KMC Controls®

KMCConquest™
Airflow Measurement System

KMC AFMS
BAC-5051E Router
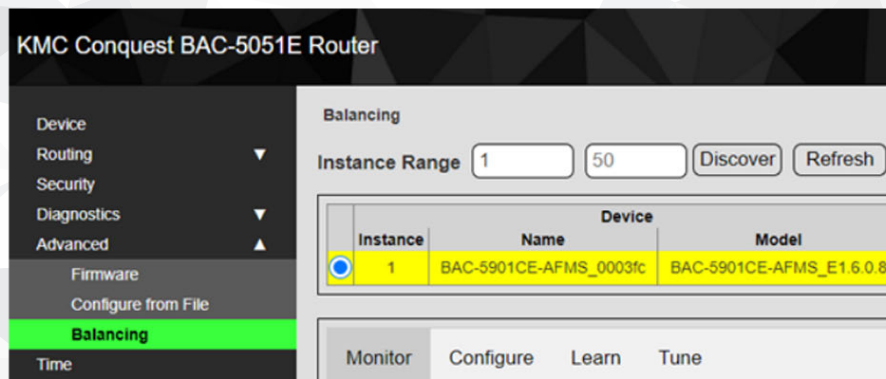## Application Guide

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Getting Started

Introduction

The BAC-5051E router can be used to configure, control, tune, and monitor the operation of a KMC Conquest Airflow Measurement System (AFMS). AFMS features are accessible through the **Balancing** web page and are active only when a valid AFMS controller has been discovered.

Prerequisites

1. Install a KMC Conquest AFMS (the controller and all system components).

   > Note: See the *Airflow Measurement System Installation Guide,* found on any AFMS controller's product page.

2. Select the application (on the AFMS controller) needed for the equipment.

   > ⚠️ **Caution:** Select the application *before* configuring other settings. Changing applications after configuration will restore most parameters to their defaults. See "Selecting an Application" in the *KMC Conquest AFMS NetSensor Application Guide,* found on any AFMS controller's product page.

   > Note: Complete basic configuration using a Conquest NetSensor, KMC Connect software, TotalControl software, and/or the KMC Converge module for Niagara WorkBench.

3. Set the AFMS controller's communication parameters.

   > Note: See the above note on the basic configuration methods.

4. Configure the router and set up routing.

   > Note: See the *Application and Installation Guide for the BAC-5051E Router* for details.

Accessing the Router's AFMS Features

1. Use an Internet browser to log in.

2. From the **Advanced** group, select **Balancing**.

3. Enter a range of device instance values that include an AFMS controller.

4. Select **Discover**.

   > Note: Up to 50 devices will be added to the list.

5. Select an AFMS controller from the list of discovered units.

Note: The background of the selected unit changes to yellow and four tabs for the AFMS are added to the bottom of the page.

Setting Up an AFMS

To set up an AFMS using the router, complete the following processes in this order:

1. *Setting AFMS Parameters* on page 5

2. *Calibrating the AFMS's Sensors* on page 7

3. *Running AFMS Learning Mode* on page 8

Note: In environmental conditions where you can't run Learning Mode, see *Manually Entering Damper Characterization Data* on page 15.

Setting AFMS Parameters

Before Beginning

Before setting a KMC Conquest Airflow Measurement System's parameters in **AFMS**, ensure that the *Prerequisites* on page 3 have been met.

> ⚠️ **Caution:** Select the appropriate application on the AFMS controller *before* configuring other settings. Changing applications after configuration will restore most parameters to their defaults. See "Selecting an Application" in the *KMC Conquest AFMS NetSensor Application Guide,* found on any AFMS controller's product page.

Setting the Parameters

1. Select the **Configure** tab.

2. For **Supply Area**, enter the measurement (in square feet) of the cross section where the supply airflow pickup tubes were installed.

   > Note: For guidance about the location of the pickup tubes, see "Mounting the Supply Airflow Pickup Tubes" in the *Airflow Measurement System Installation Guide*, found on any AFMS controller's product page.

3. Choose to either leave **Enable Low Limit** set to **ON** (the default), or to turn it **OFF**.

   > ⚠️ **Warning: ON** is recommended to prevent freezing of equipment. If not needed (due to your equipment's particular nature), you might choose to turn it **OFF**.

4. Either leave **Low Temp Limit** set to the default (37°F), or adjust the value.

   > Note: If the mixed air temperature reaches the **Low Temp Limit** set here (and **Enable Low Limit** is set to **ON**) the outside air damper will modulate toward closed to prevent freezing of the equipment.

5. For **Stroke Time (Seconds)**, enter the time (in seconds) that it takes for the damper to go from 100% open to 100% closed.

6. For **Damper Reverse Action**:

   - Select **NORMAL** if the greater the output signal to the damper actuator is, the more the damper opens (if 10 volts = 100% open).

   - Select **REVERSE** if the greater the output signal to the damper actuator is, the more the damper closes (if 10 volts = 100% closed).

7. For **Actuator Voltage**, select the voltage range of the damper actuator (2 to 10 volts or 0 to 10 volts).

8. Select **ON** for **Learn Damper Span**.

> Note: Before the AFMS controller can run **Learning Mode**, it must learn the minimum and maximum incline of the damper using the inclinometer.

9. Select **Save**.

Continue to *Calibrating the AFMS's Sensors* .

Calibrating the AFMS's Sensors

1. Select the **Tune** tab.

2. Under **Offset** for **Supply Air Flow**, enter the CFM offset (determined by a TAB technician) for the supply air pressure transducer.

3. Under **Multiplier** for **Supply Air Flow**, enter the multiplier (determined by a TAB technician) for the supply air pressure transducer.

4. Under **Offset** for **Outside Air Temp**, **Return Air Temp**, and **Mixed Air Temp**, enter the °F offsets (determined by a TAB technician) for the outside, return, and mixed air temperature sensors.

5. Select **Save**.

> Note: For more information on the AFMS's sensors, see the *Airflow Measurement System Selection Guide*, found on any AFMS controller's product page.

Continue to *Running AFMS Learning Mode* on page 8.

Running AFMS Learning Mode

Before Starting Learning Mode

For valid results, first ensure that:

- The parameters are set correctly. (See *Setting AFMS Parameters* on page 5.)

- The sensors are calibrated. (See *Calibrating the AFMS's Sensors* on page 7.)

- The supply air fan is running at a normal, steady rate (without hunting or sporadic spikes).

- If the unit has a heat recovery wheel, it is turned off.

- If any heating or cooling sources are located upstream of the MAT sensor, they are turned off.

- If the unit has a bypass damper, it is set to 100% open.

Checking Learn Ready Status

1. Select the **Learn** tab.

2. Take note whether **Learn Ready** reports **READY** or **NOT READY**.

Interpreting Learn Ready Status

If **READY** is reported, you may manually start **Learning Mode**. (Continue to *Manually Starting Learning Mode* on page 9.)

If **NOT READY** is reported:

- Check **Sensor Fault**. If **FAULT** is reported, fix any faults found.

  > Note: Go to **Monitor** to find more detailed information on faults. (See *Monitoring with an AFMS* on page 13.)

- Ensure that **Learn Damper Span** has completed.

  > Note: (Under **Configure**,) **Learn Damper Span** must currently be **OFF**, and **Damper Span Learned** must report **LEARNED**.

- **Mixed Air Temp Low Limit Control** may be **ACTIVE**. If that is the case, continue to *Enabling Learning Mode to Auto Start* on page 9.

  > Note: Go to **Monitor** to find **Mixed Air Temp Low Limit Control**. Go to **Configure** to find **Enable Low Limit** and **Low Temp Limit**. (See *Setting AFMS Parameters* on page 5 for important guidance on Low Limit.)

- Check **Min Delta Temp**. If the current ΔT (the absolute difference between the outside and return air temperatures) is less than the minimum difference allowed, then continue to *Enabling Learning Mode to Auto Start* on page 9.

> Note: Go to **Monitor** to find **Outside Air Temp** and **Return Air Temp**. Calculate the absolute difference, then compare to **Min Delta Temp**.

Manually Starting Learning Mode

If **Learn Ready** reports **READY** (see *Checking Learn Ready Status* on page 8), you may start **Learning Mode** manually.

1. Leave **Min Delta Temp** set to the default, or adjust it if needed.

> Note: If the ΔT becomes less than the **Min Delta Temp**, the AFMS controller will abort Learning Mode. This is to insure that the controller does not receive unusable learning samples. Setting the **Min Delta Temp** at a 10°F or larger difference is recommended.

2. Leave **Time Between Samples (Seconds)** set to the default, or adjust it if needed.

> Note: Most often, **Time Between Samples (Seconds)** can be left on the default (60 seconds). You might increase the value if the damper **Stroke Time** (see *Setting AFMS Parameters* on page 5) is longer than that of a typical unit, or if the damper actuator requires extra time to respond. You might decrease it if a large ΔT is present and time at the site is limited. However, too little time between samples could result in inaccurate measurements.

3. For **Learning Mode**, select **ON**.

4. Select **Save**.

5. Wait for **Learning Mode** to complete.

> Note: To calculate the total time (in minutes) that **Learning Mode** should take to complete, multiply **Time Between Samples (Seconds)** by 91, then divide by 60.

> Note: **Learn Timer** shows the elapsed time since **Learning Mode** started.

Enabling Learning Mode to Auto Start

If **Learn Ready** reports **NOT READY** because of currently unfavorable temperatures (see *Interpreting Learn Ready Status* on page 8) you may enable the AFMS controller to automatically start **Learning Mode** when it detects favorable temperatures at a later time.

1. Leave **Min Delta Temp** set to the default, or adjust it if needed.

> Note: If the ΔT becomes less than the **Min Delta Temp**, the AFMS controller will abort Learning Mode. This is to insure that the controller does not receive unusable learning samples. 10°F or more **Min Delta Temp** is recommended.

2. Leave **Auto Start Delta Temp** set to the default, or adjust it if needed.

> Note: When the ΔT reaches the **Auto Start Delta Temp**, Learning Mode will start. Learning Mode will complete if the ΔT remains greater than the **Min Delta Temp** for the entire duration. An **Auto Start Delta Temp** that is at least 10°F more than **Min Delta Temp** is recommended.

3. Leave **Time Between Samples (Seconds)** set to the default, or adjust it if needed.

> Note: Most often, **Time Between Samples (Seconds)** can be left on the default (60 seconds). You might increase the value if the damper **Stroke Time (Seconds)** (found under **Configure > Damper**) is longer than that of a typical unit, or if the damper actuator requires extra time to respond.

4. For **Auto Learn Enable**, select **ON**.

5. Select **Save**.

> Note: See the **Date of Last Learn** and the **OAT When Learned** once **Learning Mode** has run automatically.

Alternative to Running Learning Mode

While not ideal, the damper characterization data can be calculated and entered manually. This should only be done if — in the allotted time for setting up the AFMS — the ΔT is unlikely to remain greater than the **Min Delta Temp** for the duration of **Learning Mode**. See *Manually Entering Damper Characterization Data* on page 15 for guidance.

Controlling Airflow with an AFMS

About

After *Setting Up an AFMS* on page 4, you can control outside air flow, or control mixed air temperature. Also, for setup or maintenance purposes, you can command a damper position.

Alternatively, you can pass through control of the damper actuator to an external controller, using the AFMS for measurement and monitoring only. (See *Monitoring with an AFMS* on page 13.)

Controlling Outside Air Flow

1. Select the **Configure** tab.

2. From the **Control Mode** dropdown menu, select **OA FLOW CTRL**.

3. Enter an **Outside Air Flow Setpoint** (as CFM).

4. Select **Save**.

> Note: The outside air damper will modulate to maintain the **Outside Air Flow Setpoint**. If **Enable Low Limit** is **ON** and the mixed air temperature reaches the **Low Temp Limit**, the damper will modulate toward closed to prevent freezing of the equipment. If an occupancy sensor is used, this **Control Mode** will only be active when the served space is occupied.

Controlling Mixed Air Temperature

1. From the tabs that appear, select **Configure**.

2. From the **Control Mode** dropdown menu, select **MAT CTRL**.

3. Enter a **Mixed Air Temp Setpoint**.

4. Select **Save**.

> Note: The outside air damper will modulate to maintain the **Mixed Air Temp Setpoint**. If **Enable Low Limit** is **ON** and the mixed air temperature reaches the **Low Temp Limit**, the damper will modulate toward closed to prevent freezing of the equipment. If an occupancy sensor is used, this **Control Mode** will only be active when the served space is occupied.

Commanding a Damper Position

1. From the tabs that appear, select **Configure**.

2. From the **Control Mode** drop-down menu, select **DMPR POSITION CTRL**.

3. Enter an **Outside Air Damper Setpoint** (0–100% open).

4. Select **Save**.

Note: The AFMS controller will command the damper to the **Outside Air Damper Setpoint**. If **Enable Low Limit** is **ON** and the mixed air temperature reaches the **Low Temp Limit**, the damper will modulate toward closed to prevent freezing of the equipment. If an occupancy sensor is used, this **Control Mode** will only be active when the served space is occupied.

Enabling Pass Through

1. From the tabs that appear, select **Configure**.

2. From the **Control Mode** drop-down menu, select **PASS THROUGH**.

3. Select **Save**.

Note: The external controller (if the AFMS controller is wired to one) will be allowed to control the damper actuator. (For wiring details, see the *Airflow Measurement System Installation Guide,* found on any AFMS controller's product page.) This **Control Mode** will only be active when **Learn Damper Span** and **Learning Mode** (under the **Learn** tab) are **OFF**.

⚠ **Warning:** The **Enable Low Limit** and **Low Temp Limit** do *not* apply when in **PASS THROUGH**. Ensure the external controller has its own low limit and other safeties configured to prevent equipment damage.

Monitoring with an AFMS

Accessing Monitoring

Select the **Monitor** tab.

Monitoring Operation

Label	Description
Outside Air Flow	The AFMS controller's current outside air CFM calculation displays here.
AFMS Status	**NORMAL** = No faults are detected. **LEARN MODE** = **Learning Mode** is **ON**. (See *Running AFMS Learning Mode* on page 8.) **SPAN MODE** = **Learn Damper Span** is **ON**. (See *Setting AFMS Parameters* on page 5.) **SERVICE** = One or more faults are detected. (See *Monitoring Faults* on page 13.)
Control Mode	The saved **Control Mode** (**OA FLOW CTRL**, **MAT CTRL**, **DMPR POSITION CTRL** or **PASS THROUGH**) displays here. (See *Controlling Airflow with an AFMS* on page 11.)
Damper Position	The damper's percentage open displays here.
Occupancy	The default is **OCCUPIED**. If an occupancy sensor is used and the served space is vacant, **UNOCCUPIED** will display.
Outside Air Temp	The outside air temperature sensor's measurement displays here.
Return Air Temp	The return air temperature sensor's measurement displays here.
Mixed Air Temp	The mixed air temperature sensor's measurement displays here.

Monitoring Faults

Label	Description
Outside Air Sensor Fault	**FAULT** = The outside air temperature sensor is missing or shorted.
Return Air Sensor Fault	**FAULT** = The return air temperature sensor is missing or shorted.
Mixed Air Sensor Fault	**FAULT** = The mixed air temperature sensor is missing or shorted.
Sensor Fault	**FAULT** = One or more of the three temperature sensors is missing or shorted.
Damper Control Fault	If the saved **Control Mode** is **DMPR POSITION CTRL** (see *Commanding a Damper Position* on page 11), **FAULT** will display if the damper position is more than 15% off from the **Outside Air Damper Setpoint** for longer than the **Stroke Time (Seconds)** (found under **Configure** > **Damper**). This indicates that the damper is not moving properly.
Outside Air Control Fault	If the saved **Control Mode** is **OA FLOW CTRL** (see *Controlling Outside Air Flow* on page 11), **FAULT** will display if **Outside Air Flow** is more than 15% off from the **Outside Air Flow Setpoint** for longer than the **Stroke Time (Seconds)** (found under **Configure** > **Damper**). This indicates that the damper is not moving properly.

Label	Description
Mixed Air Flow Fault	If the saved **Control Mode** is **MAT CTRL** (see *Controlling Mixed Air Temperature* on page 11), **FAULT** will display if **Mixed Air Temp** is more than 15°F off from the **Mixed Air Temp Setpoint** for longer than the **Stroke Time (Seconds)** (found under **Configure > Damper**). This indicates that the damper is not moving properly.
Outside Air Flow Fault	**FAULT** = The calculation of the airflow based on the damper characterization data (see *Accessing the Damper Characterization Table* on page 15) has differed from the calculation using the current temperatures by more than the tolerance (20% difference default) for longer than 10 minutes. Ensure that the equipment is in the same physical condition as it was when **Learning Mode** was run. **Learning Mode** may need to be run again and/or sensors re-calibrated.
Mixed Air Temp Low Limit Control	**ACTIVE** = The damper is modulating toward closed to prevent freezing of the equipment because the **Mixed Air Temp** is lower than the **Low Temp Limit** (found under **Configure > General**).
	INACTIVE = Either the **Mixed Air Temp** is higher than the **Low Temp Limit**, or **Enable Low Limit** is set to **OFF**.
	See the related low limit information in *Setting AFMS Parameters* on page 5.

Accessing the Damper Characterization Table

Manually Entering Damper Characterization Data

While not ideal, the damper characterization data can be calculated and entered manually in the **AFMS Table**. This should only be done if − in the allotted time for *Setting Up an AFMS* on page 4 − the ΔT is unlikely to be greater than the **Min Delta Temp** for the duration of **Learning Mode**. In that case, for reliability, running Learning Mode at a later available time is still recommended.

Accessing the AFMS Table

Select the **Tune** tab.

Interpreting the AFMS Table

Label	Description
Flow	Percentage (expressed as a decimal) of the supply airflow that is outside airflow at the given outside air damper position
Diff Pressure **(pressure assist application only)**	The pressure differential (in inches of water column) at the given outside air damper position See the KMC Conquest AFMS documentation for pressure assist information.
Outside Air Closed	Outside air damper at closed position
Outside Air 5	Outside air damper at 0−5% open
Outside Air 10	Outside air damper at 5−10% open
Outside Air 15	Outside air damper at 10−15% open
Outside Air 20	Outside air damper at 10−20% open
Outside Air 30	Outside air damper at 20−30% open
Outside Air 40	Outside air damper at 30−40% open
Outside Air 50	Outside air damper at 40−50% open
Outside Air 60	Outside air damper at 50−60% open
Outside Air 70	Outside air damper at 60−70% open
Outside Air 80	Outside air damper at 70−80% open
Outside Air 90	Outside air damper at 80−90% open
Outside Air 100	Outside air damper at 90−100% open

Calculating the damper characterization data

Use the %OA equation found in ASHRAE Standard 111, section 7.6.3.3: "Flow Rate Approximation by Temperature Ratio".

Note: Find ASHRAE Standard 111 on this page of read-only versions of ASHRAE standards.

Note: See *Controlling Airflow with an AFMS* on page 11 for how to set the outside air damper to the required positions for the measurements.

Note: See *Monitoring with an AFMS* on page 13 for where to find the sensor readings.

Continue to *Getting Started* on page 3.

Verifying the Damper Characterization Data

Should the damper characterization data require verification, measurements should only be made using NIST-traceable instruments and the method described in ASHRAE Standard 111. (See the details in *Manually Entering Damper Characterization Data* on page 15.)

Important Notices

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