBIN_1009	Value written to Modbus holding registers 41017 and 41018
41019 41020	MBIN_1010	Value written to Modbus holding registers 41019 and 41020
41021 41022	MBIN_1011	Value written to Modbus holding registers 41021 and 41022
41023 41024	MBIN_1012	Value written to Modbus holding registers 41023 and 41024
41025 41026	MBIN_1013	Value written to Modbus holding registers 41025 and 41026
41027 41028	MBIN_1014	Value written to Modbus holding registers 41027 and 41028
41029 41030	MBIN_1015	Value written to Modbus holding registers 41029 and 41030
41031 41032	MBIN_1016	Value written to Modbus holding registers 41031 and 41032
41033 41034	MBIN_1017	Value written to Modbus holding registers 41033 and 41034
41035 41036	MBIN_1018	Value written to Modbus holding registers 41035 and 41036
41037 41038	MBIN_1019	Value written to Modbus holding registers 41037 and 41038
41039 41040	MBIN_1020	Value written to Modbus holding registers 41039 and 41040

Controller #2 Modbus™ Coil Map

Table 8-8 through Table 8-24 list the Modbus coil map for Controller #2. The same coil map is used for Controllers #4 and #6 (when present).

Table 8-8. Field Transducer Input Block (Controller #2 Modbus Coil Map)

Coil	Variable	Description
001-048	SPARE	
049	BRG8_LINK_ALM	Bridge 8 fiber optic link alarm
050	BRG9_LINK_ALM	Bridge 9 fiber optic link alarm
051	BRGA_LINK_ALM	Bridge A fiber optic link alarm
052	BRGB_LINK_ALM	Bridge B fiber optic link alarm
053	BRGC_LINK_ALM	Bridge C fiber optic link alarm
054	BRGD_LINK_ALM	Bridge D fiber optic link alarm
055	BRGE_LINK_ALM	Bridge E fiber optic link alarm
056	BRGF_LINK_ALM	Bridge F fiber optic link alarm
057	BRG0_LINK_ALM	Bridge 0 fiber optic link alarm
058	BRG1_LINK_ALM	Bridge 1 fiber optic link alarm
059	BRG2_LINK_ALM	Bridge 2 fiber optic link alarm
060	BRG3_LINK_ALM	Bridge 3 fiber optic link alarm
061	BRG4_LINK_ALM	Bridge 4 fiber optic link alarm
062	BRG5_LINK_ALM	Bridge 5 fiber optic link alarm
063	BRG6_LINK_ALM	Bridge 6 fiber optic link alarm
064	BRG7_LINK_ALM	Bridge 7 fiber optic link alarm
065	FLDTRN_F7_BAD	FLDTRN: U35 counter out of range
066	FLDTRN_F6_BAD	FLDTRN: U29 counter out of range
067	FLDTRN_F5_BAD	FLDTRN: U31 counter out of range
068	FLDTRN_F4_BAD	FLDTRN: U27 counter out of range
069	FLDTRN_F3_BAD	FLDTRN: U28 counter out of range
070	FLDTRN_F2_BAD	FLDTRN: U19 counter out of range
071	FLDTRN_F1_BAD	FLDTRN: U22 counter out of range
072	PLL_NOT_LOCKED	PLL not locked
073-077	SPARE	
078	FLDTRN_F10_BAD	FLDTRN: U38 counter out of range
079	FLDTRN_F9_BAD	FLDTRN: U39 counter out of range
080	FLDTRN_F8_BAD	FLDTRN: U33 counter out of range
081-128	SPARE	

Table 8-9. Bridge 0 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
129	SPARE	
130	IN_EXECUTE_STATE:	
131	BRG_RUN_ENABLED:	LATCH when ON_CMD received
132	BRG_NOT_READY_FB:	WORKING
133	BRG_TRP_REQ_FB:	LATCH for trip brg trip req

Coil	Variable	Description
134	BRG_TRP_FB:	Bridge is tripped
135	BRG_ALM_FB:	Bridge has a alarm
136	BRG_RUN_FB:	Bridge is running
137-140	SPARE	
141	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
142	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
143	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
144	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
145	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
146	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
147	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
148	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
149	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
150	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
151	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
152	DC_STUCK_OPEN:	DC breaker stuck open - Latched
153	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
154	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
155	SCRCN:	SCR CN disabled on Hi Temp
156	SCRCP:	SCR CP disabled on Hi Temp
157	SCRBN:	SCR BN disabled on Hi Temp
158	SCRBP:	SCR BP disabled on Hi Temp
159	SCRAN:	SCR AN disabled on Hi Temp
160	SCRAP:	SCR AP disabled on Hi Temp
161	BAD_SS:	BAD STATE SELECT INPUT
162	CSLINEC:	C PHASE CONDUCTION SENSOR FAILED
163	CSLINEB:	B PHASE CONDUCTION SENSOR FAILED
164	CSLINEA:	A PHASE CONDUCTION SENSOR FAILED
165	CSCN:	CONDUCTION SENSOR PHASE C NEGATIVE NOT CONDUCTING
166	CSCP:	CONDUCTION SENSOR PHASE C POSITIVE NOT CONDUCTING
167	CSBN:	CONDUCTION SENSOR PHASE B NEGATIVE NOT CONDUCTING
168	CSBP:	CONDUCTION SENSOR PHASE B POSITVE NOT CONDUCTING
169	SCRAN_LTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
170	SCRAP_HTEMP:	PHASE A POSITIVE HEAT SINK HI TEMP ALARM
171	SCRAP_LTEMP:	PHASE A POSITIVE HEAT SINK LOW TEMP ALARM
172	AIRTHI:	BRIDGE AIR TEMPERATURE IS TOO HI

Coil	Variable	Description
173	FAN_FB_ALM:	FAN FEED BACK NOT PRESENT
174	LOSS OF COOLING	HEATSINKS ABOVE LOW THRESHOLD AND AIR ABOVE THRESHOLD
175	SPARE	
176	ALM_BRG_TRP_REQ_FB	BRIDGE IS TRIPPED - THIS BIT MUST BE CLEARED TO RUN AGAIN
177	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
178	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
179	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
180	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
181	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
182	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
183	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
184	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
185	RTD4_OPEN:	RTD #4 IS OPEN
186	RTD3_SHORT:	RTD #3 IS SHORT
187	RTD3_OPEN:	RTD #3 IS OPEN
188	RTD2_SHORT:	RTD #2 IS SHORT
189	RTD2_OPEN:	RTD #2 IS OPEN
190	RTD1_SHORT:	RTD #1 IS SHORT
191	RTD1_OPEN:	RTD #1 IS OPEN
192	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
193	BRG_LINK_ALARM:	BRIDGE LINK BAD
194	RTD7_SHORT:	RTD #7 IS SHORT
195	RTD7_OPEN:	RTD #7 IS OPEN
196	RTD6_SHORT:	RTD #6 IS SHORT
197	RTD6_OPEN:	RTD #6 IS OPEN
198	RTD5_SHORT:	RTD #5 IS SHORT
199	RTD5_OPEN:	RTD #5 IS OPEN
200	RTD4_SHORT:	RTD #4 IS OPEN
201	SPARE:	
202	FUSE_LC	OPEN LINE OR FUSE PHASE C
203	FUSE_LB	OPEN LINE OR FUSE PHASE B
204	FUSE_LA	OPEN LINE OR FUSE PHASE A
205	VCO_FV4:	F_TO_V4 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
206	VCO_FV3:	F_TO_V3 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
207	VCO_FV2:	F_TO_V2 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
208	VCO_FV1:	F_TO_V1 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
209	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
210	MAIN_FAN_STUCK_ON:	Main Fan Stuck On

Coil	Variable	Description
211	BACKUP_FAN_NOT_ON:	Backup Fan Not On
212	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
213	XFER_TO_MAIN_FAN:	Transfer to Main Fan
214	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
215-224	SPARE:	

Table 8-10. Bridge 1 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
225	SPARE	
226	IN_EXECUTE_STATE:	
227	BRG_RUN_ENABLED:	LATCH when ON_CMD received
228	BRG_NOT_READY_FB:	WORKING
229	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
230	BRG_TRP_FB:	Bridge is tripped
231	BRG_ALM_FB:	Bridge has a alarm
232	BRG_RUN_FB:	Bridge is running
233-236	SPARE	
237	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
238	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
239	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
240	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
241	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
242	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
243	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
244	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
245	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
246	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
247	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
248	DC_STUCK_OPEN:	DC breaker stuck open - Latched
249	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
250	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
251	SCRCN:	SCR CN disabled on Hi Temp
252	SCRCP:	SCR CP disabled on Hi Temp
253	SCRBN:	SCR BN disabled on Hi Temp
254	SCRBP:	SCR BP disabled on Hi Temp
255	SCRAN:	SCR AN disabled on Hi Temp
256	SCRAP:	SCR AP disabled on Hi Temp
257	BAD_SS:	BAD STATE SELECT INPUT
258	CSLINEC:	C PHASE CONDUCTION SENSOR FAILED

Coil	Variable	Description
259	CSLINEB:	B PHASE CONDUCTION SENSOR FAILED
260	CSLINEA:	A PHASE CONDUCTION SENSOR FAILED
261	CSCN:	CONDUCTION SENSOR PHASE C NEGATIVE NOT CONDUCTING
262	CSCP:	CONDUCTION SENSOR PHASE C POSITIVE NOT CONDUCTING
263	CSBN:	CONDUCTION SENSOR PHASE B NEGATIVE NOT CONDUCTING
264	CSBP:	CONDUCTION SENSOR PHASE B POSITVE NOT CONDUCTING
265	SCRAN_LTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
266	SCRAP_HTEMP:	PHASE A POSITIVE HEAT SINK HI TEMP ALARM
267	SCRAP_LTEMP:	PHASE A POSITIVE HEAT SINK LOW TEMP ALARM
268	AIRTHI:	BRIDGE AIR TEMPERATURE IS TOO HI
269	FAN_FB_ALM:	FAN FEED BACK NOT PRESENT
270	LOSS OF COOLING	HEATSINKS ABOVE LOW THRESHOLD AND AIR ABOVE THRESHOLD
271	SPARE	
272	ALM_BRG_TRP_REQ_FB	BRIDGE IS TRIPPED - THIS BIT MUST BE CLEARED TO RUN AGAIN
273	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
274	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
275	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
276	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
277	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
278	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
279	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
280	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
281	RTD4_OPEN:	RTD #4 IS OPEN
282	RTD3_SHORT:	RTD #3 IS SHORT
283	RTD3_OPEN:	RTD #3 IS OPEN
284	RTD2_SHORT:	RTD #2 IS SHORT
285	RTD2_OPEN:	RTD #2 IS OPEN
286	RTD1_SHORT:	RTD #1 IS SHORT
287	RTD1_OPEN:	RTD #1 IS OPEN
288	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
289	BRG_LINK_ALARM:	BRIDGE LINK BAD
290	RTD7_SHORT:	RTD #7 IS SHORT
291	RTD7_OPEN:	RTD #7 IS OPEN
292	RTD6_SHORT:	RTD #6 IS SHORT
293	RTD6_OPEN:	RTD #6 IS OPEN
294	RTD5_SHORT:	RTD #5 IS SHORT
295	RTD5_OPEN:	RTD #5 IS OPEN
296	RTD4_SHORT:	RTD #4 IS OPEN

Coil	Variable	Description
297	spare	
298	FUSE_LC	OPEN LINE OR FUSE PHASE C
299	FUSE_LB	OPEN LINE OR FUSE PHASE B
300	FUSE_LA	OPEN LINE OR FUSE PHASE A
301	VCO_FV4:	F_TO_V4 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
302	VCO_FV3:	F_TO_V3 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
303	VCO_FV2:	F_TO_V2 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
304	VCO_FV1:	F_TO_V1 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
305	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
306	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
307	BACKUP_FAN_NOT_ON:	Backup Fan Not On
308	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
309	XFER_TO_MAIN_FAN:	Transfer to Main Fan
310	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
311-320	SPARE:	

Table 8-11. Bridge 2 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
321	SPARE	
322	IN_EXECUTE_STATE:	
323	BRG_RUN_ENABLED:	LATCH when ON_CMD received
324	BRG_NOT_READY_FB:	WORKING
325	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
326	BRG_TRP_FB:	Bridge is tripped
327	BRG_ALM_FB:	Bridge has a alarm
328	BRG_RUN_FB:	Bridge is running
329-332	SPARE	
333	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
334	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
335	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
336	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
337	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
338	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
339	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
340	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
341	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
342	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
343	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched

Coil	Variable	Description
344	DC_STUCK_OPEN:	DC breaker stuck open - Latched
345	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
346	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
347	SCRCN:	SCR CN disabled on Hi Temp
348	SCRCP:	SCR CP disabled on Hi Temp
349	SCRBN:	SCR BN disabled on Hi Temp
350	SCRBP:	SCR BP disabled on Hi Temp
351	SCRAN:	SCR AN disabled on Hi Temp
352	SCRAP:	SCR AP disabled on Hi Temp
353	BAD_SS:	BAD STATE SELECT INPUT
354	CSLINEC:	C PHASE CONDUCTION SENSOR FAILED
355	CSLINEB:	B PHASE CONDUCTION SENSOR FAILED
356	CSLINEA:	A PHASE CONDUCTION SENSOR FAILED
357	CSCN:	CONDUCTION SENSOR PHASE C NEGATIVE NOT CONDUCTING
358	CSCP:	CONDUCTION SENSOR PHASE C POSITIVE NOT CONDUCTING
359	CSBN:	CONDUCTION SENSOR PHASE B NEGATIVE NOT CONDUCTING
360	CSBP:	CONDUCTION SENSOR PHASE B POSITVE NOT CONDUCTING
361	SCRAN_LTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
362	SCRAP_HTEMP:	PHASE A POSITIVE HEAT SINK HI TEMP ALARM
363	SCRAP_LTEMP:	PHASE A POSITIVE HEAT SINK LOW TEMP ALARM
364	AIRTHI:	BRIDGE AIR TEMPERATURE IS TOO HI
365	FAN_FB_ALM:	FAN FEED BACK NOT PRESENT
366	LOSS OF COOLING	HEATSINKS ABOVE LOW THRESHOLD AND AIR ABOVE THRESHOLD
367	SPARE	
368	ALM_BRG_TRP_REQ_FB	BRIDGE IS TRIPPED - THIS BIT MUST BE CLEARED TO RUN AGAIN
369	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
370	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
371	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
372	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
373	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
374	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
375	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
376	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
377	RTD4_OPEN:	RTD #4 IS OPEN
378	RTD3_SHORT:	RTD #3 IS SHORT
379	RTD3_OPEN:	RTD #3 IS OPEN
380	RTD2_SHORT:	RTD #2 IS SHORT

Coil	Variable	Description
381	RTD2_OPEN:	RTD #2 IS OPEN
382	RTD1_SHORT:	RTD #1 IS SHORT
383	RTD1_OPEN:	RTD #1 IS OPEN
384	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
385	BRG_LINK_ALARM:	BRIDGE LINK BAD
386	RTD7_SHORT:	RTD #7 IS SHORT
387	RTD7_OPEN:	RTD #7 IS OPEN
388	RTD6_SHORT:	RTD #6 IS SHORT
389	RTD6_OPEN:	RTD #6 IS OPEN
390	RTD5_SHORT:	RTD #5 IS SHORT
391	RTD5_OPEN:	RTD #5 IS OPEN
392	RTD4_SHORT:	RTD #4 IS OPEN
393	spare	
394	FUSE_LC	OPEN LINE OR FUSE PHASE C
395	FUSE_LB	OPEN LINE OR FUSE PHASE B
396	FUSE_LA	OPEN LINE OR FUSE PHASE A
397	VCO_FV4:	F_TO_V4 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
398	VCO_FV3:	F_TO_V3 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
399	VCO_FV2:	F_TO_V2 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
400	VCO_FV1:	F_TO_V1 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
401	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
402	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
403	BACKUP_FAN_NOT_ON:	Backup Fan Not On
404	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
405	XFER_TO_MAIN_FAN:	Transfer to Main Fan
406	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
407-416	SPARE:	

Table 8-12. Bridge 3 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
417	SPARE	
418	IN_EXECUTE_STATE:	
419	BRG_RUN_ENABLED:	LATCH when ON_CMD received
420	BRG_NOT_READY_FB:	WORKING
421	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
422	BRG_TRP_FB:	Bridge is tripped
423	BRG_ALM_FB:	Bridge has a alarm
424	BRG_RUN_FB:	Bridge is running
425-428	SPARE	
429	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4

Coil	Variable	Description
430	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
431	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
432	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
433	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
434	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
435	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
436	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
437	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
438	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
439	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
440	DC_STUCK_OPEN:	DC breaker stuck open - Latched
441	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
442	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
443	SCRCN:	SCR CN disabled on Hi Temp
444	SCRCP:	SCR CP disabled on Hi Temp
445	SCRBN:	SCR BN disabled on Hi Temp
446	SCRBP:	SCR BP disabled on Hi Temp
447	SCRAN:	SCR AN disabled on Hi Temp
448	SCRAP:	SCR AP disabled on Hi Temp
449	BAD_SS:	BAD STATE SELECT INPUT
450	CSLINEC:	C PHASE CONDUCTION SENSOR FAILED
451	CSLINEB:	B PHASE CONDUCTION SENSOR FAILED
452	CSLINEA:	A PHASE CONDUCTION SENSOR FAILED
453	CSCN:	CONDUCTION SENSOR PHASE C NEGATIVE NOT CONDUCTING
454	CSCP:	CONDUCTION SENSOR PHASE C POSITIVE NOT CONDUCTING
455	CSBN:	CONDUCTION SENSOR PHASE B NEGATIVE NOT CONDUCTING
456	CSBP:	CONDUCTION SENSOR PHASE B POSITVE NOT CONDUCTING
457	SCRAN_LTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
458	SCRAP_HTEMP:	PHASE A POSITIVE HEAT SINK HI TEMP ALARM
459	SCRAP_LTEMP:	PHASE A POSITIVE HEAT SINK LOW TEMP ALARM
460	AIRTHI:	BRIDGE AIR TEMPERATURE IS TOO HI
461	FAN_FB_ALM:	FAN FEED BACK NOT PRESENT
462	LOSS OF COOLING	HEATSINKS ABOVE LOW THRESHOLD AND AIR ABOVE THRESHOLD
463	SPARE	
464	ALM_BRG_TRP_REQ_FB	BRIDGE IS TRIPPED - THIS BIT MUST BE CLEARED TO RUN AGAIN

Coil	Variable	Description
465	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
466	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
467	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
468	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
469	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
470	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
471	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
472	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
473	RTD4_OPEN:	RTD #4 IS OPEN
474	RTD3_SHORT:	RTD #3 IS SHORT
475	RTD3_OPEN:	RTD #3 IS OPEN
476	RTD2_SHORT:	RTD #2 IS SHORT
477	RTD2_OPEN:	RTD #2 IS OPEN
478	RTD1_SHORT:	RTD #1 IS SHORT
479	RTD1_OPEN:	RTD #1 IS OPEN
480	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
481	BRG_LINK_ALARM:	BRIDGE LINK BAD
482	RTD7_SHORT:	RTD #7 IS SHORT
483	RTD7_OPEN:	RTD #7 IS OPEN
484	RTD6_SHORT:	RTD #6 IS SHORT
485	RTD6_OPEN:	RTD #6 IS OPEN
486	RTD5_SHORT:	RTD #5 IS SHORT
487	RTD5_OPEN:	RTD #5 IS OPEN
488	RTD4_SHORT:	RTD #4 IS OPEN
489	spare	
490	FUSE_LC	OPEN LINE OR FUSE PHASE C
491	FUSE_LB	OPEN LINE OR FUSE PHASE B
492	FUSE_LA	OPEN LINE OR FUSE PHASE A
493	VCO_FV4:	F_TO_V4 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
494	VCO_FV3:	F_TO_V3 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
495	VCO_FV2:	F_TO_V2 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
496	VCO_FV1:	F_TO_V1 BLOCK HAS NO INPUT FROM TRANSDUCER (IT CARD)
497	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
498	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
499	BACKUP_FAN_NOT_ON:	Backup Fan Not On
500	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
501	XFER_TO_MAIN_FAN:	Transfer to Main Fan
502	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
503-513	SPARE:	

Table 8-13. Bridge 4 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
513	SPARE	
514	IN_EXECUTE_STATE:	
515	BRG_RUN_ENABLED:	LATCH when ON_CMD received
516	BRG_NOT_READY_FB:	WORKING
517	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
518	BRG_TRP_FB:	Bridge is tripped
519	BRG_ALM_FB:	Bridge has a alarm
520	BRG_RUN_FB:	Bridge is running
521-524	SPARE	
525	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
526	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
527	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
528	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
529	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
530	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
531	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
532	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
533	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
534	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
535	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
536	DC_STUCK_OPEN:	DC breaker stuck open - Latched
537	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
538	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
539	SCRCN:	SCR CN disabled on Hi Temp
540	SCRCP:	SCR CP disabled on Hi Temp
541	SCRBN:	SCR BN disabled on Hi Temp
542	SCRBP:	SCR BP disabled on Hi Temp
543	SCRAN:	SCR AN disabled on Hi Temp
544	SCRAP:	SCR AP disabled on Hi Temp
545	BAD_SS:	Bad state select input
546	CSLINEC:	C phase conduction sensor failed
547	CSLINEB:	B phase conduction sensor failed
548	CSLINEA:	A phase conduction sensor failed
549	CSCN:	Conduction sensor phase c negative not conducting
550	CSCP:	Conduction sensor phase c positive not conducting
551	CSBN:	Conduction sensor phase b negative not conducting
552	CSBP:	Conduction sensor phase b positve not conducting
553	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm

Coil	Variable	Description
554	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
555	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
556	AIRTHI:	Bridge air temperature is too hi
557	FAN_FB_ALM:	Fan feed back not present
558	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
559	SPARE	
560	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
561	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
562	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
563	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
564	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
565	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
566	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
567	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
568	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
569	RTD4_OPEN:	RTD #4 is open
570	RTD3_SHORT:	RTD #3 is short
571	RTD3_OPEN:	RTD #3 is open
572	RTD2_SHORT:	RTD #2 is short
573	RTD2_OPEN:	RTD #2 is open
574	RTD1_SHORT:	RTD #1 is short
575	RTD1_OPEN:	RTD #1 is open
576	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
577	BRG_LINK_ALARM:	Bridge link bad
578	RTD7_SHORT:	RTD #7 is shorted
579	RTD7_OPEN:	RTD #7 is open
580	RTD6_SHORT:	RTD #6 is shorted
581	RTD6_OPEN:	RTD #6 is open
582	RTD5_SHORT:	RTD #5 is shorted
583	RTD5_OPEN:	RTD #5 is open
584	RTD4_SHORT:	RTD #4 is open
585	spare	
586	FUSE_LC	Open line or fuse phase c
587	FUSE_LB	Open line or fuse phase b
588	FUSE_LA	Open line or fuse phase a
589	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
590	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
591	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
592	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
593	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
594	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
595	BACKUP_FAN_NOT_ON:	Backup Fan Not On

Coil	Variable	Description
596	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
597	XFER_TO_MAIN_FAN:	Transfer to Main Fan
598	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
599-608	SPARE:	

Table 8-14. Bridge 5 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
609	SPARE	
610	IN_EXECUTE_STATE:	
611	BRG_RUN_ENABLED:	LATCH when ON_CMD received
612	BRG_NOT_READY_FB:	WORKING
613	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
614	BRG_TRP_FB:	Bridge is tripped
615	BRG_ALM_FB:	Bridge has a alarm
616	BRG_RUN_FB:	Bridge is running
617-620	SPARE	
621	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
622	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
623	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
624	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
625	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
626	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
627	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
628	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
629	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
630	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
631	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
632	DC_STUCK_OPEN:	DC breaker stuck open - Latched
633	CSAN:	Conduction sensor phase a negative not conducting
634	CSAP:	Conduction sensor phase a positive not conducting
635	SCRCN:	SCR CN disabled on Hi Temp
636	SCRCP:	SCR CP disabled on Hi Temp
637	SCRBN:	SCR BN disabled on Hi Temp
638	SCRBP:	SCR BP disabled on Hi Temp
639	SCRAN:	SCR AN disabled on Hi Temp
640	SCRAP:	SCR AP disabled on Hi Temp
641	BAD_SS:	Bad state select input
642	CSLINEC:	C phase conduction sensor failed
643	CSLINEB:	B phase conduction sensor failed
644	CSLINEA:	A phase conduction sensor failed
645	CSCN:	conduction sensor phase c negative not conducting

Coil	Variable	Description
646	CSCP:	Conduction sensor phase c positive not conducting
647	CSBN:	Conduction sensor phase b negative not conducting
648	CSBP:	Conduction sensor phase b positve not conducting
649	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
650	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
651	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
652	AIRTHI:	Bridge air temperature is too hi
653	FAN_FB_ALM:	Fan feed back not present
654	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
655	SPARE	
656	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
657	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
658	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
659	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
660	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
661	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
662	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
663	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
664	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
665	RTD4_OPEN:	RTD #4 is open
666	RTD3_SHORT:	RTD #3 is shorted
667	RTD3_OPEN:	RTD #3 is open
668	RTD2_SHORT:	RTD #2 is shorted
669	RTD2_OPEN:	RTD #2 is open
670	RTD1_SHORT:	RTD #1 is shorted
671	RTD1_OPEN:	RTD #1 is open
672	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
673	BRG_LINK_ALARM:	Bridge link bad
674	RTD7_SHORT:	RTD #7 is shorted
675	RTD7_OPEN:	RTD #7 is open
676	RTD6_SHORT:	RTD #6 is shorted
677	RTD6_OPEN:	RTD #6 is open
678	RTD5_SHORT:	RTD #5 is shorted
679	RTD5_OPEN:	RTD #5 is open
680	RTD4_SHORT:	RTD #4 is open
681		
682	FUSE_LC	Open line or fuse phase c
683	FUSE_LB	Open line or fuse phase b
684	FUSE_LA	Open line or fuse phase a
685	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
686	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
687	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)

Coil	Variable	Description
688	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
689	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
690	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
691	BACKUP_FAN_NOT_ON:	Backup Fan Not On
692	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
693	XFER_TO_MAIN_FAN:	Transfer to Main Fan
694	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
695-704	SPARE:	

Table 8-15. Bridge 6 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
705	SPARE	
706	IN_EXECUTE_STATE:	
707	BRG_RUN_ENABLED:	LATCH when ON_CMD received
708	BRG_NOT_READY_FB:	WORKING
709	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
710	BRG_TRP_FB:	Bridge is tripped
711	BRG_ALM_FB:	Bridge has a alarm
712	BRG_RUN_FB:	Bridge is running
713-716	SPARE	
717	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
718	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
719	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
720	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
721	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
722	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
723	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
724	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
725	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
726	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
727	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
728	DC_STUCK_OPEN:	DC breaker stuck open - Latched
729	CSAN:	Conduction sensor phase a negative not conducting
730	CSAP:	Conduction sensor phase a positive not conducting
731	SCRCN:	SCR CN disabled on Hi Temp
732	SCRCP:	SCR CP disabled on Hi Temp
733	SCRBN:	SCR BN disabled on Hi Temp
734	SCRBP:	SCR BP disabled on Hi Temp
735	SCRAN:	SCR AN disabled on Hi Temp
736	SCRAP:	SCR AP disabled on Hi Temp
737	BAD_SS:	Bad state select input

Coil	Variable	Description
738	CSLINEC:	C phase conduction sensor failed
739	CSLINEB:	B phase conduction sensor failed
740	CSLINEA:	A phase conduction sensor failed
741	CSCN:	Conduction sensor phase c negative not conducting
742	CSCP:	Conduction sensor phase c positive not conducting
743	CSBN:	Conduction sensor phase b negative not conducting
744	CSBP:	Conduction sensor phase b positve not conducting
745	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
746	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
747	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
748	AIRTHI:	Bridge air temperature is too hi
749	FAN_FB_ALM:	Fan feed back not present
750	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
751	SPARE	
752	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
753	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
754	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
755	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
756	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
757	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
758	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
759	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
760	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
761	RTD4_OPEN:	RTD #4 is open
762	RTD3_SHORT:	RTD #3 is shorted
763	RTD3_OPEN:	RTD #3 is open
764	RTD2_SHORT:	RTD #2 is shorted
765	RTD2_OPEN:	RTD #2 is open
766	RTD1_SHORT:	RTD #1 is shorted
767	RTD1_OPEN:	RTD #1 is open
768	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
769	BRG_LINK_ALARM:	Bridge link bad
770	RTD7_SHORT:	RTD #7 is shorted
771	RTD7_OPEN:	RTD #7 is open
772	RTD6_SHORT:	RTD #6 is shorted
773	RTD6_OPEN:	RTD #6 is open
774	RTD5_SHORT:	RTD #5 is shorted
775	RTD5_OPEN:	RTD #5 is open
776	RTD4_SHORT:	RTD #4 is open
777	spare	
778	FUSE_LC	Open line or fuse phase c
779	FUSE_LB	Open line or fuse phase b

Coil	Variable	Description
780	FUSE_LA	Open line or fuse phase a
781	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
782	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
783	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
784	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
785	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
786	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
787	BACKUP_FAN_NOT_ON:	Backup Fan Not On
788	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
789	XFER_TO_MAIN_FAN:	Transfer to Main Fan
790	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
791-800	SPARE:	

Table 8-16. Bridge 7 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
801	SPARE	
802	IN_EXECUTE_STATE:	
803	BRG_RUN_ENABLED:	LATCH when ON_CMD received
804	BRG_NOT_READY_FB:	WORKING
805	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
806	BRG_TRP_FB:	Bridge is tripped
807	BRG_ALM_FB:	Bridge has a alarm
808	BRG_RUN_FB:	Bridge is running
809-812	SPARE	
813	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
814	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
815	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
816	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
817	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
818	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
819	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
820	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
821	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
822	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
823	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
824	DC_STUCK_OPEN:	DC breaker stuck open - Latched
825	CSAN:	Conduction sensor phase a negative not conducting
826	CSAP:	Conduction sensor phase a positive not conducting
827	SCRCN:	SCR CN disabled on Hi Temp
828	SCRCP:	SCR CP disabled on Hi Temp
829	SCRBN:	SCR BN disabled on Hi Temp

Coil	Variable	Description
830	SCRBP:	SCR BP disabled on Hi Temp
831	SCRAN:	SCR AN disabled on Hi Temp
832	SCRAP:	SCR AP disabled on Hi Temp
833	BAD_SS:	Bad state select input
834	CSLINEC:	C phase conduction sensor failed
835	CSLINEB:	B phase conduction sensor failed
836	CSLINEA:	A phase conduction sensor failed
837	CSCN:	Conduction sensor phase c negative not conducting
838	CSCP:	Conduction sensor phase c positive not conducting
839	CSBN:	Conduction sensor phase b negative not conducting
840	CSBP:	Conduction sensor phase b positve not conducting
841	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
842	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
843	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
844	AIRTHI:	Bridge air temperature is too hi
845	FAN_FB_ALM:	Fan feed back not present
846	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
847	SPARE	
848	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
849	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
850	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
851	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
852	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
853	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
854	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
855	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
856	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
857	RTD4_OPEN:	RTD #4 is open
858	RTD3_SHORT:	RTD #3 is shorted
859	RTD3_OPEN:	RTD #3 is open
860	RTD2_SHORT:	RTD #2 is shorted
861	RTD2_OPEN:	RTD #2 is open
862	RTD1_SHORT:	RTD #1 is shorted
863	RTD1_OPEN:	RTD #1 is open
864	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
865	BRG_LINK_ALARM:	Bridge link bad
866	RTD7_SHORT:	RTD #7 is shorted
867	RTD7_OPEN:	RTD #7 is open
868	RTD6_SHORT:	RTD #6 is shorted
869	RTD6_OPEN:	RTD #6 is open
870	RTD5_SHORT:	RTD #5 is shorted
871	RTD5_OPEN:	RTD #5 is open

Coil	Variable	Description
872	RTD4_SHORT:	RTD #4 is open
873	spare	
874	FUSE_LC	Open line or fuse phase c
875	FUSE_LB	Open line or fuse phase b
876	FUSE_LA	Open line or fuse phase a
877	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
878	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
879	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
880	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
881	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
882	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
883	BACKUP_FAN_NOT_ON:	Backup Fan Not On
884	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
885	XFER_TO_MAIN_FAN:	Transfer to Main Fan
886	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
887-896	SPARE:	

Table 8-17. Bridge 8 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
897	SPARE	
898	IN_EXECUTE_STATE:	
899	BRG_RUN_ENABLED:	LATCH when ON_CMD received
900	BRG_NOT_READY_FB:	WORKING
901	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
902	BRG_TRP_FB:	Bridge is tripped
903	BRG_ALM_FB:	Bridge has a alarm
904	BRG_RUN_FB:	Bridge is running
905-908	SPARE	
909	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
910	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
911	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
912	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
913	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
914	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
915	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
916	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
917	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
918	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
919	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
920	DC_STUCK_OPEN:	DC breaker stuck open - Latched
921	CSAN:	Conduction sensor phase a negative not conducting

Coil	Variable	Description
922	CSAP:	Conduction sensor phase a positive not conducting
923	SCRCN:	SCR CN disabled on Hi Temp
924	SCRCP:	SCR CP disabled on Hi Temp
925	SCRBN:	SCR BN disabled on Hi Temp
926	SCRBP:	SCR BP disabled on Hi Temp
927	SCRAN:	SCR AN disabled on Hi Temp
928	SCRAP:	SCR AP disabled on Hi Temp
929	BAD_SS:	Bad state select input
930	CSLINEC:	C phase conduction sensor failed
931	CSLINEB:	B phase conduction sensor failed
932	CSLINEA:	A phase conduction sensor failed
933	CSCN:	Conduction sensor phase c negative not conducting
934	CSCP:	Conduction sensor phase c positive not conducting
935	CSBN:	Conduction sensor phase b negative not conducting
936	CSBP:	Conduction sensor phase b positve not conducting
937	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
938	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
939	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
940	AIRTHI:	Bridge air temperature is too hi
941	FAN_FB_ALM:	Fan feed back not present
942	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
943	SPARE	
944	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
945	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
946	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
947	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
948	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
949	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
950	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
951	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
952	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
953	RTD4_OPEN:	RTD #4 is open
954	RTD3_SHORT:	RTD #3 is shorted
955	RTD3_OPEN:	RTD #3 is open
956	RTD2_SHORT:	RTD #2 is shorted
957	RTD2_OPEN:	RTD #2 is open
958	RTD1_SHORT:	RTD #1 is shorted
959	RTD1_OPEN:	RTD #1 is open
960	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
961	BRG_LINK_ALARM:	Bridge link bad
962	RTD7_SHORT:	RTD #7 is shorted
963	RTD7_OPEN:	RTD #7 is open

Coil	Variable	Description
964	RTD6_SHORT:	RTD #6 is shorted
965	RTD6_OPEN:	RTD #6 is open
966	RTD5_SHORT:	RTD #5 is shorted
967	RTD5_OPEN:	RTD #5 is open
968	RTD4_SHORT:	RTD #4 is open
969	spare	
970	FUSE_LC	Open line or fuse phase c
971	FUSE_LB	Open line or fuse phase b
972	FUSE_LA	Open line or fuse phase a
973	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
974	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
975	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
976	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
977	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
978	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
979	BACKUP_FAN_NOT_ON:	Backup Fan Not On
980	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
981	XFER_TO_MAIN_FAN:	Transfer to Main Fan
982	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
983-992	SPARE:	

Table 8-18. Bridge 9 (Controller #2 Modbus Coil Map)

Coil	Variable	Description
993	SPARE	
994	IN_EXECUTE_STATE:	
995	BRG_RUN_ENABLED:	LATCH when ON_CMD received
996	BRG_NOT_READY_FB:	WORKING
997	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
998	BRG_TRP_FB:	Bridge is tripped
999	BRG_ALM_FB:	Bridge has a alarm
1000	BRG_RUN_FB:	Bridge is running
1001-1004	SPARE	
1005	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1006	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1007	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1008	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1009	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1010	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1011	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1012	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off

Coil	Variable	Description
1013	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1014	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1015	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1016	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1017	CSAN:	Conduction sensor phase a negative not conducting
1018	CSAP:	Conduction sensor phase a positive not conducting
1019	SCRCN:	SCR CN disabled on Hi Temp
1020	SCRCP:	SCR CP disabled on Hi Temp
1021	SCRBN:	SCR BN disabled on Hi Temp
1022	SCRBP:	SCR BP disabled on Hi Temp
1023	SCRAN:	SCR AN disabled on Hi Temp
1024	SCRAP:	SCR AP disabled on Hi Temp
1025	BAD_SS:	bad state select input
1026	CSLINEC:	C phase conduction sensor failed
1027	CSLINEB:	B phase conduction sensor failed
1028	CSLINEA:	A phase conduction sensor failed
1029	CSCN:	Conduction sensor phase c negative not conducting
1030	CSCP:	Conduction sensor phase c positive not conducting
1031	CSBN:	Conduction sensor phase b negative not conducting
1032	CSBP:	Conduction sensor phase b positve not conducting
1033	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
1034	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
1035	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
1036	AIRTHI:	Bridge air temperature is too hi
1037	FAN_FB_ALM:	Fan feed back not present
1038	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1039	SPARE	
1040	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1041	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
1042	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
1043	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
1044	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
1045	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
1046	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
1047	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
1048	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
1049	RTD4_OPEN:	RTD #4 is open
1050	RTD3_SHORT:	RTD #3 is shorted
1051	RTD3_OPEN:	RTD #3 is open
1052	RTD2_SHORT:	RTD #2 is shorted
1053	RTD2_OPEN:	RTD #2 is open
1054	RTD1_SHORT:	RTD #1 is shorted

Coil	Variable	Description
1055	RTD1_OPEN:	RTD #1 is open
1056	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
1057	BRG_LINK_ALARM:	Bridge link bad
1058	RTD7_SHORT:	RTD #7 is shorted
1059	RTD7_OPEN:	RTD #7 is open
1060	RTD6_SHORT:	RTD #6 is shorted
1061	RTD6_OPEN:	RTD #6 is open
1062	RTD5_SHORT:	RTD #5 is shorted
1063	RTD5_OPEN:	RTD #5 is open
1064	RTD4_SHORT:	RTD #4 is open
1065		
1066	FUSE_LC	Open line or fuse phase c
1067	FUSE_LB	Open line or fuse phase b
1068	FUSE_LA	Open line or fuse phase a
1069	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1070	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1071	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1072	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1073	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1074	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1075	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1076	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1077	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1078	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1079-1088	SPARE:	

Table 8-19. Bridge A (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1089	SPARE	
1090	IN_EXECUTE_STATE:	
1091	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1092	BRG_NOT_READY_FB:	WORKING
1093	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1094	BRG_TRP_FB:	Bridge is tripped
1095	BRG_ALM_FB:	Bridge has a alarm
1096	BRG_RUN_FB:	Bridge is running
1097-1100	SPARE	
1101	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1102	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1103	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1104	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1105	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running

Coil	Variable	Description
1106	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1107	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1108	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1109	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1110	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1111	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1112	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1113	CSAN:	Conduction sensor phase a negative not conducting
1114	CSAP:	Conduction sensor phase a positive not conducting
1115	SCRCN:	SCR CN disabled on Hi Temp
1116	SCRCP:	SCR CP disabled on Hi Temp
1117	SCRBN:	SCR BN disabled on Hi Temp
1118	SCRBP:	SCR BP disabled on Hi Temp
1119	SCRAN:	SCR AN disabled on Hi Temp
1120	SCRAP:	SCR AP disabled on Hi Temp
1121	BAD_SS:	Bad state select input
1122	CSLINEC:	C phase conduction sensor failed
1123	CSLINEB:	B phase conduction sensor failed
1124	CSLINEA:	A phase conduction sensor failed
1125	CSCN:	Conduction sensor phase c negative not conducting
1126	CSCP:	Conduction sensor phase c positive not conducting
1127	CSBN:	Conduction sensor phase b negative not conducting
1128	CSBP:	Conduction sensor phase b positve not conducting
1129	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
1130	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
1131	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
1132	AIRTHI:	Bridge air temperature is too hi
1133	FAN_FB_ALM:	Fan feed back not present
1134	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1135	SPARE	
1136	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1137	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
1138	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
1139	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
1140	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
1141	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
1142	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
1143	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
1144	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
1145	RTD4_OPEN:	RTD #4 is open

Coil	Variable	Description
1146	RTD3_SHORT:	RTD #3 is shorted
1147	RTD3_OPEN:	RTD #3 is open
1148	RTD2_SHORT:	RTD #2 is shorted
1149	RTD2_OPEN:	RTD #2 is open
1150	RTD1_SHORT:	RTD #1 is shorted
1151	RTD1_OPEN:	RTD #1 is open
1152	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
1153	BRG_LINK_ALARM:	Bridge link bad
1154	RTD7_SHORT:	RTD #7 is shorted
1155	RTD7_OPEN:	RTD #7 is open
1156	RTD6_SHORT:	RTD #6 is shorted
1157	RTD6_OPEN:	RTD #6 is open
1158	RTD5_SHORT:	RTD #5 is shorted
1159	RTD5_OPEN:	RTD #5 is open
1160	RTD4_SHORT:	RTD #4 is open
1161	spare	
1162	FUSE_LC	Open line or fuse phase c
1163	FUSE_LB	Open line or fuse phase b
1164	FUSE_LA	Open line or fuse phase a
1165	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1166	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1167	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1168	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1169	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1170	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1171	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1172	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1173	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1174	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1175-1184	SPARE:	

Table 8-20. Bridge B (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1185	SPARE	
1186	IN_EXECUTE_STATE:	
1187	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1188	BRG_NOT_READY_FB:	WORKING
1189	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1190	BRG_TRP_FB:	Bridge is tripped
1191	BRG_ALM_FB:	Bridge has a alarm
1192	BRG_RUN_FB:	Bridge is running
1193-1196	SPARE	

Coil	Variable	Description
1197	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1198	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1199	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1200	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1201	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1202	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1203	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1204	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1205	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1206	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1207	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1208	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1209	CSAN:	Conduction sensor phase a negative not conducting
1210	CSAP:	Conduction sensor phase a positive not conducting
1211	SCRCN:	SCR CN disabled on Hi Temp
1212	SCRCP:	SCR CP disabled on Hi Temp
1213	SCRBN:	SCR BN disabled on Hi Temp
1214	SCRBP:	SCR BP disabled on Hi Temp
1215	SCRAN:	SCR AN disabled on Hi Temp
1216	SCRAP:	SCR AP disabled on Hi Temp
1217	BAD_SS:	Bad state select input
1218	CSLINEC:	C phase conduction sensor failed
1219	CSLINEB:	B phase conduction sensor failed
1220	CSLINEA:	A phase conduction sensor failed
1221	CSCN:	Conduction sensor phase c negative not conducting
1222	CSCP:	Conduction sensor phase c positive not conducting
1223	CSBN:	Conduction sensor phase b negative not conducting
1224	CSBP:	Conduction sensor phase b positve not conducting
1225	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
1226	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
1227	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
1228	AIRTHI:	Bridge air temperature is too hi
1229	FAN_FB_ALM:	Fan feed back not present
1230	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1231	SPARE	
1232	ALM_BRG_TRP_REQ_FB	bridge is tripped - this bit must be cleared to run again
1233	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
1234	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
1235	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
1236	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm

Coil	Variable	Description
1237	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
1238	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
1239	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
1240	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
1241	RTD4_OPEN:	RTD #4 is open
1242	RTD3_SHORT:	RTD #3 is shorted
1243	RTD3_OPEN:	RTD #3 is open
1244	RTD2_SHORT:	RTD #2 is shorted
1245	RTD2_OPEN:	RTD #2 is open
1246	RTD1_SHORT:	RTD #1 is shorted
1247	RTD1_OPEN:	RTD #1 is open
1248	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
1249	BRG_LINK_ALARM:	Bridge link bad
1250	RTD7_SHORT:	RTD #7 is shorted
1251	RTD7_OPEN:	RTD #7 is open
1252	RTD6_SHORT:	RTD #6 is shorted
1253	RTD6_OPEN:	RTD #6 is open
1254	RTD5_SHORT:	RTD #5 is shorted
1255	RTD5_OPEN:	RTD #5 is open
1256	RTD4_SHORT:	RTD #4 is open
1257	spare	
1258	FUSE_LC	Open line or fuse phase c
1259	FUSE_LB	Open line or fuse phase b
1260	FUSE_LA	Open line or fuse phase a
1261	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1262	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1263	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1264	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1265	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1266	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1267	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1268	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1269	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1270	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1271- 1280	SPARE:	

Table 8-21. Bridge C (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1281	SPARE	
1282	IN_EXECUTE_STATE:	
1283	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1284	BRG_NOT_READY_FB:	WORKING

Coil	Variable	Description
1285	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1286	BRG_TRP_FB:	Bridge is tripped
1287	BRG_ALM_FB:	Bridge has a alarm
1288	BRG_RUN_FB:	Bridge is running
1289-1292	SPARE	
1293	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1294	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1295	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1296	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1297	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1298	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1299	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1300	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1301	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1302	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1303	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1304	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1305	CSAN:	Conduction sensor phase a negative not conducting
1306	CSAP:	Conduction sensor phase a positive not conducting
1307	SCRCN:	SCR CN disabled on Hi Temp
1308	SCRCP:	SCR CP disabled on Hi Temp
1309	SCRBN:	SCR BN disabled on Hi Temp
1310	SCRBP:	SCR BP disabled on Hi Temp
1311	SCRAN:	SCR AN disabled on Hi Temp
1312	SCRAP:	SCR AP disabled on Hi Temp
1313	BAD_SS:	bad state select input
1314	CSLINEC:	C phase conduction sensor failed
1315	CSLINEB:	B phase conduction sensor failed
1316	CSLINEA:	A phase conduction sensor failed
1317	CSCN:	Conduction sensor phase c negative not conducting
1318	CSCP:	Conduction sensor phase c positive not conducting
1319	CSBN:	Conduction sensor phase b negative not conducting
1320	CSBP:	Conduction sensor phase b positve not conducting
1321	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
1322	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm
1323	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
1324	AIRTHI:	Bridge air temperature is too hi
1325	FAN_FB_ALM:	Fan feed back not present
1326	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1327	SPARE	

Coil	Variable	Description
1328	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1329	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
1330	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
1331	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
1332	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
1333	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
1334	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
1335	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
1336	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
1337	RTD4_OPEN:	RTD #4 is open
1338	RTD3_SHORT:	RTD #3 is shorted
1339	RTD3_OPEN:	RTD #3 is open
1340	RTD2_SHORT:	RTD #2 is shorted
1341	RTD2_OPEN:	RTD #2 is open
1342	RTD1_SHORT:	RTD #1 is shorted
1343	RTD1_OPEN:	RTD #1 is open
1344	SCRCN_HTEMP:	Phase c negative heat sink hi temp alarm
1345	BRG_LINK_ALARM:	Bridge link bad
1346	RTD7_SHORT:	RTD #7 is shorted
1347	RTD7_OPEN:	RTD #7 is open
1348	RTD6_SHORT:	RTD #6 is shorted
1349	RTD6_OPEN:	RTD #6 is open
1350	RTD5_SHORT:	RTD #5 is shorted
1351	RTD5_OPEN:	RTD #5 is open
1352	RTD4_SHORT:	RTD #4 is open
1353	spare	
1354	FUSE_LC	Open line or fuse phase c
1355	FUSE_LB	Open line or fuse phase b
1356	FUSE_LA	Open line or fuse phase a
1357	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1358	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1359	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1360	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1361	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1362	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1363	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1364	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1365	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1366	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1367-1376	SPARE:	

Table 8-22. Bridge D (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1377	SPARE	
1378	IN_EXECUTE_STATE:	
1379	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1380	BRG_NOT_READY_FB:	WORKING
1381	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1382	BRG_TRP_FB:	Bridge is tripped
1383	BRG_ALM_FB:	Bridge has a alarm
1384	BRG_RUN_FB:	Bridge is running
1385-1388	SPARE	
1389	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1390	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1391	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1392	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1393	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1394	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1395	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1396	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1397	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1398	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1399	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1400	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1401	CSAN:	Conduction sensor phase a negative not conducting
1402	CSAP:	Conduction sensor phase a positive not conducting
1403	SCRCN:	SCR CN disabled on Hi Temp
1404	SCRCP:	SCR CP disabled on Hi Temp
1405	SCRBN:	SCR BN disabled on Hi Temp
1406	SCRBP:	SCR BP disabled on Hi Temp
1407	SCRAN:	SCR AN disabled on Hi Temp
1408	SCRAP:	SCR AP disabled on Hi Temp
1409	BAD_SS:	Bad state select input
1410	CSLINEC:	C phase conduction sensor failed
1411	CSLINEB:	B phase conduction sensor failed
1412	CSLINEA:	A phase conduction sensor failed
1413	CSCN:	Conduction sensor phase c negative not conducting
1414	CSCP:	Conduction sensor phase c positive not conducting
1415	CSBN:	Conduction sensor phase b negative not conducting
1416	CSBP:	Conduction sensor phase b positve not conducting
1417	SCRAN_LTEMP:	Phase a negative heat sink low temp alarm
1418	SCRAP_HTEMP:	Phase a positive heat sink hi temp alarm

Coil	Variable	Description
1419	SCRAP_LTEMP:	Phase a positive heat sink low temp alarm
1420	AIRTHI:	Bridge air temperature is too hi
1421	FAN_FB_ALM:	Fan feed back not present
1422	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1423	SPARE	
1424	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1425	SCRCN_LTEMP:	Phase c negative heat sink low temp alarm
1426	SCRCP_HTEMP:	Phase c positive heat sink hi temp alarm
1427	SCRCP_LTEMP:	Phase c positive heat sink low temp alarm
1428	SCRBN_HTEMP:	Phase b negative heat sink hi temp alarm
1429	SCRBN_LTEMP:	Phase b negative heat sink low temp alarm
1430	SCRBP_HTEMP:	Phase b positive heat sink hi temp alarm
1431	SCRBP_LTEMP:	Phase b positive heat sink low temp alarm
1432	SCRAN_HTEMP:	Phase a negative heat sink low temp alarm
1433	RTD4_OPEN:	RTD #4 is open
1434	RTD3_SHORT:	RTD #3 is shorted
1435	RTD3_OPEN:	RTD #3 is open
1436	RTD2_SHORT:	RTD #2 is shorted
1437	RTD2_OPEN:	RTD #2 is open
1438	RTD1_SHORT:	RTD #1 is shorted
1439	RTD1_OPEN:	RTD #1 is open
1440	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
1441	BRG_LINK_ALARM:	BRIDGE LINK BAD
1442	RTD7_SHORT:	RTD #7 is shorted
1443	RTD7_OPEN:	RTD #7 is open
1444	RTD6_SHORT:	RTD #6 is shorted
1445	RTD6_OPEN:	RTD #6 is open
1446	RTD5_SHORT:	RTD #5 is shorted
1447	RTD5_OPEN:	RTD #5 is open
1448	RTD4_SHORT:	RTD #4 is open
1449		
1450	FUSE_LC	Open line or fuse phase c
1451	FUSE_LB	Open line or fuse phase b
1452	FUSE_LA	Open line or fuse phase a
1453	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1454	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1455	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1456	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1457	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1458	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1459	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1460	MAIN_ON_FAN_NOT_ON:	Main Fan Not On

Coil	Variable	Description
1461	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1462	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1463-1472	SPARE:	

Table 8-23. Bridge E (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1473	SPARE	
1474	IN_EXECUTE_STATE:	
1475	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1476	BRG_NOT_READY_FB:	WORKING
1477	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1478	BRG_TRP_FB:	Bridge is tripped
1479	BRG_ALM_FB:	Bridge has a alarm
1480	BRG_RUN_FB:	Bridge is running
1481-1484	SPARE	
1485	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1486	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1487	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1488	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1489	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1490	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1491	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1492	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1493	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1494	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1495	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1496	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1497	CSAN:	Conduction sensor phase a negative not conducting
1498	CSAP:	Conduction sensor phase a positive not conducting
1499	SCRCN:	SCR CN disabled on Hi Temp
1500	SCRCP:	SCR CP disabled on Hi Temp
1501	SCRBN:	SCR BN disabled on Hi Temp
1502	SCRBP:	SCR BP disabled on Hi Temp
1503	SCRAN:	SCR AN disabled on Hi Temp
1504	SCRAP:	SCR AP disabled on Hi Temp
1505	BAD_SS:	Bad state select input
1506	CSLINEC:	C phase conduction sensor failed
1507	CSLINEB:	B phase conduction sensor failed
1508	CSLINEA:	A phase conduction sensor failed

Coil	Variable	Description
1509	CSCN:	Conduction sensor phase c negative not conducting
1510	CSCP:	Conduction sensor phase c positive not conducting
1511	CSBN:	Conduction sensor phase b negative not conducting
1512	CSBP:	Conduction sensor phase b positve not conducting
1513	SCRAN_LTEMP:	Phase A negative heat sink low temp alarm
1514	SCRAP_HTEMP:	Phase A positive heat sink hi temp alarm
1515	SCRAP_LTEMP:	Phase A positive heat sink low temp alarm
1516	AIRTHI:	Bridge air temperature is too hi
1517	FAN_FB_ALM:	Fan feedback not present
1518	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1519	SPARE	
1520	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1521	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
1522	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
1523	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
1524	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
1525	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
1526	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
1527	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
1528	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
1529	RTD4_OPEN:	RTD #4 IS OPEN
1530	RTD3_SHORT:	RTD #3 IS SHORT
1531	RTD3_OPEN:	RTD #3 IS OPEN
1532	RTD2_SHORT:	RTD #2 IS SHORT
1533	RTD2_OPEN:	RTD #2 IS OPEN
1534	RTD1_SHORT:	RTD #1 IS SHORT
1535	RTD1_OPEN:	RTD #1 IS OPEN
1536	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
1537	BRG_LINK_ALARM:	BRIDGE LINK BAD
1538	RTD7_SHORT:	RTD #7 IS SHORT
1539	RTD7_OPEN:	RTD #7 IS OPEN
1540	RTD6_SHORT:	RTD #6 IS SHORT
1541	RTD6_OPEN:	RTD #6 IS OPEN
1542	RTD5_SHORT:	RTD #5 IS SHORT
1543	RTD5_OPEN:	RTD #5 IS OPEN
1544	RTD4_SHORT:	RTD #4 IS OPEN
1545	spare	
1546	FUSE_LC	OPEN LINE OR FUSE PHASE C
1547	FUSE_LB	OPEN LINE OR FUSE PHASE B
1548	FUSE_LA	OPEN LINE OR FUSE PHASE A
1549	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1550	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)

Coil	Variable	Description
1551	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1552	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1553	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1554	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1555	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1556	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1557	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1558	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1559-1568	SPARE:	

Table 8-24. Bridge F (Controller #2 Modbus Coil Map)

Coil	Variable	Description
1569	SPARE	
1570	IN_EXECUTE_STATE:	
1571	BRG_RUN_ENABLED:	LATCH when ON_CMD received
1572	BRG_NOT_READY_FB:	WORKING
1573	BRG_TRP_REQ_FB:	LATCH for trip brg trip req
1574	BRG_TRP_FB:	Bridge is tripped
1575	BRG_ALM_FB:	Bridge has a alarm
1576	BRG_RUN_FB:	Bridge is running
1577-1580	SPARE	
1581	DIGIN_IN4_FB:	DIG_IN block feedbacks input 4
1582	DIGIN_IN3_FB:	DIG_IN block feedbacks input 3
1583	DIGIN_IN2_FB:	DIG_IN block feedbacks input 2
1584	DIGIN_IN1_FB:	DIG_IN block feedbacks input 1
1585	BLKS_NOT_EXECUTING:	Should be set in all states except exe and running
1586	IN_NOT_ZERO:	Bridge off and negative bridge current too big - self clearing
1587	IP_NOT_ZERO:	Bridge off and positive bridge current too big - self clearing
1588	IBR_NOT_ZERO:	Positive of Negative bridge current not zero with bridge off
1589	AC_STUCK_CLOSED:	AC bridge breaker stuck closed - Latched
1590	AC_STUCK_OPEN:	Ac bridge breaker stuck open - Latched
1591	DC_STUCK_CLOSED:	DC breaker stuck closed - Latched
1592	DC_STUCK_OPEN:	DC breaker stuck open - Latched
1593	CSAN:	CONDUCTION SENSOR PHASE A NEGATIVE NOT CONDUCTING
1594	CSAP:	CONDUCTION SENSOR PHASE A POSITIVE NOT CONDUCTING
1595	SCRCN:	SCR CN disabled on Hi Temp
1596	SCRCP:	SCR CP disabled on Hi Temp
1597	SCRBN:	SCR BN disabled on Hi Temp

Coil	Variable	Description
1598	SCRBP:	SCR BP disabled on Hi Temp
1599	SCRAN:	SCR AN disabled on Hi Temp
1600	SCRAP:	SCR AP disabled on Hi Temp
1601	BAD_SS:	BAD STATE SELECT INPUT
1602	CSLINEC:	C PHASE CONDUCTION SENSOR FAILED
1603	CSLINEB:	B PHASE CONDUCTION SENSOR FAILED
1604	CSLINEA:	A PHASE CONDUCTION SENSOR FAILED
1605	CSCN:	Conduction sensor phase c negative not conducting
1606	CSCP:	Conduction sensor phase c positive not conducting
1607	CSBN:	Conduction sensor phase b negative not conducting
1608	CSBP:	Conduction sensor phase b positve not conducting
1609	SCRAN_LTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
1610	SCRAP_HTEMP:	PHASE A POSITIVE HEAT SINK HI TEMP ALARM
1611	SCRAP_LTEMP:	PHASE A POSITIVE HEAT SINK LOW TEMP ALARM
1612	AIRTHI:	BRIDGE AIR TEMPERATURE IS TOO HI
1613	FAN_FB_ALM:	FAN FEED BACK NOT PRESENT
1614	LOSS OF COOLING	Heatsinks above low threshold and air above threshold
1615	SPARE	
1616	ALM_BRG_TRP_REQ_FB	Bridge is tripped - this bit must be cleared to run again
1617	SCRCN_LTEMP:	PHASE C NEGATIVE HEAT SINK LOW TEMP ALARM
1618	SCRCP_HTEMP:	PHASE C POSITIVE HEAT SINK HI TEMP ALARM
1619	SCRCP_LTEMP:	PHASE C POSITIVE HEAT SINK LOW TEMP ALARM
1620	SCRBN_HTEMP:	PHASE B NEGATIVE HEAT SINK HI TEMP ALARM
1621	SCRBN_LTEMP:	PHASE B NEGATIVE HEAT SINK LOW TEMP ALARM
1622	SCRBP_HTEMP:	PHASE B POSITIVE HEAT SINK HI TEMP ALARM
1623	SCRBP_LTEMP:	PHASE B POSITIVE HEAT SINK LOW TEMP ALARM
1624	SCRAN_HTEMP:	PHASE A NEGATIVE HEAT SINK LOW TEMP ALARM
1625	RTD4_OPEN:	RTD #4 IS OPEN
1626	RTD3_SHORT:	RTD #3 IS SHORT
1627	RTD3_OPEN:	RTD #3 IS OPEN
1628	RTD2_SHORT:	RTD #2 IS SHORT
1629	RTD2_OPEN:	RTD #2 IS OPEN
1630	RTD1_SHORT:	RTD #1 IS SHORT
1631	RTD1_OPEN:	RTD #1 IS OPEN
1632	SCRCN_HTEMP:	PHASE C NEGATIVE HEAT SINK HI TEMP ALARM
1633	BRG_LINK_ALARM:	BRIDGE LINK BAD
1634	RTD7_SHORT:	RTD #7 IS SHORT
1635	RTD7_OPEN:	RTD #7 IS OPEN
1636	RTD6_SHORT:	RTD #6 IS SHORT
1637	RTD6_OPEN:	RTD #6 IS OPEN
1638	RTD5_SHORT:	RTD #5 IS SHORT
1639	RTD5_OPEN:	RTD #5 IS OPEN

Coil	Variable	Description
1640	RTD4_SHORT:	RTD #4 IS OPEN
1641	spare	
1642	FUSE_LC	OPEN LINE OR FUSE PHASE C
1643	FUSE_LB	OPEN LINE OR FUSE PHASE B
1644	FUSE_LA	OPEN LINE OR FUSE PHASE A
1645	VCO_FV4:	F_TO_V4 block has no input from transducer (IT card)
1646	VCO_FV3:	F_TO_V3 block has no input from transducer (IT card)
1647	VCO_FV2:	F_TO_V2 block has no input from transducer (IT card)
1648	VCO_FV1:	F_TO_V1 block has no input from transducer (IT card)
1649	BACKUP_FAN_STUCK_ON:	Backup Fan Stuck On
1650	MAIN_FAN_STUCK_ON:	Main Fan Stuck On
1651	BACKUP_FAN_NOT_ON:	Backup Fan Not On
1652	MAIN_ON_FAN_NOT_ON:	Main Fan Not On
1653	XFER_TO_MAIN_FAN:	Transfer to Main Fan
1654	XFER_TO_BACKUP_FAN:	Transfer to Backup Fan
1655-1664	SPARE:	

Controller #2 Modbus™ Holding Registers

Table 8-25 through Table 8-41 list the Modbus holding registers for Controller #2. The same holding registers are used for Controllers #4 and #6 (when present).

Table 8-25. Spare (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40001, 40002	SPARE	
40003, 40004	SPARE	
40005, 40006	SPARE	
40007, 40008	SPARE	
40009, 40010	SPARE	
40011, 40012	SPARE	
40013, 40014	SPARE	
40015, 40016	SPARE	

Table 8-26. Bridge 0 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40017	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40018	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40019	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40020	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40021	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP

Register	Variable	Description
40022	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40023	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40024	SCRAP_CURRENT:	From CSL block in BCM
40025	SCRAN_CURRENT:	From CSL block in BCM
40026	SCRBP_CURRENT:	From CSL block in BCM
40027	SCRBN_CURRENT:	From CSL block in BCM
40028	SCRCP_CURRENT:	From CSL block in BCM
40029	SCRCN_CURRENT:	From CSL block in BCM
40030	BRG_POS_CURRENT:	From CSL block in BCM
40031	BRG_NEG_CURRENT:	From CSL block in BCM
40032	SPARE:	

Table 8-27. Bridge 1 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40033	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40034	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40035	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40036	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40037	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40038	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40039	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40040	SCRAP_CURRENT:	From CSL block in BCM
40041	SCRAN_CURRENT:	From CSL block in BCM
40042	SCRBP_CURRENT:	From CSL block in BCM
40043	SCRBN_CURRENT:	From CSL block in BCM
40044	SCRCP_CURRENT:	From CSL block in BCM
40045	SCRCN_CURRENT:	From CSL block in BCM
40046	BRG_POS_CURRENT:	From CSL block in BCM
40047	BRG_NEG_CURRENT:	From CSL block in BCM
40048	SPARE:	

Table 8-28. Bridge 2 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40049	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40050	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40051	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP

Register	Variable	Description
40052	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40053	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40054	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40055	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40056	SCRAP_CURRENT:	From CSL block in BCM
40057	SCRAN_CURRENT:	From CSL block in BCM
40058	SCRBP_CURRENT:	From CSL block in BCM
40059	SCRBN_CURRENT:	From CSL block in BCM
40060	SCRCP_CURRENT:	From CSL block in BCM
40061	SCRCN_CURRENT:	From CSL block in BCM
40062	BRG_POS_CURRENT:	From CSL block in BCM
40063	BRG_NEG_CURRENT:	From CSL block in BCM
40064	SPARE:	

Table 8-29. Bridge 3 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40065	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40066	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40067	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40068	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40069	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40070	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40071	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40072	SCRAP_CURRENT:	From CSL block in BCM
40073	SCRAN_CURRENT:	From CSL block in BCM
40074	SCRBP_CURRENT:	From CSL block in BCM
40075	SCRBN_CURRENT:	From CSL block in BCM
40076	SCRCP_CURRENT:	From CSL block in BCM
40077	SCRCN_CURRENT:	From CSL block in BCM
40078	BRG_POS_CURRENT:	From CSL block in BCM
40079	BRG_NEG_CURRENT:	From CSL block in BCM
40080	SPARE:	

Table 8-30. Bridge 4 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40081	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40082	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40083	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40084	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40085	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40086	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40087	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40088	SCRAP_CURRENT:	From CSL block in BCM
40089	SCRAN_CURRENT:	From CSL block in BCM
40090	SCRBP_CURRENT:	From CSL block in BCM
40091	SCRBN_CURRENT:	From CSL block in BCM
40092	SCRCP_CURRENT:	From CSL block in BCM
40093	SCRCN_CURRENT:	From CSL block in BCM
40094	BRG_POS_CURRENT:	From CSL block in BCM
40095	BRG_NEG_CURRENT:	From CSL block in BCM

Table 8-31. Bridge 5 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40097	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40098	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40099	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40100	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40101	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40102	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40103	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40104	SCRAP_CURRENT:	From CSL block in BCM
40105	SCRAN_CURRENT:	From CSL block in BCM
40106	SCRBP_CURRENT:	From CSL block in BCM
40107	SCRBN_CURRENT:	From CSL block in BCM
40108	SCRCP_CURRENT:	From CSL block in BCM
40109	SCRCN_CURRENT:	From CSL block in BCM
40110	BRG_POS_CURRENT:	From CSL block in BCM
40111	BRG_NEG_CURRENT:	From CSL block in BCM
40112	SPARE:	

Table 8-32. Bridge 6 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40113	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40114	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40115	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40116	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40117	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40118	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40119	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40120	SCRAP_CURRENT:	From CSL block in BCM
40121	SCRAN_CURRENT:	From CSL block in BCM
40122	SCRBP_CURRENT:	From CSL block in BCM
40123	SCRBN_CURRENT:	From CSL block in BCM
40124	SCRCP_CURRENT:	From CSL block in BCM
40125	SCRCN_CURRENT:	From CSL block in BCM
40126	BRG_POS_CURRENT:	From CSL block in BCM
40127	BRG_NEG_CURRENT:	From CSL block in BCM
40128	SPARE:	

Table 8-33. Bridge 7 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40129	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40130	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40131	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40132	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40133	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40134	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40135	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40136	SCRAP_CURRENT:	From CSL block in BCM
40137	SCRAN_CURRENT:	From CSL block in BCM
40138	SCRBP_CURRENT:	From CSL block in BCM
40139	SCRBN_CURRENT:	From CSL block in BCM
40140	SCRCP_CURRENT:	From CSL block in BCM
40141	SCRCN_CURRENT:	From CSL block in BCM
40142	BRG_POS_CURRENT:	From CSL block in BCM
40143	BRG_NEG_CURRENT:	From CSL block in BCM
40144	SPARE:	

Table 8-34. Bridge 8 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40145	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40146	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40147	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40148	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40149	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40150	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40151	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40152	SCRAP_CURRENT:	From CSL block in BCM
40153	SCRAN_CURRENT:	From CSL block in BCM
40154	SCRBP_CURRENT:	From CSL block in BCM
40155	SCRBN_CURRENT:	From CSL block in BCM
40156	SCRCP_CURRENT:	From CSL block in BCM
40157	SCRCN_CURRENT:	From CSL block in BCM
40158	BRG_POS_CURRENT:	From CSL block in BCM
40159	BRG_NEG_CURRENT:	From CSL block in BCM
40160	SPARE:	

Table 8-35. Bridge 9 (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40161	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40162	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40163	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40164	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40165	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40166	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40167	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40168	SCRAP_CURRENT:	From CSL block in BCM
40169	SCRAN_CURRENT:	From CSL block in BCM
40170	SCRBP_CURRENT:	From CSL block in BCM
40171	SCRBN_CURRENT:	From CSL block in BCM
40172	SCRCP_CURRENT:	From CSL block in BCM
40173	SCRCN_CURRENT:	From CSL block in BCM
40174	BRG_POS_CURRENT:	From CSL block in BCM
40175	BRG_NEG_CURRENT:	From CSL block in BCM
40176	SPARE:	

Table 8-36. Bridge A (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40177	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40178	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40179	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40180	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40181	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40182	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40183	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40184	SCRAP_CURRENT:	From CSL block in BCM
40185	SCRAN_CURRENT:	From CSL block in BCM
40186	SCRBP_CURRENT:	From CSL block in BCM
40187	SCRBN_CURRENT:	From CSL block in BCM
40188	SCRCP_CURRENT:	From CSL block in BCM
40189	SCRCN_CURRENT:	From CSL block in BCM
40190	BRG_POS_CURRENT:	From CSL block in BCM
40191	BRG_NEG_CURRENT:	From CSL block in BCM
40192	SPARE:	

Table 8-37. Bridge B (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40193	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40194	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40195	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40196	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40197	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40198	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40199	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40200	SCRAP_CURRENT:	From CSL block in BCM
40201	SCRAN_CURRENT:	From CSL block in BCM
40202	SCRBP_CURRENT:	From CSL block in BCM
40203	SCRBN_CURRENT:	From CSL block in BCM
40204	SCRCP_CURRENT:	From CSL block in BCM
40205	SCRCN_CURRENT:	From CSL block in BCM
40206	BRG_POS_CURRENT:	From CSL block in BCM
40207	BRG_NEG_CURRENT:	From CSL block in BCM
40208	SPARE:	

Table 8-38. Bridge C (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40209	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40210	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40211	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40212	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40213	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40214	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40215	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40216	SCRAP_CURRENT:	From CSL block in BCM
40217	SCRAN_CURRENT:	From CSL block in BCM
40218	SCRBP_CURRENT:	From CSL block in BCM
40219	SCRBN_CURRENT:	From CSL block in BCM
40220	SCRCP_CURRENT:	From CSL block in BCM
40221	SCRCN_CURRENT:	From CSL block in BCM
40222	BRG_POS_CURRENT:	From CSL block in BCM
40223	BRG_NEG_CURRENT:	From CSL block in BCM
40224	SPARE:	

Table 8-39. Bridge D (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40225	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40226	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40227	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40228	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40229	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40230	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40231	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40232	SCRAP_CURRENT:	From CSL block in BCM
40233	SCRAN_CURRENT:	From CSL block in BCM
40234	SCRBP_CURRENT:	From CSL block in BCM
40235	SCRBN_CURRENT:	From CSL block in BCM
40236	SCRCP_CURRENT:	From CSL block in BCM
40237	SCRCN_CURRENT:	From CSL block in BCM
40238	BRG_POS_CURRENT:	From CSL block in BCM
40239	BRG_NEG_CURRENT:	From CSL block in BCM
40240	SPARE:	

Table 8-40. Bridge E (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40241	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40242	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40243	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40244	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40245	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40246	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40247	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40248	SCRAP_CURRENT:	From CSL block in BCM
40249	SCRAN_CURRENT:	From CSL block in BCM
40250	SCRBP_CURRENT:	From CSL block in BCM
40251	SCRBN_CURRENT:	From CSL block in BCM
40252	SCRCP_CURRENT:	From CSL block in BCM
40253	SCRCN_CURRENT:	From CSL block in BCM
40254	BRG_POS_CURRENT:	From CSL block in BCM
40255	BRG_NEG_CURRENT:	From CSL block in BCM
40256	SPARE:	

Table 8-41. Bridge F (Controller #2 Modbus Holding Registers)

Register	Variable	Description
40257	RTD AP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AP
40258	RTD AN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink AN
40259	RTD BP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BP
40260	RTD BN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink BN
40261	RTD CP_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CP
40262	RTD CN_DEGREES	TEMP_MONITOR block in BCM must point to RTD in heatsink CN
40263	AIR_DEGREES	TEMP_MONITOR block in BCM must point to RTD in air
40264	SCRAP_CURRENT:	From CSL block in BCM
40265	SCRAN_CURRENT:	From CSL block in BCM
40266	SCRBP_CURRENT:	From CSL block in BCM
40267	SCRBN_CURRENT:	From CSL block in BCM
40268	SCRCP_CURRENT:	From CSL block in BCM
40269	SCRCN_CURRENT:	From CSL block in BCM
40270	BRG_POS_CURRENT:	From CSL block in BCM
40271	BRG_NEG_CURRENT:	From CSL block in BCM
40272	SPARE:	

9 • Maintenance

Preventative maintenance consists of periodic replacement of the backup battery and periodically checking that the connections between the ECM-2 and the system are clean and tight. ECM-2 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

Storage

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

Backup Battery

During a loss of operating power, ECM-2 timekeeping is maintained by a battery located in a holder on the lower side of the module. Battery replacement every five years is recommended to maintain this capability. The ECM-2 uses a BR2032 lithium coin battery (Basler P/N 38526). Battery replacement is facilitated through the battery holder's glide-out tray. Refer to Figure 9-1. Spent batteries should be disposed of in an environmentally-responsible manner.

Caution

Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket when inserting a battery. Battery polarity must be correct in order to provide backup for the real-time clock.

Note

Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

When the system is connected to IRIG or NTP, the internal time clock is updated automatically; therefore the backup battery is not necessary.

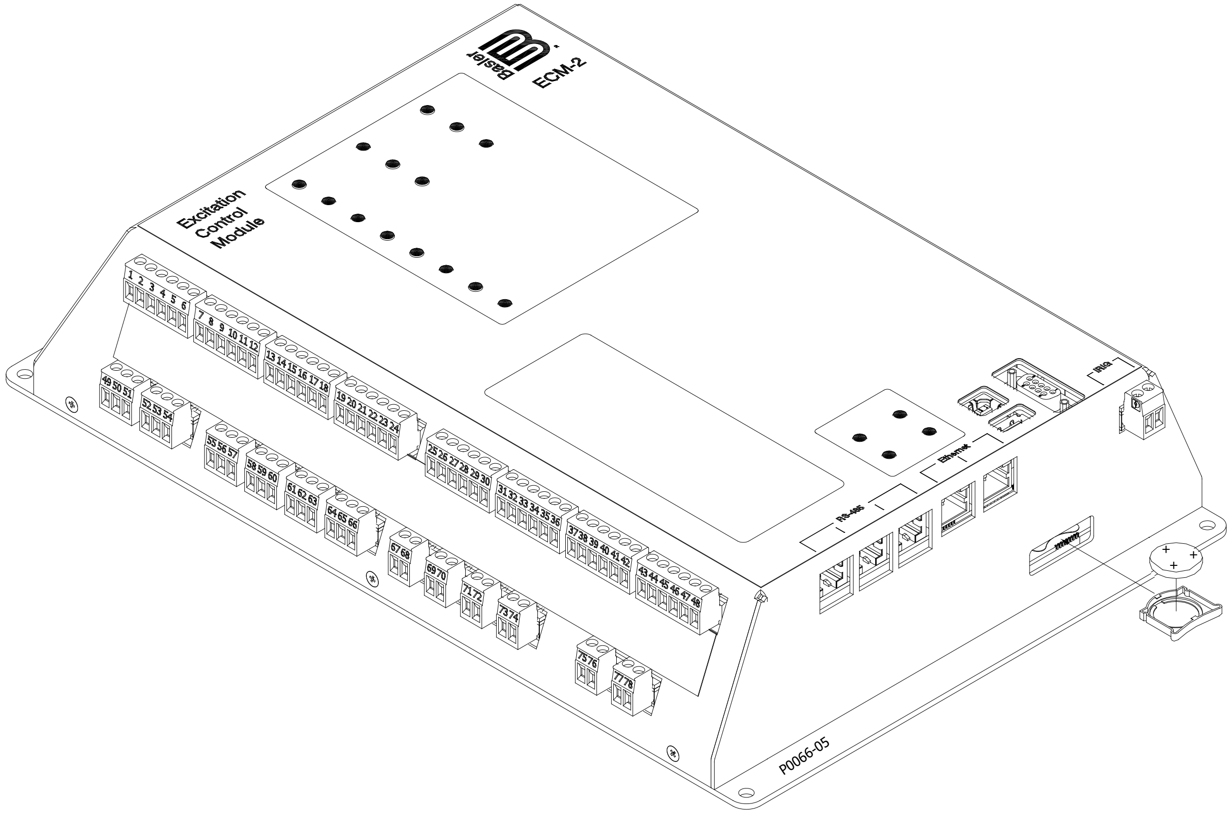


Figure 9-1. Battery Replacement

10 • Specifications

ECM-2 electrical and physical specifications are listed in the following paragraphs.

Operating Power (2 Inputs)

Nominal .... 24 Vdc
Range... 17 to 36 Vdc
Hold-Up (Ride Through)...................................... 0.2 s
Burden.. 30 W

Analog Inputs (24)

Maximum Range .... 57 Vdc/40 Vac rms

Analog Outputs (2)

Analog Voltage Output

Voltage Control Output Range .... ±10 Vdc or 0 to +10 Vdc
Burden.. 1 kΩ minimum

Analog Current Output

Current Control Output Range .... 4 to 20 mAdc
Burden.. 800 Ω maximum

Input Contacts (4)

Range... 24 Vdc or 125 Vdc/120 Vac (switch-selectable)

Input contact switches are set at the factory according to the DECS-2100 system. For information on changing the voltage range, refer to *Installation*.

Output Contacts (4)

Carry Ratings (Resistive)

24 Vdc/125 Vdc.. 7.0 Adc
120 Vac .... 7.0 Aac

Make and Break Ratings (Resistive)

24 Vdc .... 7.0 Adc
125 Vdc .... 0.2 Adc
120 Vac .... 7.0 Aac

Regulation

Accuracy and Stability

Regulation Accuracy .... ±0.1% over the load range, at rated power factor and constant generator frequency
Steady-State Stability.. ±0.2% at constant load and frequency

Temperature Stability .... ±0.5% between 0 and 50°C (32 and 122°F) at constant load and frequency
Response Time .... <1 cycle

Automatic Voltage Regulation (AVR)

Voltage Range .... 40 to 120% of rated generator terminal voltage
Frequency Range.. 20 to 180 Hz (50/60 Hz systems)

AVR with Reactive Current Compensation

Compensation Range .... ±20%
Time Constant Range .... 0.1 to 4 s
Setting Accuracy .... ±0.1%

Manual Regulation

Generator Field Current
Range.. 1 or 5% no-load to 125% full-load
Accuracy.. ±0.5%

Generator Field Voltage
Range.. 5% no-load to 125% full-load
Accuracy.. ±0.5%

Exciter Field Current
Range.. 1 or 5% no-load to 125% full-load
Accuracy.. ±0.5%

Exciter Field Voltage
Range.. 5% no-load to 125% full-load
Accuracy.. ±0.5%

Var Control Regulation

Range.. –100 to +100% of generator MVA rating
Accuracy.. ±0.5%

PF Regulation

Range.. –0.5 to –1.0 leading, 0.5 to 1.0 lagging
Accuracy.. ±0.5%

Setpoint Traverse Rate

Setting Range .... 5 to 200 s

Limiters

Minimum Excitation

Generator Capability Curve
Pickup Range... 0 to 125% of generator MVA rating (leading)
Time Delay Range .... 0 to 60 s
Accuracy.. ±1%

Stability Limit Accuracy
Pickup Range..0 to 125% of generator MVA rating (leading)
Time Delay Range ....0 to 60 s
Accuracy...±1%

Overexcitation

Pickup Range..100 to 130% of full-load field current or voltage
Time Delay ....Inverse time curve
Accuracy...±1%

Volts per Hertz

Pickup Range..100 to 130% of generator rating
Time Delay ....Inverse time, between 2 defined endpoints
Time Delay 1 Range ....10 to 1,000 s
Time Delay 2 Range ....0.2 to 10 s

Overvoltage

Pickup Range..100 to 130% of generator rating
Pickup Accuracy...±0.5%
Time Delay Range ....0 to 60 s
Accuracy...±1%

Undervoltage

Pickup Range..30 to 100% of generator rating
Pickup Accuracy...±0.5%
Time Delay Range ....0 to 60 s
Accuracy...±1%

Minimum Field Excitation

Pickup Range..0 to 100% of full-load field current or voltage
Time Delay Range ....0 to 300 s
Accuracy...±1%

Instantaneous Overcurrent

Setpoint Range (52 breaker open).......................10 to 120% of no-load field current
Setpoint Range (52 breaker closed) ....100 to 400% of full-load field current
Time Delay Range ....0 to 60 s
Accuracy...±1%

Var

Setpoint Range ....0 to 200% of generator rating
Time Delay Range ....0 to 300 s
Accuracy...±1%

Generator Line Current

Setpoint Range ....20 to 400% generator rating
Time Delay Range ....0 to 60 s
Accuracy...±1%

Protection Functions

Minimum Excitation

Generator Capability Curve

Pickup Range .... 0 to 125% of generator MVA rating (leading)
Time Delay Range .... 0.02 to 10 s

Stability Limit

Pickup Range .... 0 to 125% of generator MVA rating (leading)
Time Delay Range .... 0.02 to 10 s

Overexcitation

Pickup Range .... 100 to 140% of generator rating
Time Delay Range .... 0.02 to 10 s

Volts per Hertz

Pickup Range .... 100 to 140% of generator rating
Time Delay Range .... 0.02 to 10 s

Overvoltage

Pickup Range .... 110 to 160% of generator rating
Time Delay Range .... 0.02 to 20 s

Undervoltage

Pickup Range .... 30 to 100% of generator rating
Time Delay Range .... 0.02 to 20 s

Minimum Field Excitation

Pickup Range .... 0 to 100% of full-load field current or voltage
Time Delay Range .... 0.02 to 240 s

Instantaneous Overcurrent

Pickup Range .... 100 to 500% of rated generator or exciter field current
Time Delay Range .... 0.02 to 2 s

Var

Pickup Range .... 0 to 200% of generator rating
Time Delay Range .... 0.02 to 300 s

Generator Line Current

Pickup Range .... 100 to 200% of generator rating
Time Delay Range .... 0.02 to 20 s

Alarm Indication

Generator Field Temperature Monitor

Low Temperature Level Setpoint Range .... 40°C to 150°C (104°F to 302°F)
High Temperature Level Setpoint Range............. 40°C to 150°C (104°F to 302°F)
High Temperature Level Time Delay Range........ 0.2 to 20 s

Exciter Field Temperature Monitor

Low Temperature Level Setpoint Range .... 40°C to 150°C (104°F to 302°F)
High Temperature Level Setpoint Range............ 40°C to 150°C (104°F to 302°F)
High Temperature Level Time Delay Range........ 0.2 to 20 s

Data Logger

Data log records are stored in non-volatile memory every 10 minutes.
Inputs per Record.. 12
Sampling Rate Interval.. 1 s minimum
Record Size.. 100,000 points per record

Event Recorder

Event records are stored in non-volatile memory once the event is captured.
Number of Event Records.................................. 4
Inputs per Record.. 8
Sampling Rate Interval.. 1 ms minimum
Record Size.. 100,000 points per record

Sequence of Events Recording

Up to 16,000 events are time- and date-stamped and stored in non-volatile memory.
Number of User-Programmable Inputs 64

Metering Accuracy

Generator and Bus Voltage................................. ±1%
Generator and Bus Frequency............................ ±0.1 Hz
Generator Line Current .... ±1%
Generator Apparent Power (VA).......................... ±1%
Generator Active Power (W) .... ±1%
Generator Reactive Power (var) .... ±1%
Power Factor... ±0.02 PF
Field Current and Voltage .... ±1%
Auxiliary Voltage and Current Input .... ±1%

Communication Interface

USB Ports (2)

USB 1 (Intended for Computer Interface)
Type .... USB 2.0, Type-B
Data Transfer Speed... 12 MB/s (Full Speed)

USB 2 (Intended for Memory Storage Device)
Type .... USB 2.0, Type-A
Data Transfer Speed... 12 MB/s (Full Speed)

Ethernet Ports (2)

Type ....RJ-45, eight-pin, 10BASE-T/100BASE-TX
Maximum Length (One Network Segment)..........328 ft (100 m)

RS-485 Ports (3)

Type RJ-45, eight-pin
Data Transfer Speed ....Minimum 115,200 baud

RS-232 Port (1)

Type D-sub, nine-pin
Data Transfer Speed ....Maximum 115,200 baud

Backup Battery for Real-Time Clock

The backup battery maintains the real-time clock when neither IRIG nor NTP is connected.
Battery Replacement Interval..............................Every 5 years
Battery Holdup Time with Power Off....................Approximately 5 years
Battery Type ....Rayovac BR2032, lithium, coin-type, 3 Vdc, 195 mAh
Basler Electric P/N 38526

Environment

The ECM-2 meets the following standards.
EN-50178 (1998)..*Electronic Equipment for use in Power Installations*
IEC 60068-1 (1992)...*Basic Environmental Testing*
IEC 60068-2-1 (2007) ....*Cold Test*
IEC 60068-2-2 (2007) ....*Dry Test*
IEC 60068-2-13 (1983) ....*Altitude*
IEC 60068-2-30 (2005) ....*Damp Heat*
IEC 60255-21-1 (1988) ....*Vibration*
IEC 60255-21-2 (1988) ....*Shock and Bump*
IEC 60255-22-1 (2007) ....*Oscillatory Test Wave (SWC)*
IEC 61000-4-2 (2008) ....*Electrostatic Discharge*
IEC 61000-4-3 (2008) ....*Radiated Radio Frequency Electromagnetic Field*
IEC 61000-4-4 (2007) ....*Electrical Test Transient Burst*
IEC 61000-4-5 (2008) ....*Surge Immunity*
IEC 61000-4-6 (2008) ....*Conducted Disturbance Induced by RF Fields (Current Injection)*
IEC 61000-4-8 (2009) ....*Testing and Measurement Techniques (Power Frequency Magnetic Field Immunity*
IEC 61000-6-2 (2005) ....*Generic Immunity*
IEC 61000-6-4 (2006) ....*Generic Immunity*

Operating and Storage Temperature

Operating Range...–40°C to +60°C (–104°F to +140°F)
Storage Range ....–40°C to +65°C (–104°F to +149°F)

Humidity

Operating Range...0 to 95% non-condensing humidity

Agency Certifications

CE Compliance

In its intended use, this equipment conforms with the relevant union harmonization legislation:
Low Voltage Directive (LVD)................................2014/35/EU
Electromagnetic Compatibility (EMC) 2014/30/EU

FCC Requirements

This product complies with FCC 47 CFR Part 15.

NIIPT

NIIPT, JSC Russian certification

Patents

U.S. Patent #6,724,643
U.S. Patent #7,345,456
Other U.S. patents pending

Physical

Weight ....2.26 kg (5.00 lb)
Size ....Refer to the *Mounting* chapter

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