OPERATIONS MANUAL

Rotor Flux Probe Monitoring System

PART #: EZDP-2064

CUTSFORTH

THE POWER OF INNOVATION™

Document #: EZDP-2064

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1. About Cutsforth

Cutsforth specializes in developing innovative new technologies and services to support the power generation industry. Cutsforth's patented EASYchange® brush holder design, online truing service, and patented shaft grounding and monitoring systems have been installed across the globe in generators of all sizes and in nearly every industry application, including nuclear, natural gas, coal, wind, and hydroelectric.

Cutsforth's knowledge and commitment to excellence drives our innovative solutions for the changing needs of the power industry. Whether it is a quick response to a critical situation or a new way of solving an old problem, our commitment to quality ensures that our customers receive the best-in-class products and services—Cutsforth is the Power of Innovation.

Cutsforth, Inc. started back in 1991 as a small company focused primarily on making replacement brush holders for generators and exciters. Today, after 25+ years in business, Cutsforth's experience and innovative designs have brought its best-in-class excitation brush holder and shaft grounding replacements and collector ring services to some of the world's largest power companies.

1.1. Cutsforth Products

- EASYchange® Removable Brush Holders
- EASYchange® Brush Condition Monitoring
- Cutsforth Shaft Grounding Systems
- Rotor Flux Monitoring
- Electro-Magnetic Interference Monitoring

1.2. Cutsforth Field Services

Cutsforth provides comprehensive product installations for all product offerings as well as on-site training after the installation. We work efficiently during your outage to ensure a smooth upgrade to our innovative solutions such as Product Installations, Online Collector Ring and Commutator Truing, Spiral Groove Restoration, and Consulting and Emergency Services.

1.3. Cutsforth Electrical Contractor Services

In addition to our Field Service installation services, Cutsforth offers turn-key services including the electrical contractor scope of work as an additional service in select regions within the US. With this service offering, Cutsforth can greatly simplify the process of monitoring product installation from beginning to end.

2. Legal Information

2.1. Limited Warranty

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For a period of ninety (90) days from the date of invoice, Cutsforth warrants that (i) its software products will perform substantially in accordance with the applicable documentation provided with the software, and (ii) the software media will be free from defects in materials and workmanship. If Cutsforth receives notice of a defect or non-conformance during the applicable warranty period, Cutsforth will, in its discretion: (i) repair or replace the affected product, or (ii) refund the fees paid for the affected product. Repaired or replaced Hardware will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer. If Cutsforth elects to repair or replace the product, Cutsforth may use new or refurbished parts or products that are equivalent to new in performance and reliability and are at least functionally equivalent to the original part or product. You must obtain an RMA number from Cutsforth before returning any product to Cutsforth. Cutsforth reserves the right to charge a fee for examining and testing Hardware not covered by the Limited Warranty.

This Limited Warranty does not apply if the defect of the product resulted from improper or inadequate maintenance, installation, repair, or calibration performed by a party other than Cutsforth; unauthorized modification; improper environment; use of an improper hardware or software key; improper use or operation outside of the specification for the product; improper voltages; accident, abuse, or neglect; or a hazard such as lightning, flood, or other act of nature.

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2.2. Copyright

2.3. Patents

Please send patent information requests to patents@cutsforth.com.

3. Safety Information

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

3.1. Safety Conventions

Additional information.

Indicates an action or specific equipment area that can result in personal injury or death from an electrical hazard if proper precautions are not taken.

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury or equipment damage.

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

Indicates possible injury from rotating parts.

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

3.2. General Safety Instructions

Only qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury should work with Cutsforth products. Among the many considerations are the following:

- Avoid contact with energized circuits.
- Avoid contact with rotating parts.
- Never install any component that appears not to be functioning in a normal manner.
- Always ensure proper installation of the holder assembly and rope refresh kit.

Before working on the generator, de-energize, lock out, and tag out all power sources to the generator, shaft, and accessory devices. Electric shock and death may result due to failure to heed this warning.

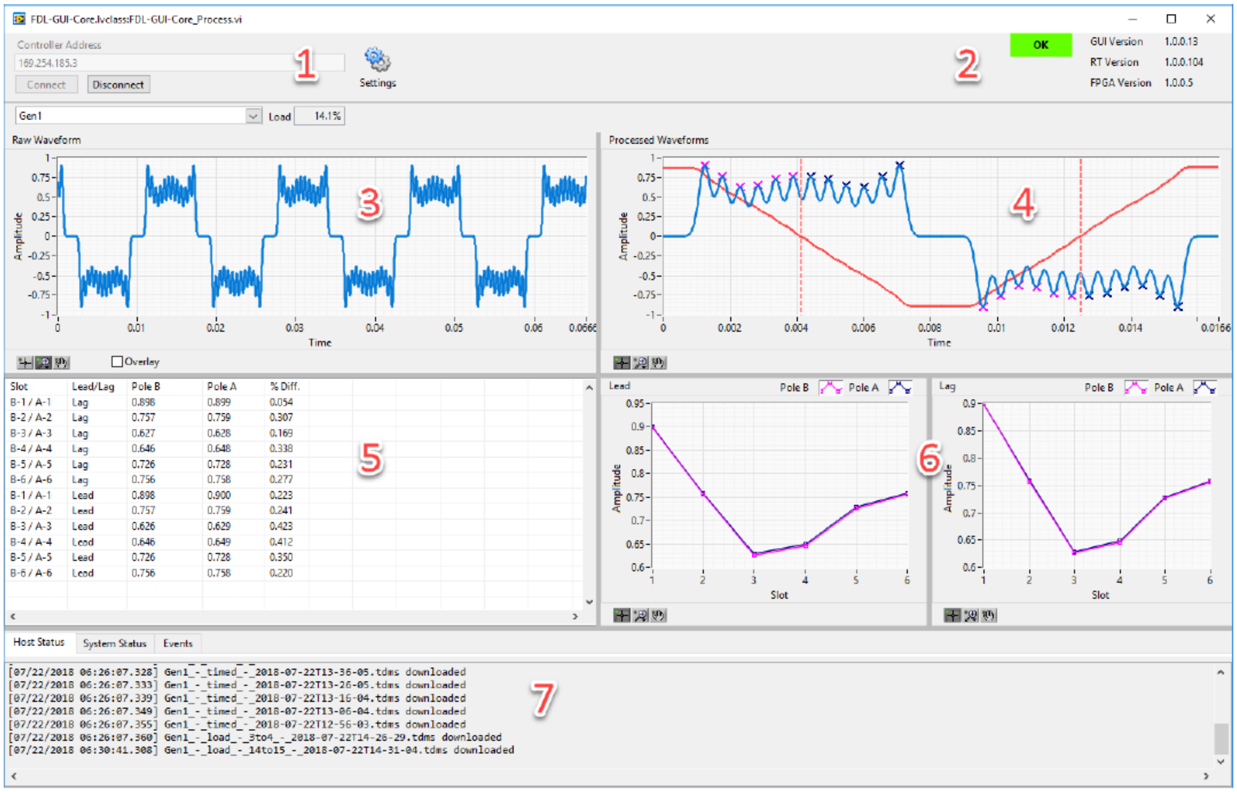
High-voltage and rotating parts can cause serious or fatal injury. Installation, operation, and maintenance of this product must be performed only by qualified personnel, in accordance with all applicable safety regulations and guidelines.

4. Rotor Flux Monitoring System

The Rotor Flux Monitoring system tracks the magnetic flux within a generator. Variances in magnetic flux indicate deterioration of winding insulation. Whether a result of thermal wear, large variation on load, contamination, or other causes, the impact to efficient generation is significant. Imbalances within the rotor damages insulation, which in turn degrades the generator's output capacity and increases vibrations, further damaging the insulation, which ultimately leads to a forced outage.

5. Host Application Overview

The image below shows the main screen for the Rotor Flux Host application that connects to the Rotor Flux Monitoring System (RFMS). The application screen contains several areas as numbered below.



NOTE

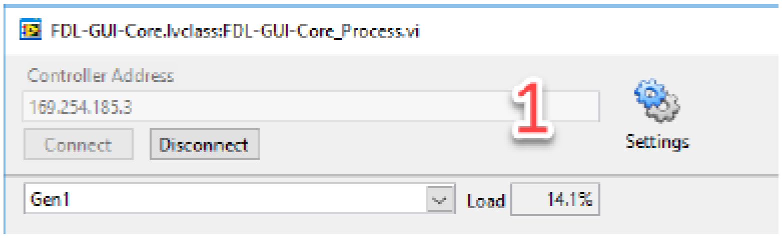
Use the slider in each section of the screen to dynamically resize the graphs and charts.

From this main screen, you can perform the following actions:

- 1: Connect to the Rotor Flux Monitoring System (RFMS) (page 10)
- 2: Viewing the Overall RFMS App Status (page 10)
- 3: Viewing the Latest Flux Signal (page 11)
- 4: Viewing Processed Flux Signals and Flux Density (page 12)
- 5: Viewing the Extrema Value Comparison Table (page 13)
- 6: Comparing Extrema Values in Graphs (page 14)
- 7: Reviewing Host Status, RFMS Status, and Events (page 14)

5.1. Connect to the Rotor Flux Monitoring System (RFMS)

The Host Configuration area (1) in the top left corner of the Host application window allows you to connect to an RFMS.



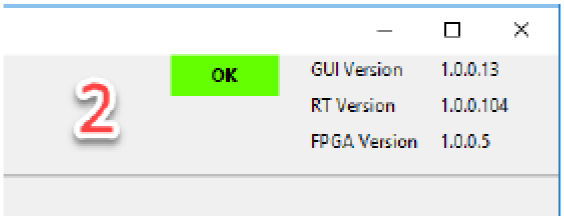
Complete these steps:

1. Enter the IP address of the RFMS in the Controller Address field.
2. Press the Connect button to connect to the RFMS.
   - If you entered an invalid IP address, the message “System not found at the specified address” appears in the Host Status tab in the Status and Events (page 14) area.
   - If a successful connection is made, the messages “System connected” and “Connected to WebDAV server” appear, with the latter message indicating that the WebDAV server used to transfer data files has successfully connected.

   Press the Disconnect button to disconnect from the RFMS.
3. In the Generator Name drop-down list, select the configured generator you want to use. The Load indicator shows a live load percentage measured from the generator load signal.

5.2. Viewing the Overall RFMS App Status

The Status area (2) shows the RFMS status (green "OK" or red "Alarm"). It also contains the version numbers of the host app (GUI) and the RTMS image (RT and FPGA) running on the embedded system (e.g., cRIO-9041).

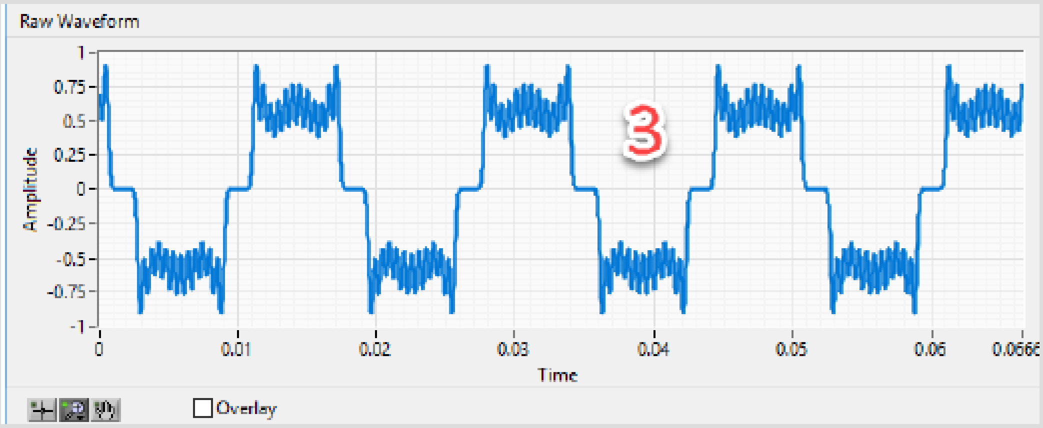


The green "OK" label turns red when the RFMS detects a rotor flux asymmetry, which indicates a shorted winding, to show that the system is in an alarm condition. If in alarm, an Ack (Acknowledge) button appears below the alarm indicator, as shown below.

The system alarm is latched and the indicator stays red until acknowledged by pressing the Ack button.

5.3. Viewing the Latest Flux Signal

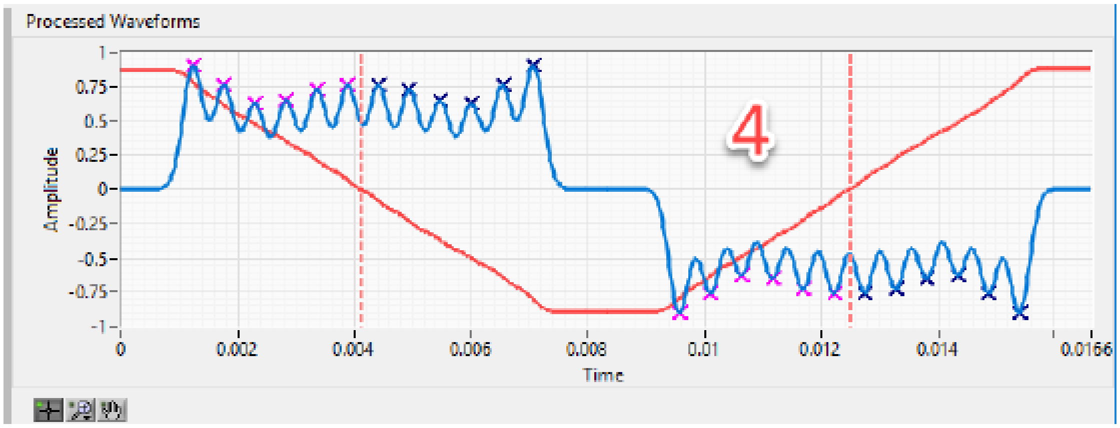
The Raw Waveform (3) graph shows the most recently captured flux signal.



The icons in the lower left corner enable cursor, zoom, and scroll. Typically, the zoom feature is the most useful. See Using Zoom on Graphs for more information.

5.4. Viewing Processed Flux Signals and Flux Density

The Processed Waveforms graph (4) plots the processed flux signal in blue and the flux density (or flux integral) in red.



The X symbols indicate the detected slot extrema: magenta for lag slots and dark blue for lead slots. From left to right, the positive-going extrema are for B Lag and A Lead, while the negative-going extrema are for A Lag and B Lead.

Extrema are ordered, from left to right, where N is the number of slots in the generator:

1. B Lag 1, …, B Lag N
2. A Lead N, …, A Lead 1 (positive-going)
3. A Lag 1, … A Lag N
4. B Lead N, …, B Lead 1 (negative-going)

NOTE

The zoom function is available here. For more information, see Using Zoom on Graphs.

5.5. Viewing the Extrema Value Comparison Table

The Extrema Value Comparison table (5) displays the numeric values of the flux signal extrema detected in the processed flux signal.

Slot	Lead/Lag	Pole B	Pole A	% Diff.
B-1 / A-1	Lag	0.898	0.899	0.054
B-2 / A-2	Lag	0.757	0.759	0.307
B-3 / A-3	Lag	0.627	0.628	0.169
B-4 / A-4	Lag	0.646	0.648	0.338
B-5 / A-5	Lag	0.726	0.728	0.231
B-6 / A-6	Lag	0.756	0.758	0.277
B-1 / A-1	Lead	0.898	0.900	0.223
B-2 / A-2	Lead	0.757	0.759	0.241
B-3 / A-3	Lead	0.626	0.629	0.423
B-4 / A-4	Lead	0.646	0.649	0.412
B-5 / A-5	Lead	0.726	0.728	0.350
B-6 / A-6	Lead	0.756	0.758	0.220

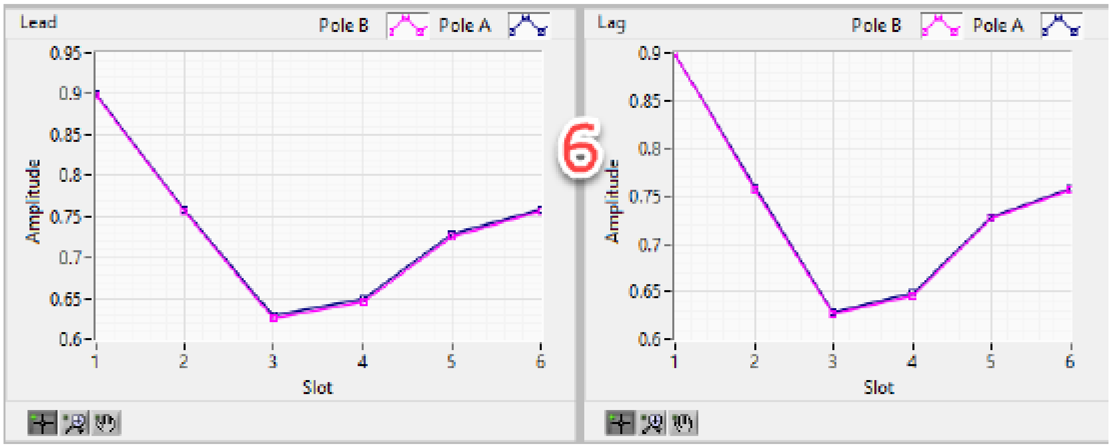
Each table row compares a slot (pole B) to its "mirror image" slot (pole A).

- Slot shows the slots being compared. For example, the third lag slots for pole B and pole A are "B-3 / A-3".
- Lead/Lag indicates if the slot is Lead or Lag.
- Pole B and Pole A show the number of flux values for those poles.
- % Diff shows the percent difference between the pole B and pole A values.

  Any value above the Shorted Turn Deviation in the Processing settings has a red background.

5.6. Comparing Extrema Values in Graphs

The two plots in the Extrema Graphs area (6) show the values in the comparison table to the left in graphs. The X-axis tick marks are the slot numbers. When one or more shorts are present, one or both of the graphs show separation in the plot traces.

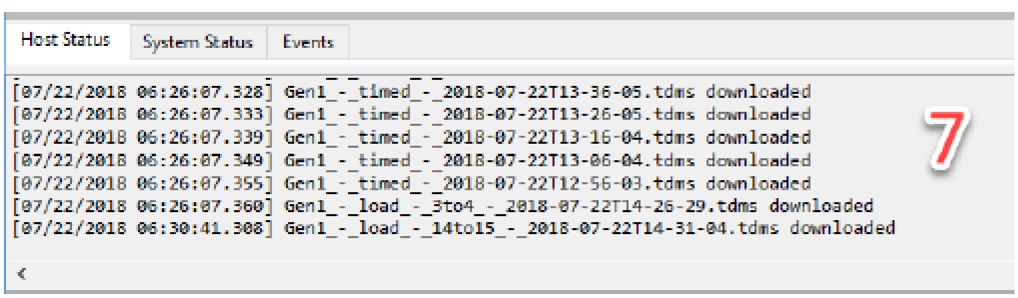


NOTE

The zoom function is available here. For more information, see Using Zoom on Graphs.

5.7. Reviewing Host Status, RFMS Status, and Events

The Host Status area (7) at the bottom has three tabs to review the host status, RFMS status, and events.



Entries in these tabs are time and date stamped. Use the scroll bar on the right side to review historical entries, up to some maximum number of archive items.

For TDMS files downloaded to the host from the RFMS, the filenames indicate the reason for creation. For example, for an elapsed time event, the filename contains the text "_timed_". For a load library registration event, the filenames contain the text "_load_" and the load range.

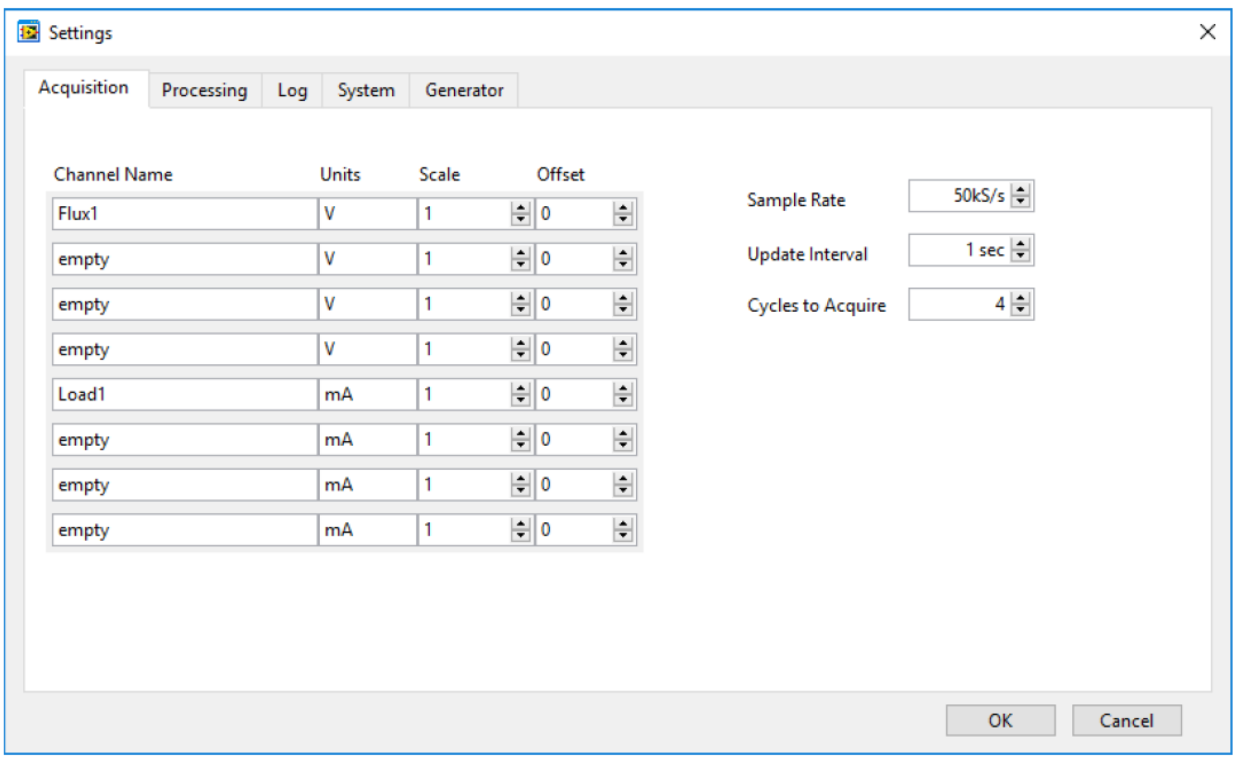
6. Changing System Settings

The Settings icon on the Host app screen opens the Settings window where you can perform the following tasks:

- Configure the Flux and Load Channels (page 15)
- Methods for Processing Raw Flux Signal (page 16)
- Configure the Logging of Flux Waveforms (page 20)
- Configure Modbus Tags (page 22)
- Configure the Generator (page 25)

6.1. Configure the Flux and Load Channels

On the Acquisitions tab of the Systems dialog, you set up the flux voltage channel and the load 4-20 mA current channel. The table on the left sets up individual channels while the fields on the right apply to all channels.



Complete these steps:

1. On the Host app screen, click the **Settings** button.

2. In the Channel Name column, enter a unique name for the channel being monitored.
3. In the Units column, enter V (Voltage) for flux channels or mA (milliamps) for load current channels.
4. In the Scale and Offset columns, enter the calibration adjustments for the incoming signal so that the value used in calculations equals:

   (Scale * Measured) + Offset

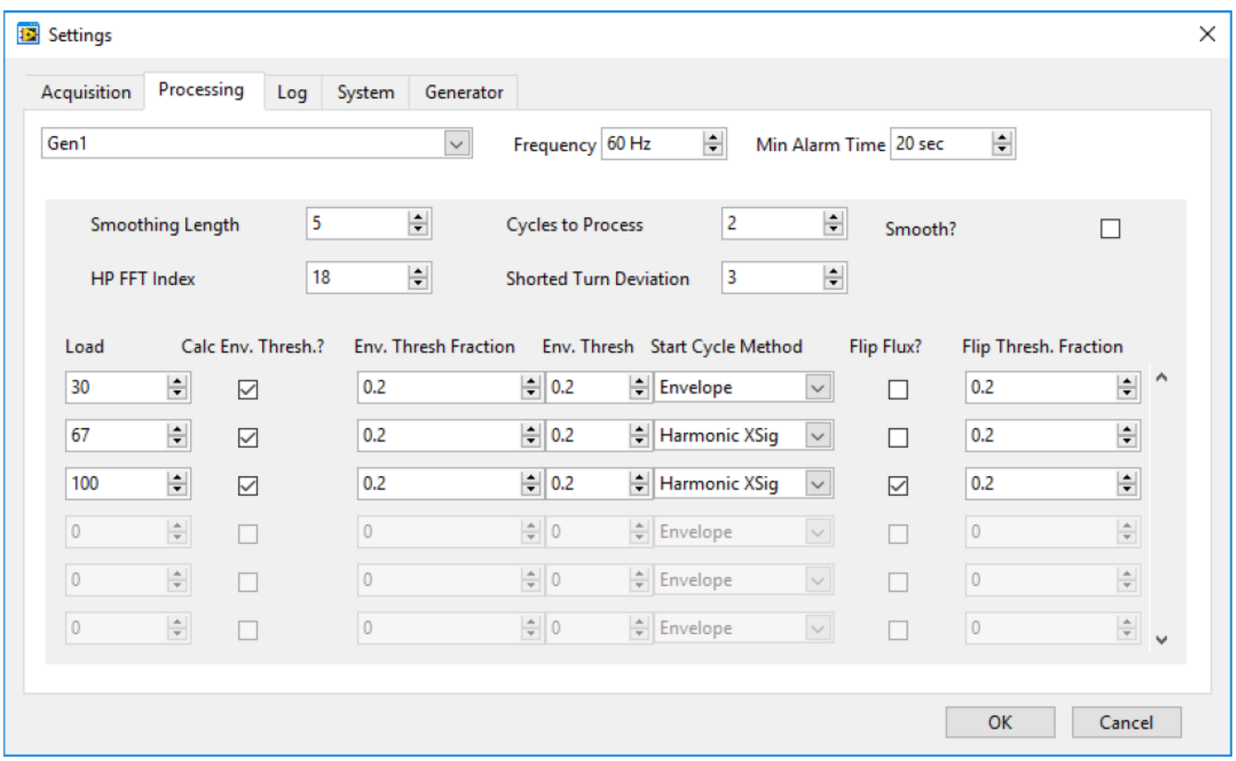
5. In the Sample Rate field, enter the rate at which the signal being tested is acquired.
6. In the Update Interval field, set how often flux signals are acquired.
7. In the Cycles to Acquire field, set the number of cycles the channel must complete before acquiring data. This value must be at least three. Larger values (more than three plus the number of poles) can help locate the flux signal cycle in noisy data.
8. Click OK to close the Settings dialog.

6.2. Methods for Processing Raw Flux Signal

At a high-level, processing raw flux signal proceeds in two stages:

1. For 2-pole generators, the raw flux signal is analyzed to locate a complete cycle without the need for a keyphasor. For 4-pole generators, a keyphasor supplies the time alignment.
2. The cycle is analyzed to locate the extrema.

The methods for processing the raw flux signal are entered in the Processing tab of the Settings dialog.

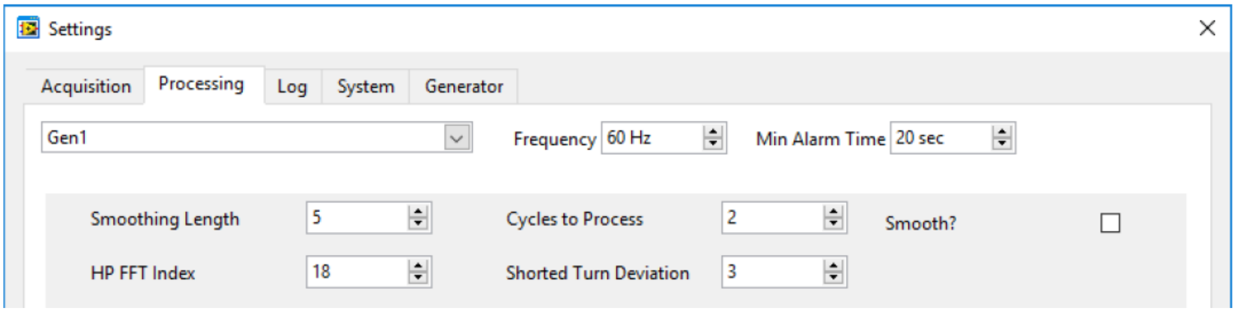


The Processing tab has three areas of data:

- Generator data (page 17)
- Flux cycle data (page 17)
- Extrema data (page 18)

6.2.1. Enter the Generator Settings for Processing Raw Flux Signal

The first line of fields at the top identify the generator and its settings.



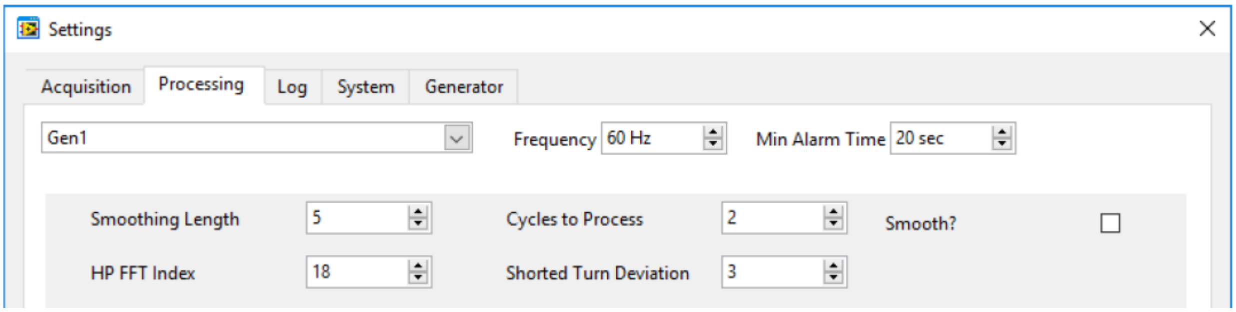
Complete these steps:

1. On the Host app screen, click the Settings button, then click the Processing tab.
2. In the drop-down menu, select the generator to set up.
3. If needed, change the generator cycle in the Frequency field.
4. In the Min Alarm Time field, set how long an alarm is ignored before being promoted to an actual alarm.

   For example, if the Min Alarm Time is 20 seconds, a suspected alarm must exist for at least 20 seconds before it becomes an actual alarm.

6.2.2. Adjust the Cycle for Processing Raw Flux Signal

The fields at the top of the gray area identify the cycle.



To adjust the processing cycle:

1. In the Smoothing Length field, enter the number of points for smoothing filter to apply to the raw waveform. This value helps minimize noise while preserving the shape of the flux signal.
2. In the Cycles to Process field, enter the number of cycles to analyze for the extrema. This number can be no more than 2 less than the Cycles to Acquire on the Acquisition settings tab. See Configure the Flux and Load Channels (page 15) for more information.
3. Check the **Smooth?** box to apply smoothing.
4. In the HP FFT Index field, enter the FFT index of the raw flux signal used to highpass filter the data to accentuate the extrema "wiggles".

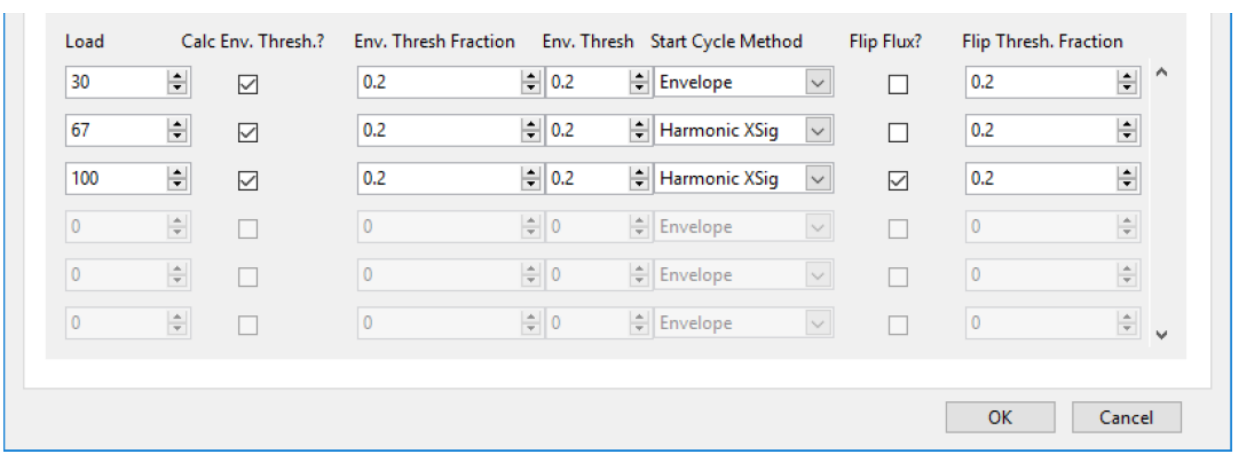
   This number is a compromise between:

   - Not filtering the meaningful wiggles in the actual extrema
   - Filtering the background cyclic behavior and the first few harmonics of this cyclic behavior
5. In the Shorted Turn Deviation field, enter the percentage used as the limit above which extrema deviations between the A and B pole are noted as high and potentially as alarm condition.
6. If you want to adjust the extrema settings, see Configure the Extrema for Raw Flux Signal (page 18). Otherwise, click **OK** to close the Settings dialog.

6.2.3. Configure the Extrema for Raw Flux Signal

The characteristics of the flux signal can change dramatically across generator loads. In the Processing settings, you can set processing parameters based on the generator load.

The parameters in each row are used for processing the raw flux signal when the generator load is at least the Load value in that row and less than the Load value in the next row. Using the parameter values in the sample below, the parameters in the first row are used between 0% and 30% load, and the parameters in the second row are used between 30% and 67% load.



Complete these steps:

1. If you are not already in the Processing settings, click the Settings button on the Host app screen, then select the Processing tab.
2. In the Load field, enter the breakpoint at or below which the rest of the parameters in the row are used for processing the raw flux signal. The units are in percentage of full generator load.

   IMPORTANT

   The Load value in last row of the table must be set to 100%.

3. For 2-pole generators, the RFMS does not require a keyphasor signal to locate the cycle. As part of the initial processing of the raw flux signal, it finds a full cycle by analyzing the waveform itself. The processing searches for regions of the flux signal with large amplitude to establish a threshold level above which the flux signal is considered large enough to have flux wiggles.

   To set how the threshold is determined:

   a. Check the Calc Env. Thresh? box to calculate the threshold based on the Env. Thresh Fraction value. Uncheck the box to use the Env. Thresh value.

   b. If using the Env. Thresh Fraction, enter the value to calculate the threshold.

   c. If using the Env. Thresh value, enter the threshold level.

4. In the Start Cycle Method column, enter the starting position of the flux signal cycle as determined by one of three methods:

   - Envelope: Based completely on the start index determined by the rough envelope of the HP filtered flux signal.
   - Harmonic XSig: Based on an average of the location where the fundamental harmonic of the raw flux signal crosses the raw flux signal and the location where the harmonic crosses zero.
   - Harmonic XZero: Based on the location where the harmonic crosses zero.

   In practice, the Envelope method works well for flux signals acquired at lower loads while the Harmonic XSig method works best on flux signals acquired at higher loads. The reason for this difference is the transition from a symmetric signal at low loads to a skewed signal at higher loads. So at higher loads, the fundamental harmonic becomes increasingly off-center as the load increases.

5. At high load, the raw flux signal can exhibit a dip towards zero in the middle of the wiggles, such that the waveform structure is concave with high average values on the edges and lower average values in the middle. With these types of waveforms, the fundamental harmonic of this signal is heavily skewed by this inverted flux signal shape. To assist with the downstream processing used to detect the start of a flux cycle, these portions of the flux signal can be flipped.

   To flip the flux signal:

   a. Check the Flip Flux? box to flip the flux signal.

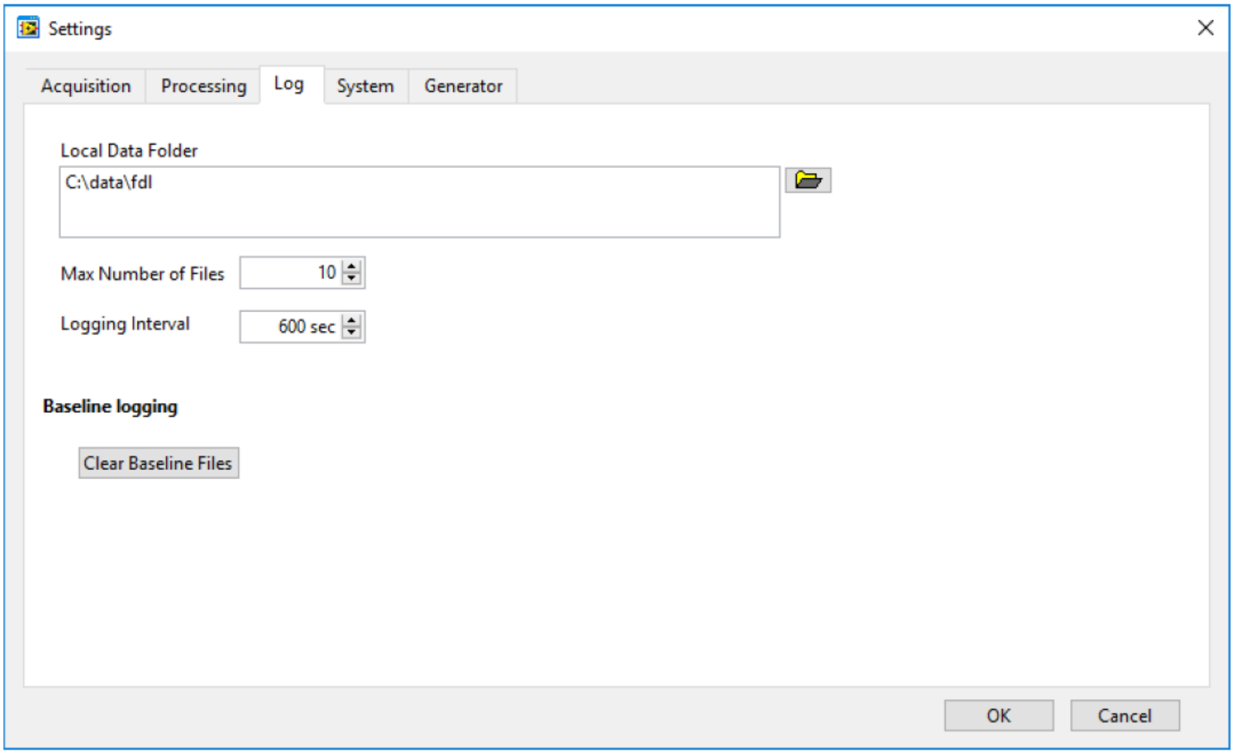
   b. In the Flip Thresh. Fraction column, enter the option that determines which values of the raw flux waveform are flipped relative to zero. If the value is:

- **Zero**: All positive flux values are flipped around the maximum positive value, so that the maximum value becomes zero and zero becomes the maximum. All negative values are similarly flipped relative to the minimum.
- **0.5**: For positive values, only the top half of the largest positive value are flipped for values above zero. For negative values, only the bottom half of the largest negative value are flipped for values below zero.
- **1**: No waveforms are flipped.

6. If you need to change the cycle settings, go to Adjust the Cycle for Processing Raw Flux Signal (page 17). Otherwise, click **OK** to close the Settings dialog.

6.3. Configure the Logging of Flux Waveforms

On the Log Settings tab, you can tell the RFMS how to log waveforms to the host.



Complete these steps:

1. On the Host app screen, click the **Settings** button, then click the Log tab.
2. In the Local Data Folder field, enter the location on the host PC where the RFMS puts the waveform files when they are available for storage.

   These files are also saved temporarily on the RFMS using a “store and forward” mechanism that reduces data loss if the Ethernet connection to the host is lost temporarily.

3. In the Max Number of Files field, enter the maximum number of files to save locally on the RFMS when the Ethernet connection is disrupted.

   When the connection is restored, all temporarily stored files are sent to the host as fast as possible. If the number of files buffered locally is less than the Max Number of Files, then no waveforms are lost. However, if the connection is down for a long time, only the most recent Max Number of Files are sent to the host when the connection is reestablished.

4. In the Logging Interval field, enter the time period after which waveforms can be saved to files.

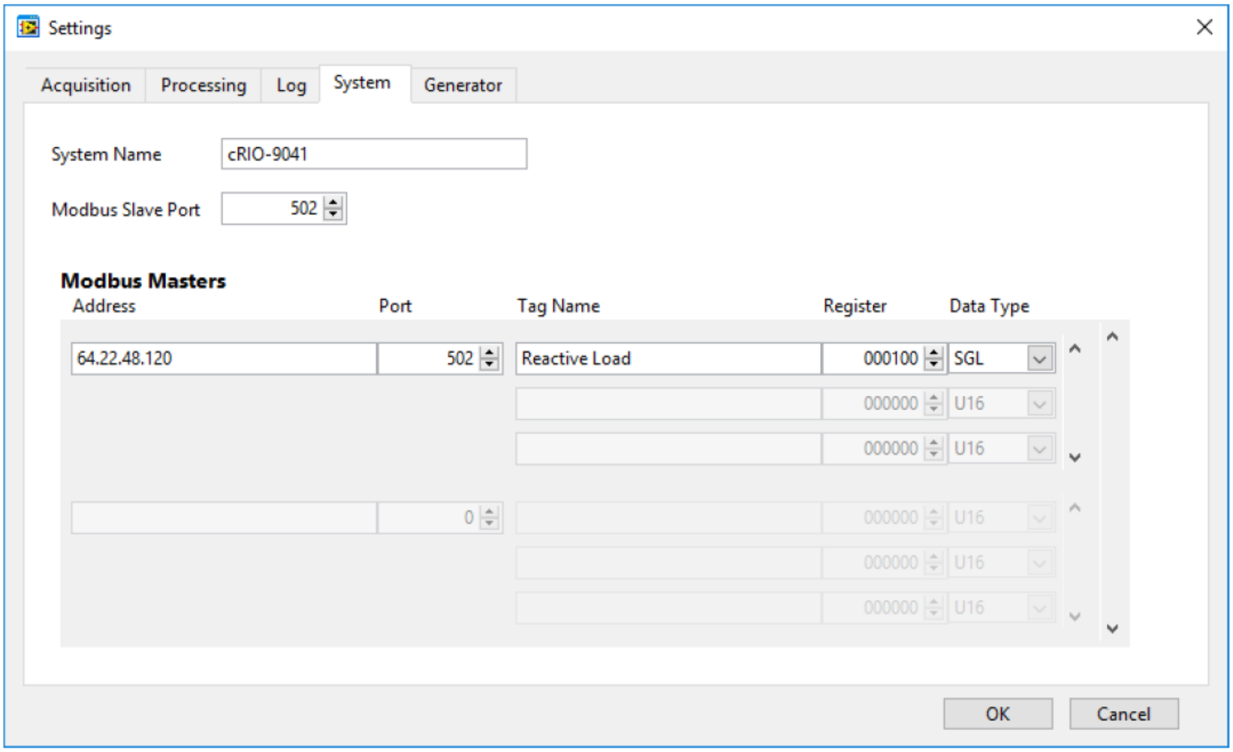
   While the RFMS acquires waveforms at the Update Interval specified in the Acquisition settings (Configure the Flux and Load Channels (page 15), these waveforms are not saved to a file. Waveforms are saved to a file only after this time specified here has elapsed.

   > NOTE
   >
   > The configuration of baseline reference waveforms storage is managed separately in an RFMS configuration file, which contains settings for the number of files for each 1% level of load and the time in seconds between saving of the raw flux signal and the last time a waveform was saved for that load level.

5. Click **OK** to close the Settings dialog.

6.4. Configure Modbus Tags

Modbus TCP is used for communicating both incoming and outgoing data. In the Modbus Masters section, you can configure data coming from the Modbus master. In the screen below, the generators Reactive Load level is being fed to the RFMS from the Modbus Master through register 100.



Complete these steps:

1. On the Host app screen, click the **Settings** button, then click the System tab.
2. In the System Name field, enter the name of the RFMS.
3. In the Modbus Slave Port field, enter the value provided by the plant, per their Modbus addressing schema.
4. In Address and Port fields, enter the IP address and port for the incoming data.
5. In the Tag Name field, enter a descriptive name for the type of data coming into the RFMS, such as Reactive Load.
6. In the Register field, enter the Modbus register number. See Modbus Registers (page 23) for a list of registers.
7. In the Data Type field, select the type of data in the register.
8. Click **OK** to close the Settings dialog.

6.4.1. Modbus Registers

The Modbus registers shown below are for two generators that each have 6 slots per pole. The actual number of registers varies depending on the number of slots, which explains the gaps between groups of values, such as Gen 1 starting at register number 0 and Gen 2 starting at register number 1000.

The Input registers are single precision floating point values.

Table 1. Input Registers

Gen 1 Lead 1	0	Input
Gen 1 Lead 2	2	Input
Gen 1 Lead 3	4	Input
Gen 1 Lead 4	6	Input
Gen 1 Lead 5	8	Input
Gen 1 Lead 6	10	Input
Gen 1 Lag 1	100	Input
Gen 1 Lag 2	102	Input
Gen 1 Lag 3	104	Input
Gen 1 Lag 4	106	Input
Gen 1 Lag 5	108	Input
Gen 1 Lag 6	110	Input

Table 2. Alarm Registers

Gen 1 Lead Alarm 1	0	Discrete
Gen 1 Lead Alarm 2	1	Discrete
Gen 1 Lead Alarm 3	2	Discrete
Gen 1 Lead Alarm 4	3	Discrete
Gen 1 Lead Alarm 5	4	Discrete
Gen 1 Lead Alarm 6	5	Discrete
Gen 1 Lag Alarm 1	6	Discrete
Gen 1 Lag Alarm 2	7	Discrete
Gen 1 Lag Alarm 3	8	Discrete
Gen 1 Lag Alarm 4	9	Discrete
Gen 1 Lag Alarm 5	10	Discrete
Gen 1 Lag Alarm 6	11	Discrete
Gen 1 Master Alarm	998	Discrete
Gen 1 Processing Errors	999	Discrete
Gen 2 Lead Alarm 1	1000	Discrete
Gen 2 Lead Alarm 2	1001	Discrete
Gen 2 Lead Alarm 3	1002	Discrete

Gen 2 Lead Alarm 4	1003	Discrete
Gen 2 Lead Alarm 5	1004	Discrete
Gen 2 Lead Alarm 6	1005	Discrete
Gen 2 Lag Alarm 1	1006	Discrete
Gen 2 Lag Alarm 2	1007	Discrete
Gen 2 Lag Alarm 3	1008	Discrete
Gen 2 Lag Alarm 4	1009	Discrete
Gen 2 Lag Alarm 5	1010	Discrete
Gen 2 Lag Alarm 6	1011	Discrete
Gen 2 Master Alarm	1998	Discrete
Gen 2 Processing Errors	1999	Discrete

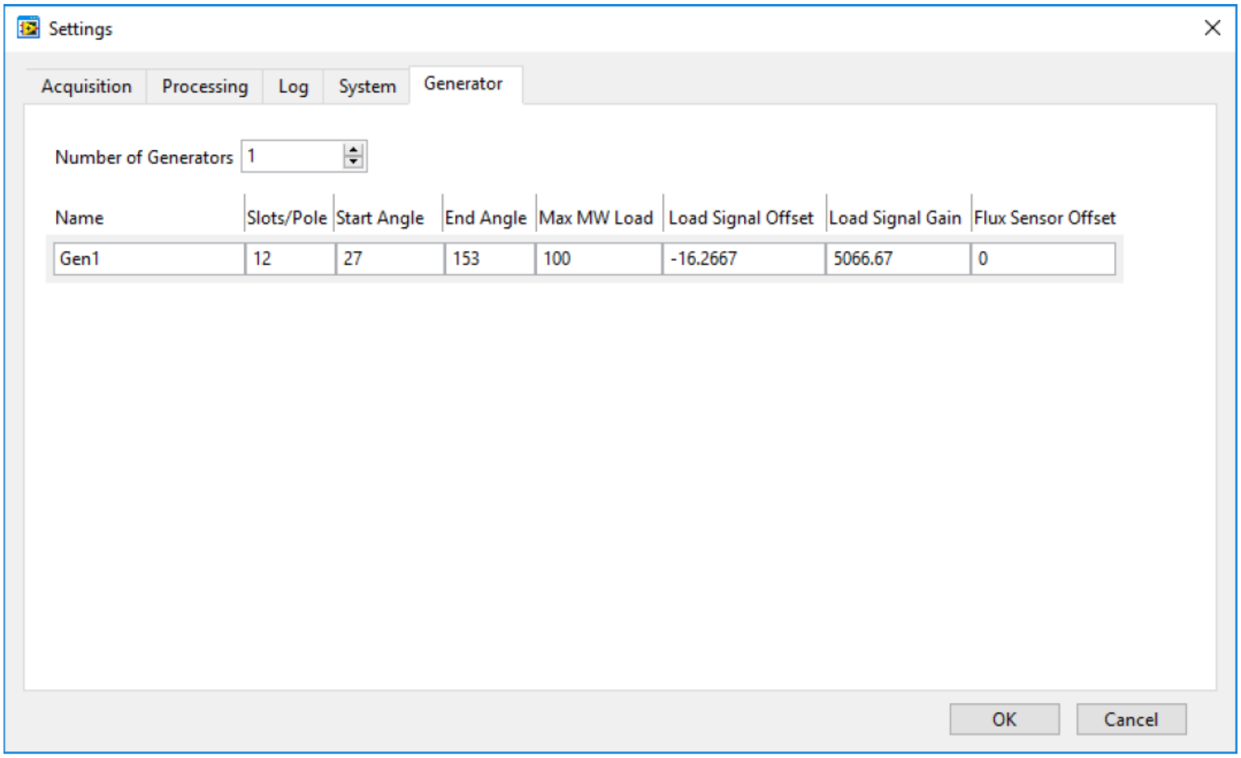
In addition to the input and alarm registers, some overall information about the generators is located in registers as shown in the table below. The registers starting at 8000 are integers, and the ones starting at 8100 are single precision floats.

Table 3. Generator Data Registers

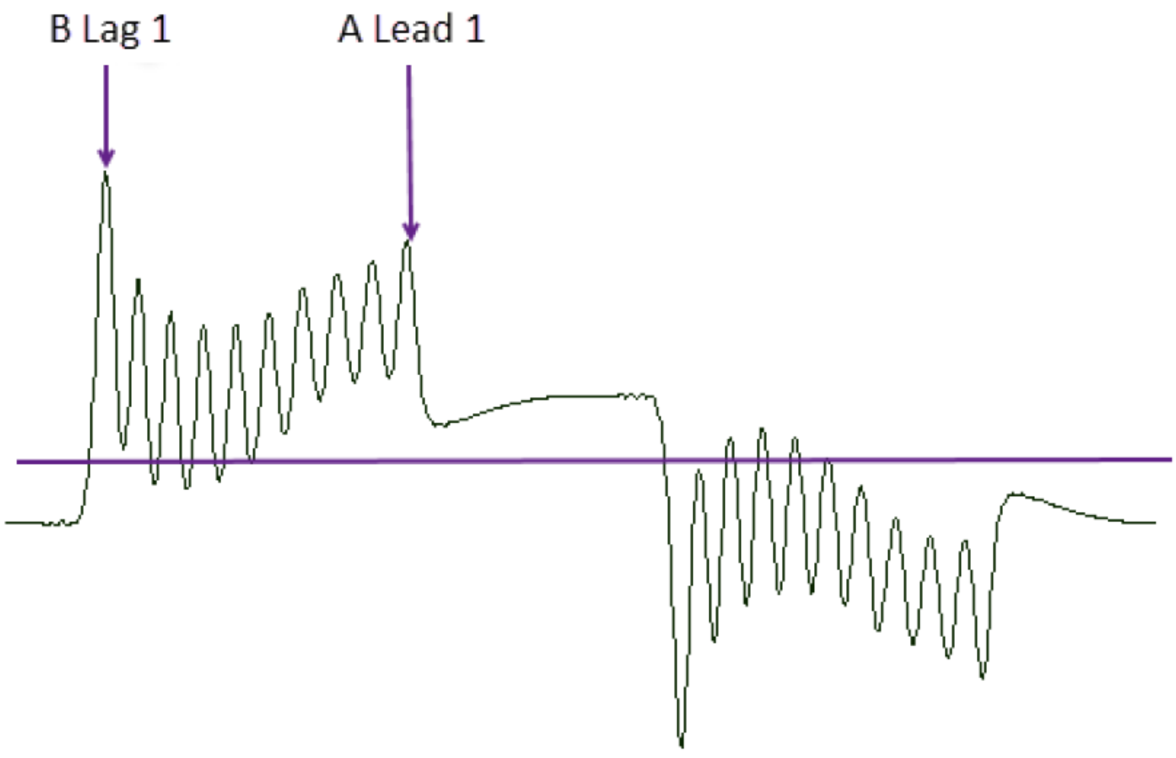
Number of generators	8000	Input
Number of slots per pole for gen 1	8001	Input
Number of slots per pole for gen 2	8002	Input
...	...	Input
Max deviation for gen 1	8100	Input
Max deviation for gen 2	8102	Input
...	...	Input

6.5. Configure the Generator

The generator configuration data is set up in tabular form, so that each row is associated with a flux channel and a 4-20 mA load channel on the RFMS data acquisition as defined in the Acquisition tab. (See Configure the Flux and Load Channels (page 15).)



The sample flux signal graph should help explain the parameters needed to configure the generators.



Complete these steps:

1. On the Host app screen, click the **Settings** button, then click the Generator tab.
2. In the Number of Generators field, enter the number of generators being configured. The range is restricted to match the hardware configuration of the RFMS.
3. In the Name column, enter the name of the generator.
4. In the Slots/Pole column, enter the slots/windings per pole. This number depends on the generator design.

   In the sample flux signal above, this parameter is 5, because there are 10 (or 2 * 5) wiggles between the leftmost and the rightmost annotated slots.
5. In the Start Angle column, enter the angle, in degrees, where the positive-going flux wiggles start (at the peak of the B Lag 1 slot in the sample above).

   The sample plot shows one complete cycle of the generator flux sensor output, and by definition, that cycle spans 360 degrees.

6. In the End Angle column, enter the angle, in degrees, where the positive-going flux wiggles stop (at the peak of A Lead 1 slot in the sample above).

   The cycle-finding algorithms use the Start Angle, End Angle, and the number of slots per pole to calculate an approximate number of points per flux wiggle. That number is then used for filtering and accessing internal calculations.

7. In the Max MW Load column, enter the maximum load signal measured by the RFMS. The percentage load value used for the reference library storage at the 1% load interval is calculated based on this value.
8. In the Load Signal Offset column, enter the bias for converting the load signal into MW for computing the MW load being output by the generator.
9. In the Load Signal Gain column, enter the gain value for converting the load signal into MW for computing the MW load being output by the generator. Combined with the Load Signal Offset, this parameter is used to convert the load measured by the RFMS as:

   MW_Load = (Load Signal Gain * Measured_Signal) + Load Signal Offset

   The MW_Load is then converted to %Load as MW_Load/Max MW Load.

10. In the Flux Sensor Offset column, enter the bias added to the flux signal to accommodate any DC offset in the flux sensor output. The flux analysis algorithms work best when the bias is near zero. With this offset, the flux signal values placed into waveforms for storage and analysis are computed as:

    Raw_Flux = Uncorrected_Flux - Flux SensorOffset

11. Click OK to close the Settings dialog.

7. Glossary

extrema	The largest and smallest value of the wavefrom within a given range.
Fast Fourier Transform (FFT)	A method for converting a signal into its frequency components, allowing for a better analysis of that signal.
flux	Rate that an electric field flows through a given area, proportional to the number of electric field lines going through a virtual surface.
flux density	The amount of flux passing through a defined area that is perpendicular to the direction of the flux.
keyphasor	An electric pulse derived from a point on a rotating shaft that serves as a zero phase reference for finding imbalance on a rotor.
lag	An alternating current that reaches its maximum value up to 90 degrees later than the voltage that produces it.
lead	An alternating current that reaches its maximum value up to 90 degrees ahead of voltage that produces it.
Modbus	A communication protocol (developed by Modicon systems) for transmitting signals from instrumentation and control devices back to a main controller or data gathering system.
Rotor Flux Monitoring System (RFMS)	A Cutsforth product that detects variances in the magnetic flux within a generator that indicate deterioration of winding insulation.
waveform	A variable that changes with time, usually representing a voltage or current. Waveforms are graphed with time on the horizontal axis.

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