inView 360 Fusion

Calibration Guide
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Introduction

This guide covers the calibration procedure for the inView 360 Fusion Around Vehicle Monitoring (AVM) system. This guide does not go into the installation procedure for any of the AVM components (cameras, electronic control unit, in-vehicle monitor, wires and cables). Before taking on the calibration process, all components should already be installed in the vehicle.

For more information on how to install the components, please see the inView 360 Fusion Installation Guide on the FRC inView 360 Fusion website page. (Please see the links on the left side of this website page for both the Installation and Calibration guides.) Or, please contact the FRC Service Team for assistance; contact details can be found online on the Contact FRC page.

About the AVM

The inView 360 Fusion Around Vehicle Monitoring (AVM) system provides drivers with a real-time, 360° picture of the area around their vehicle to help eliminate blind spots, improve pedestrian safety, prevent vehicle damage, and avoid liability costs.

To achieve the 360° picture, 4 images are captured from cameras positioned in the front, left, right, and rear of the vehicle. These images are then transferred to a computer and calibrated using software. Once calibrated, the images are transferred back to the vehicle and viewed on a monitor mounted in the cab of the vehicle.
The following flow chart helps to summarize the calibration process:

1. AVM components are installed in the vehicle.
2. Calibration pads are placed around the vehicle.
3. Camera images are captured and stored on an SD card in the vehicle.
4. Images are transferred from the vehicle to a PC.
5. PC Software performs calibration of the cameras. Calibration files are created and stored on the SD card.
6. SD card containing calibration files gets transferred from PC back to the vehicle.
7. Operator loads calibration files and verifies quality of calibrated 360° image.
8. Is calibrated 360° image good? (no distortion, can clearly see calibration pads in image)
   - Yes: Calibration is complete
   - No: Reposition calibration pads or cameras and repeat process
Preparation

Before you proceed with calibrating the AVM, you’ll need to ensure that you have the proper components, tools and computer specs.

Calibration Kit

The inView 360 Fusion calibration kit includes the following items:

- USB drive containing:
  - Calibration Tool
  - Calibration Guide (PDF)
- SD Card w/ Boot Loader
- SD Card to USB adapter
- Remote Control
- Remote Control Receiver
- Calibration Pads x 4

Recommended Tools

At the minimum, you should have the following tools to help you perform the calibration:

- Long measuring tape (100-foot recommended)
- 4 x 25-foot measuring tapes
- Large plastic square ruler
- Masking tape (any color, as long as it contrasts with the surface where the vehicle is parked when calibration images are captured)

Recommended Computer Specs

The computer should meet the following minimum requirements:

Operating System: Windows (64-bit version required) 10, 8.x, or 7.x
Processor: Intel or AMD x86
Disk Space: 3.5 GB free
RAM: 1024MB (2048 MB recommended)

Required Computer Skills

You must at minimum have some basic Windows navigation skills including knowing how to:

- Navigate Windows Explorer
- Cut & Paste files from one directory to another
- Extract files from a zip folder
Physical Environment

Ideally, calibration should be performed in a well-lit, bright shop with adequate space around the perimeter of the vehicle. There should be a minimum of 80 inches all around the vehicle.

Calibration can be completed outside, but only on a level, paved surface. Calibrating in the rain or snow is not recommended as this can cause distortion (snow or rain on the camera lenses).

Installing the Calibration Tool

The 360 Fusion Calibration Tool comes on the supplied USB drive included in your calibration kit. To install, simply unzip the calibration tool folder and move the contents to a directory on your computer.

The folder will contain several sub folders and files. Ensure that your folders look like the ones in this example:
Placing Calibration Pads

Once the AVM components have been installed, the next step is to place calibration pads around the vehicle.

**Measure your vehicle length**

Using a long tape measure, capture the length and width of the vehicle and record the values. These values will be used in the calibration software later on in the process.

**Note: Measuring Proper Length**

The furthest tips of the vehicle should be considered in your measurement, including the bumpers. However, external accessories like plows or winches should NOT be measured.

**Place your calibration pads**

1. Start by placing measuring tapes in front of the vehicle, starting from the front of the tires and going forward (measuring tapes 1 & 2).

2. Position tape 3 squarely in front of the vehicle's bumper. Use a square ruler to ensure that measuring tape 3 is perpendicular with tapes 1 & 2. The following values will help you determine where to place your calibration pads.
3. Refer to your (approximate) vehicle length in the following table, and record the **Horizontal (H)** and **Vertical (V)** values.

<table>
<thead>
<tr>
<th>Vehicle Length in Feet</th>
<th>Vertical (V) and Horizontal (H) Spacing in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>20’</td>
<td>25”</td>
</tr>
<tr>
<td>25’</td>
<td>30”</td>
</tr>
<tr>
<td>30’</td>
<td>40”</td>
</tr>
<tr>
<td>40’</td>
<td>35” - 40”</td>
</tr>
<tr>
<td>45’</td>
<td>40” - 50”</td>
</tr>
</tbody>
</table>

4. Place tape 4 a distance of “V” in front of the vehicle, again ensuring that it is perpendicular to tapes 1 & 2. This is your **Vertical** distance

5. Place the calibration pads a distance of “H” in front and to the left or right of the vehicle. This is your **Horizontal** distance
6. Repeat the same procedure for the rear of the vehicle. Here’s what the vehicle would look like from above, when calibration pads are place properly.

![Diagram of vehicle with calibration pads](image)

**About Horizontal and Vertical Values**

Since different vehicles have varying heights and widths, the values may not work for your vehicle shape. In order to properly calibrate the AVM system, you will need to calibrate using the initial recommended values, then re-adjust the pads or cameras, and repeat calibration until you have the desired image.

Ultimately, the calibrated image should be clear, distortion free, and you should see the calibration pads clearly on the in-cab monitor. Take a look at the following images side by side:

![Image A](image) ![Image B](image)

**Image A** has some distortion on the calibration pads in the rear of the vehicle. You can see that there is a “ghosting” effect. Image A would need to be **re-calibrated**.

In **image B**, you see that the image has no distortion and the pads can be made out clearly in the image.
Setting the System for Calibration

After you've placed down your pads and recorded your measurements, you're ready to begin the calibration process. First, you'll need to capture the images from the cameras and transfer them to your computer for calibration.

Capturing AVM images

To capture the images, you'll need to do the following:

1. Insert SD card (with SAV-BOOT) into the Electronic Control Unit (ECU).
2. Power up the ECU. The ECU detects the SD card on power up, and displays the system menu.
3. Use the AVM remote control to select the Calibration option, then press the OK button (indicated on the remote by a symbol). Next, select Camera Capture and press OK again.
4. The AVM copies 4 files to the SD card.
5. When copying is done (OK appears on the screen), power down the unit, and remove the SD card.

Transferring images to your computer

Once you've captured the raw images on the SD card, you'll need to transfer them to your PC for calibration. To do this:

1. Insert the SD card (with USB adapter, if required) into the PC.
2. Navigate to the SD card location. Cut the following 4 files:
   - FRONT.bin
   - RIGHT.bin
   - LEFT.bin
   - REAR.bin
3. Navigate to the location of your Calibration Tool. You will see a sub-folder labeled Output. Open this folder and paste the 4 .bin files here.

![Folder structure with Output highlighted]

**Launching the calibration tool**

To launch the calibration tool, double-click the application icon (AVM_calibration.exe) located in the calibration tool root folder. The application displays the Vehicle Selection screen.

![Vehicle selection screen]

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Selecting vehicle and entering pattern info

On the Vehicle Selection screen, choose your vehicle type then click the next tab: Vehicle Pattern Info.

The Vehicle Pattern Info screen is where you’ll enter the vehicle measurements and pad information.

1. Enter your vehicle Length and Width.
2. Click the 2 Computation buttons located to the right of the vehicle measurement fields.
3. In the Pattern Location area, choose your unit of measure (in or mm)
4. Enter the dimensions of your calibration pads.
5. Enter the measurements used for your vertical and horizontal pad placement
6. Click **Confirm**. An image appears in the preview box below. This is your Pixel Pitch Preview.

**Understanding Pixel Pitch**

In the **Vehicle Information** box, you’ll see several values on the right-hand side. These values represent the vehicle’s “pixel pitch”. Think of pixel pitch as the vehicle’s “zoom level” when looking at the vehicle from above. A higher pixel pitch means you can see more of the area around a vehicle. A lower pixel pitch means you see less.
In the following example, we see that a **low** pixel pitch results in an image that appears **zoomed in**. When you select a **high** pixel pitch, the image appears **zoomed out**, and you can see more of the area around the vehicle (i.e., the vehicles in the surrounding area).

When you enter your vehicle length and width, the calibration tool computes a range of values based on your vehicle’s dimensions. As you change the width and length, the pixel pitch range also changes. When you change the set value, the pixel pitch preview image also changes. As mentioned, a low pixel pitch value shows less area around the vehicle. A higher value shows more.
Setting the System for Calibration

To preview a different pixel pitch value, enter a number between the min and max values, and click Confirm. The preview image will change to reflect the new value.

About View Modes

Pixel pitch values are configured differently depending on the calibration tool’s “View Mode” When setting pixel pitch values, you have set and range values for two different modes:

- NT mode
- ST (FFT) mode

Notice also that there is a View Mode selector. In the selector you have the option of choosing NT, ST or ST(FFT) view modes. But what is view mode and how does it affect the calibration procedure?
The view mode you calibrate in depends on how you wish to position the AVM monitor in the vehicle. The following images will help illustrate the effects of view mode:

If you are going to mount the monitor in a landscape position, then you’ll need to calibrate your cameras in **NT** (normal top) mode. If you wish to use a portrait position, then you’ll need to calibrate for in **ST** (separate top) mode.

Note that a third option - **ST(FFT)** (Side Top Full Front Top) works in conjunction with **ST** mode. FFT gives you a full screen view of the 360° image. This option is **only** available if you choose to calibrate the cameras in **ST** mode. The FFT image will not work if you calibrate in NT mode.

When you launch the calibration tool, the view mode will be set to NT, which is the default. To switch view modes, click the drop-down menu and select the mode you want to calibrate for.
Setting pixel pitch for NT or ST Mode

The procedure for setting pixel pitch for NT or ST mode is the same, as they share the same data fields. To set the pixel pitch for either of these modes:

1. Select the appropriate view mode from the drop-down menu.
2. In the **NT Pixel Pitch** field, enter a value between the min and max range, as calculated by the application.
3. Click **Confirm**. A preview of the pixel pitch will appear in the window below.

Setting pixel pitch for ST(FFT) Mode

The procedure for setting pixel pitch for ST(FFT) mode is similar to above:

1. Select ST(FFT) view mode from the drop-down menu.
2. In the **FFT Pixel Pitch** field, enter a value between the min and max range, as calculated by the application.
3. Click **Confirm**. A preview of the pixel pitch will appear in the window below.
Performing AVM Calibration

Once you’re done entering your vehicle data and setting your pixel pitch values, you’re ready to begin calibrating the individual cameras.

Calibrating the 4 cameras

1. Click the Vehicle Pattern Info tab

2. Choose your AVM-221 as your model.

NOTE: Choosing correct AVM

You must choose AVM-221 for calibration to work properly.

3. Switch to the AVM Calibration tab, then click Open to load your camera files. Navigate to the location of your calibration tool, select the OUTPUT folder, and click Select Folder. The front camera image will display on the screen. Notice that the FRONT.bin image is selected.
4. Select the **Zoom** button. The button will highlight blue. **Left-click to zoom in** to the image, **right-click to zoom out**. Zoom on the calibration pads until you see the image clearly. Click the Zoom button once again to exit Zoom mode.

5. Click the **PAN** button to enable pan mode. **Left-click and drag** the image until you can see the calibration pads. Click the PAN button once again to exit PAN mode.

6. Left-click on the **inward-facing corners** of the pads to “mark” them for calibration. The pads must be marked, otherwise the calibration tool will not be able to generate the 360° image.

7. Click Get **CtrlPoint** to save your marking. You’ll be taken to the next image (REAR.bin), and a check mark will appear indicating that front image was marked.
8. Repeat steps 4 to 9 and click **Calibration & Save** when finished. A pop-up will appear letting you know that calibration was done on the 4 individual cameras. Click **OK** to confirm. You will now see the calibrated 360° image on the screen.

![Calibration & Save](image)

9. Use the **Mode** selector to switch between **NT**, **ST** and **ST(FFT)** to get a preview of the 360° image in each mode.

![Mode Selector](image)

**Viewing changes in pixel pitch**

If you switch back to the **Vehicle Pattern Info** screen and change the pixel pitch values, you can preview the results on the AVM calibration screen. To do this:

1. Change the pixel pitch set value for **NT**, **ST**, or **ST(FFT)** modes, then click **Confirm**.
2. Switch to the **AVM Calibration** screen.
3. Click **Calibration & Save**. Your 360° image should change to reflect the increase/decrease in pixel pitch.
4. Change your **View Mode** to view ST or ST(FFT) modes.
Performing AVM Calibration

Tuning Cameras

Once you’re done with calibrating the individual cameras, you’re ready to move on to the next step. Here you’ll tune each individual camera to ensure that you’re getting the optimal view on the in-cab monitor.

1. Go to the **Left-Right Tuning** screen.

2. Click **Input Image** to load your recently calibrated images. Select the **Output** folder and click **Select Folder**.

3. Using the tuning buttons, adjust the left and right camera images to get the optimal view.
   a. **Roll** rotates the camera image clockwise or counter-clockwise
   b. **W-Scale** stretches the camera image vertically
   c. **H-Scale** stretches the camera image horizontally
   d. **Trans. H.** slides the camera image left or right
   e. **Trans. V.** slides the camera image up or down.

4. After you’ve tuned both Left and Right cameras, click **Apply**, then **Save**.

5. Move on to the next tab, **Front-Rear Tuning**.

6. **Repeat** the same procedure for tuning the Front and Rear cameras. Once complete, click **Apply** and **Save**, then move onto the last screen, **Parking Guide Lines**.

**Note: Viewing Tuned Images**

Once calibration is complete, the tuned images will appear on the in-cab monitor in both NT and ST modes. The driver can switch between each individual camera view by using the AVM push button installed on the dash.
Adjusting Parking Lines and Saving

The final steps of the calibration tool involve adjusting parking lines and saving the files.

1. Click **Parking Line** to load the rear camera image and display the parking lines. You'll see your rear calibration pads in the adjustment window.

2. Using your calibration pads as reference, move the parking lines until the red indicators are in line with the calibration pads. For example, if you know that your pads are 30" from the bumper, the red lines will tell you that you are within 30" of the bumper when backing up. The green and yellow lines let you know that you still have room to back up, and that you're getting close to the red zone.

3. Use the **X** and **Y** buttons to move the parking lines. Alternately, you can use the configuration buttons below to move the lines.
   - **Left Side** moves the left line outwards (towards the left)
   - **Left** moves both lines to the left
   - **Left Side R** moves the left line inwards (towards the right)
   - **Up** moves both lines up
   - **Down** moves both lines down
   - **Right Side L** moves the right line inwards (towards the left)
   - **Right** moves both lines to the right
   - **Right Side** moves the right line outwards (towards the right)

4. Click **Save** when done.
5. Click **NT Save** or **ST Save**

**Warning: Do not save in both modes**

Do NOT click both NT Save and ST Save buttons. You can only save one set of calibration files on to the SD card. If you choose to save in both modes, the files may interfere with one another, and the ECU may not be able to load the images properly.

If you saved in both modes on the SD card, delete all contents on the card and save again before transferring back to the ECU.

6. Navigate to your SD card folder in Windows Explorer. Ensure that the SD card is empty by deleting the 4 camera files that were there previously (if you haven’t already done so).

7. Click **Select Folder** to copy the calibration files to the SD card.

8. Navigate to the SD card folder with Windows Explorer and verify that the calibration files were copied to the card. You should see files similar to the ones in the following image. If no files appear on the card, attempt to save again or contact **FRC Service** for help.

9. Remove SD card and transfer it back to the ECU in the vehicle.
Verifying Calibration

The next stage of the calibration process involves transferring the calibration files back to the AVM and verifying image quality.

Calibrating Files on ECU

1. Put the SD card into the ECU.
2. Power up the device. The configuration screen appears.
3. Navigate (using remote control) to the Calibration option and press OK ().
4. Select Manual Calibration then click OK (). The ECU will begin to load the files from the SD card.
5. Wait until the calibration process is complete. When you see the following screen, then the process is complete.
6. Power down the unit. Remove SD card and power up unit once again. The monitor should display the calibrated 360° image along with the front, right, left or rear images.

7. Cycle the various camera views with the AVM push button.

8. Put the vehicle in reverse. The monitor will display the rear camera along with the guide lines automatically.

Calibration Image Test

To verify the accuracy of the AVM calibration, use tape to create 2 lines, one on each side of the vehicle. Place each tape a distance of ½ the vehicle’s width away from the vehicle. Alternately, you can do this by moving the vehicle to a parking spot with painted lines.

Looking at the in-cab monitor, the AVM should render 2 straight vertical lines. If the lines are bent or warped, then the image needs to be calibrated once again. Either adjust the camera positions, or move the pads, then repeat the calibration procedure. If this does not solve your problem, please contact FRC Service for assistance.
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Support Information

Contacting FRC (Fire Research Corporation)

FRC Customer Service and Product Support:

(8am to 5pm EST weekdays)

- Main Phone: 631.724.8888
- Fax: 631.360.9727 (24 hours)
- Website: Contact FRC

If your 360 Fusion system needs to be returned, please contact FRC Technical Support, and provide the model and/or serial number of your unit. Ask for a Return Merchandise Authorization (RMA) number. An RMA number allows the Service Technicians to better track your product when it comes in for service. Please show the RMA number on the outside of the package. ANY RETURNED PRODUCT WITHOUT AN RMA NUMBER MAY BE REFUSED.

Product Information

For product information and documentation related to the 360 Fusion system, please visit the inView 360 Fusion product page on the FRC website.

Or, for additional information, you may wish to visit Safe Fleet Community’s 360 Fusion product page. Please contact FRC Service for the username and password to this online help community website.

Warranty

Complete warranty details are available online on the FRC Limited Warranty page.