



SightLine

APPLICATIONS

EAN-NUC-and-DPR

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Alerts

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 **CAUTION:** Alerts to a potential hazard that may result in personal injury, or an unsafe practice that causes damage to the equipment if not avoided.

 **IMPORTANT:** Identifies crucial information that is important to setup and configuration procedures.

 *Used to emphasize points or reminds the user of something. Supplementary information that aids in the use or understanding of the equipment or subject that is not critical to system use.*



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1 Overview

SightLine firmware has the capability of performing Non-Uniformity Correction (NUC) and Dead Pixel Removal (DPR). This function is enabled by using the NUC/DPR option in the *Configure* dropdown menu in Panel Plus.

Both NUC and DPR help to improve the video and imaging quality from an IR camera. This function is useful for cameras that do not have this feature built-in from the manufacturer.

The calibration process should be performed once for every camera and lens. It may need to be done again in the future if quality noticeably degrades. Due to the natural drifting of the sensors and camera there is not a specific timeframe for this calibration process.

For best results, NUC/DPR will run on raw digital video output from the camera. This feature is available starting with firmware version 2.25 and requires purchase of the Blend app bit.

This document describes procedures using the 1500-OEM. Similar procedures can be applied to the 3000-OEM.

1.1 Associated Documents

[EAN-Startup Guide 1500-OEM](#): Describes steps for connecting, configuring, and testing the 1500-OEM video processing board on the 1500-AB accessory board.

[EAN-Startup Guide 3000-OEM](#): Describes steps for connecting, configuring, and testing the 3000-OEM video processing board on the 3000-IO interface board.

[Interface Command and Control \(IDD\)](#): Describes the native communications protocol used by the SightLine Applications product line. The IDD is also available as a local download on the [Software Download](#) page.

Panel Plus User Guide: Provides descriptions of all the settings in the Panel Plus application. (Located in the Panel Plus application in the *Help* menu.)

1.2 SightLine Software Requirements

ⓘ IMPORTANT: The Panel Plus software version should match the firmware version running on the board.

1.3 Application Bit Requirements

The functions described in this EAN require Application Bits (app bits) purchased from SightLine. App bits reside on the hardware unit and are enabled with a license file provided by SightLine at initial unit purchase or during a license upgrade process. License files use a hardware ID that is applicable to a specific hardware serial number. For questions and upgrade support contact [SightLine Sales](#).

Table 1: Application Bits Requirement Table

Function	Min SW Version	Required Application Bit(s)
DPR and NUC	2.25.xx	DPR, NUC, and Blending. 0x0100



2 How NUC and DPR Work

The system acquires a fixed number of raw unprocessed still images from the MWIR camera. A set of images is collected at two temperatures. The first set is collected at a temperature representing the operational high temperature (e.g., 50°C). The second temperature represents the operation low temperature (e.g., 25°C). This provides a sufficient sample behavior of the camera over a range of temperatures that will be experienced in the field. From these images, the software then determines which pixels are non-operational (dead) and may need to be replaced at run time.

Non-Uniformity Correction is performed by accumulating statistics from the collected images and calculating a gain and offset for each pixel in the image that will be applied at run time. The DPR and NUC tables are saved as files on the hardware and may be loaded at run time.

Multiple tables can be created to accommodate different operational scenarios for a given camera. For example, a DPR/NUC table may be created that represents flying over the ocean and another table for operations in the mountains.

3 Interface Boards

The interface board kits for the 1500-OEM and 3000-OEM come with screws, nuts, and stand-offs for connecting to the video processing boards and the camera. See the [ICD-1500 Adapter Boards](#) and [ICD-3000 Adapter Boards](#) for power requirements, thermal management, interface specifications, and connector pin-outs.

ⓘ IMPORTANT: All boards should be connected first before applying power.

- 1500-CL interface board (connects to 1500-OEM)
- 1500-FFC interface board (connects to 1500-OEM)
- 1500-AB board (serial and network interface)
- MicroSD card (installed)
- 3000-CL interface board (connects to 3000-OEM)
- 3000-FFC interface board (connects to 3000-OEM)
- 3000-IO board (serial and network interface)
- Camera Link Cable

3.1 Camera Requirements

- IR imaging capability
- Ability to output unaltered pixel values
- 16 bit or 14-bit Gray Scale capability
- Max camera resolution width of 640 width x 512 height
- Camera power supply and heat source
- Two different uniform temperature targets. (~20°C apart). For example, a thermal black body and associated power supply capable of maintaining temperatures approximating expected operational high and low temperatures.

 *The correct FPGA version should be installed on the 1500-OEM to match the camera and digital video adapter. See [EAN-Camera Compatibility](#) for specific information.*



4 Hardware Connections

The FLIR Neutrino camera is used as an example in this section. Specific camera hardware connections will vary by camera.

 This section shows camera connection diagrams for both the Camera Link board and the FFC interface board.

4.1 Hardware Bench Setup 1500-OEM / 1500-CL

This section describes the connection for the 1500-OEM and the 1500-CL interface board to the supporting components. The 1500-AB board is used as the serial and network interface board.

1. Connect SLA-CAB-1514 Molex cable to the 1500-OEM J3 (14-pin) connector and to the 1500-AB J3 (14-pin) connector. This provides analog video, network, and serial connections to the 1500-OEM.
2. Connect a network cable to the 1500-AB Ethernet port.
3. Connect the Camera Link cable to the 1500-CL interface board and the Camera Link interface on the FLIR Neutrino camera.
4. Connect to FLIR Neutrino camera:
 - a. Connect USB cable to a USB power source.
 - b. Connect 12V power cables to camera cooler.
5. Connect black body to power source and set temperature to expected operational high temperature.
6. Connect the SLA-PWR-B05V to the 1500-AB board. A green light indicates the 1500-AB is powered on.
7. Slide the switch to the left to power-on the 1500-OEM board. A blue light on the 1500-AB board and a green light on the 1500-OEM indicate that all the boards are powered on.

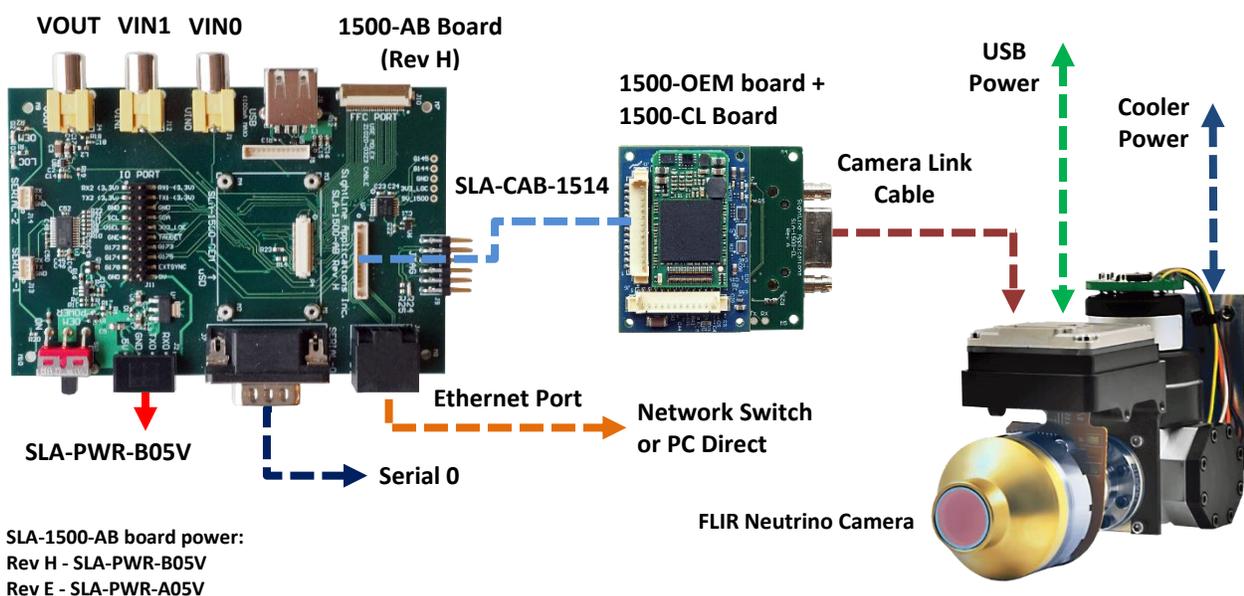


Figure 1: 1500-OEM / 1500-CL FLIR Neutrino Camera Bench Setup



- 5. Plug in the power adapter (SLA-PWR-C12V) to an AC power source. A green light on the 3000-IO board indicates that all boards are powered on

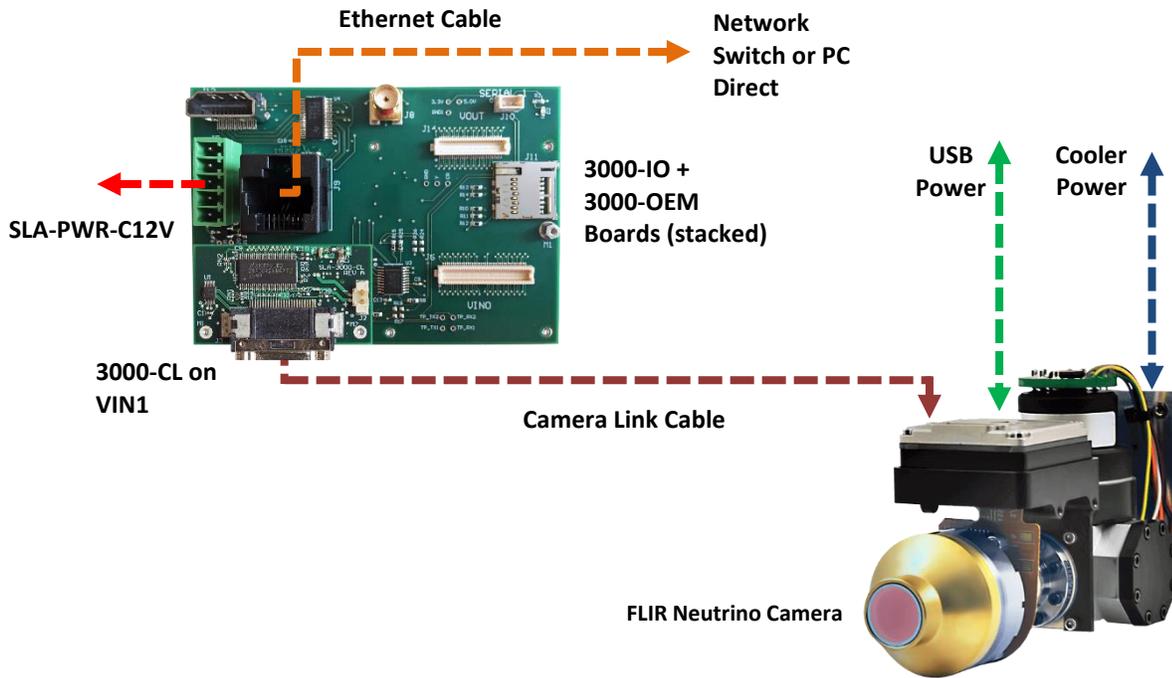


Figure 3: 3000-OEM / 3000-CL FLIR Neutrino Camera Bench Setup

4.4 Hardware Bench Setup 3000-OEM / 3000-FFC

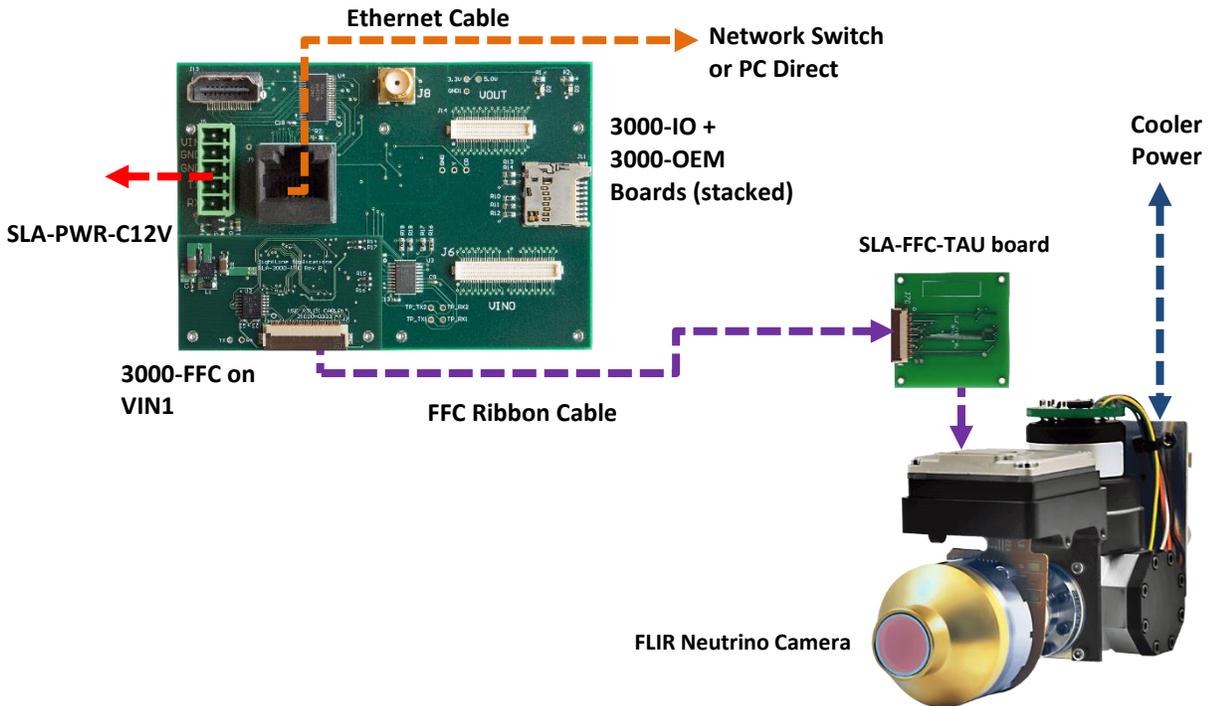


Figure 4: 3000-OEM / 3000-FFC FLIR Neutrino Camera Bench Setup



5 Configuration Settings

The FLIR Neutrino camera is used as an example in this section. Specific camera settings will vary by camera. The 3000-OEM and 1500-OEM configuration procedures are similar. The 3000-OEM requires additional steps. The following steps reference the Panel Plus software.

1. Connect to the board over an Ethernet connection using the Panel Plus application. See the [EAN-Startup Guide 1500-OEM](#) for connection instructions.
2. Verify that the board has the correct FPGA code loaded to support the camera.
3. In the *Video* tab, click *Stabilization/OFF*.
4. From the main menu » *Configure* » *Acquisition Settings*. Set the fields as shown for the 1500-OEM. The *Apply* button will turn red indicating input field changes have been detected.

3000-OEM: If the 3000-CL adapter board is installed on VIN1, use Cam 2 for the Camera Index. If the adapter board is installed in on VINO, use Cam 0.

5. Click the *Apply* button.

Camera Index: Digital

Camera Type: Generic Digital

Frame Step: 0

Apply

Hit *Apply*, then *Save Parameters* and cycle power. Check for errors in menu *View >> User Warnings*.

Generic Digital Settings (Applies to CameraType: Generic Digital Only)

AutoFill

Height: 480 Width: 640 Resulting Flag Bits: 0x240

Vertical Front Porch: 0 Horizontal Front Porch: 0 Bit Depth: 14

Input: Gray Scale YUV color G8 16bit in Bayer Laser Interlaced Byte Swap

Invert V-Sync Polarity Invert H-Sync Polarity UB0 Sync/Crop: None

Camera Init Code: InitCameraLink

Options:

Big: Height: 0 Width: Vertical Blanking: 0 Horizontal Blanking: 0

Select None if using the FFC Board

Figure 5: 1500-OEM Camera Configuration Settings

6. From the *Connect* tab, select *Network* and *Cam 2*. This enables video to display in Panel Plus. Click *Stream Network Video to This PC*.

Video Output:

Cam 2 Network

Stream Network Video to This PC Advanced IP...



7. 3000-OEM additional settings:

- a. From the *Multi Camera* tab select *Network 0* and *Camera 2*. This enables video to display in Panel Plus. If the 3000-FPC board is connected to VIN0 select *Camera 0*.
- b. Click the *Send* button to save the settings to the parameter file.

Decode @ P+	Display	Cameras				Multi	Blend	None	Resolution
		0	1	2	3				
<input checked="" type="radio"/>	Network 0	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Out=In ▾
<input type="radio"/>	Network 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Out=In ▾
	Analog	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	NTSC ▾
	HDMI	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	720p60 ▾
	HD-SDI	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	720p60 ▾

- 8. Close the *Acquisition Settings dialog* window.
- 9. Save and activate the settings:
 - a. Main menu » *Parameters* » *Save to Board*.
 - b. Main menu » *Reset* » *Board*.
 - c. Wait for the system to boot, and then reconnect to the board. Make sure the board connects.

5.1 Calculate NUC and DPR Tables

- 1. From the main menu in Panel Plus » *Configure* » *NUC/DPR*.
- 2. Click *Reset All*. This will put the system in a known state for calculating NUC/DPR.
- 3. Point the camera at the temperature source that is being used for operational high temperature.



The target plate should fill the entire field of view of the camera to provide a UNIFORM image at this temperature.

- 4. Set the *Add Frames* field to 30 (default), and then click *Add*. The frames will be captured within a few seconds.

IMPORTANT: There is no feedback once this is complete.

Add Frames:

- 5. Point the camera at an operational low temperature source. The target plate should fill the entire field of view to provide a uniform temperature in the picture.
- 6. Click *Add*. This completes the data needed for NUC and DPR calculations.



7. Click *2 Point NUC* to perform the non-uniformity correction process. This step will automatically enable the NUC and DPR image processing. The image should become smooth (Figure 6).

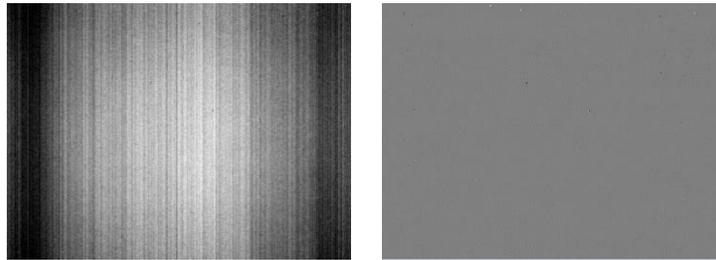


Figure 6: NUC and DPR Process

8. In the *Dead Pixel Replacement* section of the NUC dialog window, use The *Gain* and *Offset* selections in the *Show* section to adjust the max and min values to help fine tune the dead pixel replacement parameters.



The image will change to black and white. Numbers are shown in the upper left corner with a histogram drawn over the top of it. The histogram displays the values of the image (Figure 7).

There should be only one peak on the graph. The mean should be near 1.00. The standard deviation can vary. The max and min values should be set to at least 4 standard deviations above and below the mean. This is not a fixed value and will vary depending on the application.

In the example on the left, round up the standard deviation to .06 and multiply by 4. This results in 124% and 76% for the max and min *Pixel Gain* values respectively.

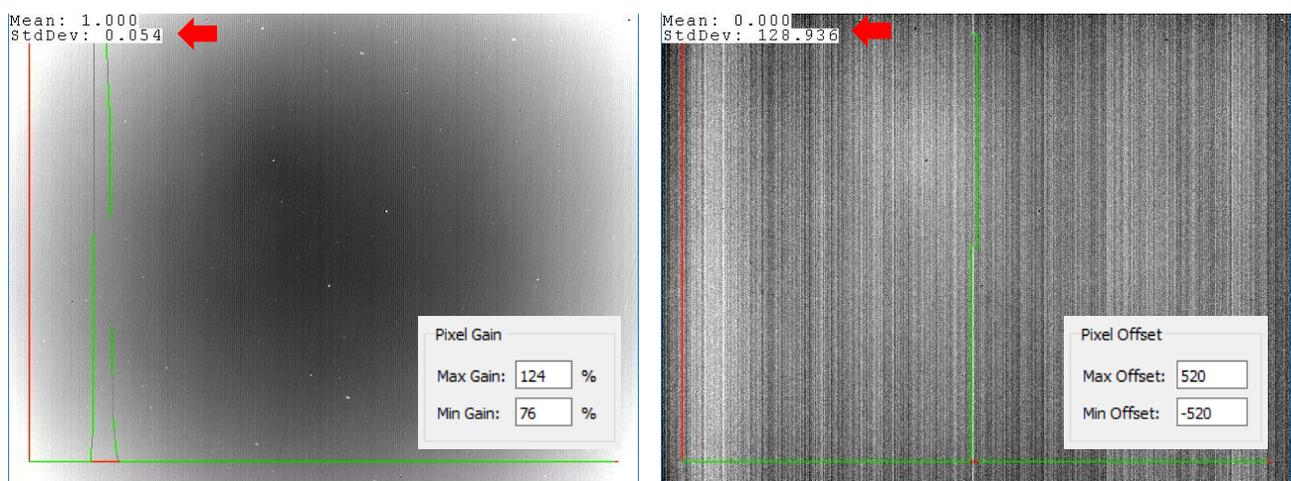


Figure 7: Fine Tuning Dead Pixel Replacement Parameters

In the example on the right, this can be repeated for the *Pixel Offset* values. The mean and the standard deviation appear in the upper left. Round up the standard deviation to 130.00 and multiply by 4. This results in a max and min offset of 520 and -520 values respectively.



9. Click on *Calc Dead Pixels*. The video may freeze or disappear briefly while the calculation happens. When the image returns, the dead pixels should be gone.

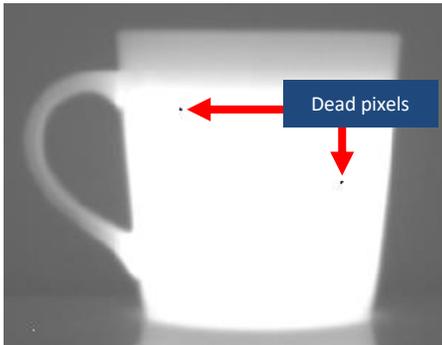


Figure 8: NUC without DPR



Figure 9: NUC with DPR

10. Save the NUC table to the microSD card file system. Enter a filename in the NUC table field. Click *Save*.

*Optional: Click the *Set as Default* button to apply the file at bootup.*

NUC:

1 Point NUC 2 Point NUC Reset Gain Reset Offset

integration2_00ms Save Load Set as Default

11. Save the DPR table to the microSD card file system. Enter a filename in the dead pixel table field. Click *Save*. Click the *Set as Default* button to apply the file at bootup.

Number of Dead Pixels: 0 Request

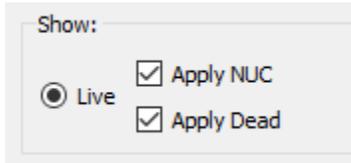
rightMWIR Save Load Set as Default

*If the *Save as Default* button was selected for either file, save the parameters to the board, and then reset the board to apply changes (see [Setting a Default NUC and DPR Table](#)).*



5.2 Test Settings

1. Point the camera at a scene. From the main menu in Panel Plus » *Configure* » *NUC/DPR*.
2. In the *Active* section, toggle the *Apply NUC* checkbox. The video should be smoother, and less streaked with NUC enabled. Toggle the *Apply Dead* checkbox. If any dead pixels are visible when inactive, they should look better when set to active.



3. Repeat the steps to create, save, and apply alternative NUC and DPR files.

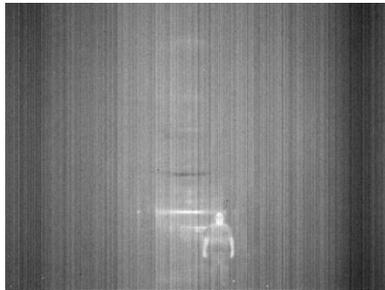


Figure 10: Image without NUC/DPR



Figure 11: Image with NUC/DPR

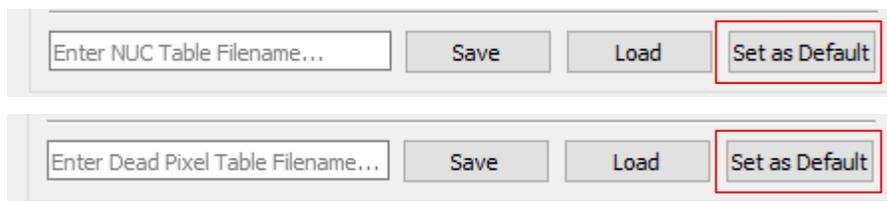
5.3 Setting a Default NUC and DPR Table

To automatically load a NUC table or dead pixel table when the system is booted up:

1. Enter the desired table name into the filename field and click *Set as Default*.
2. Save the parameters to the board and reset the board. Main menu » *Parameters* » *Save to Board*, main menu » *Reset* » *Board*.

When the system reboots, the selected NUC table and dead pixel table is loaded.

3. To remove the selected default table. Leave the filename field blank and click *Set as Default*.



After following the pop-up windows instructions and restarting the system the image should appear without the NUC table or dead pixel table applied.

Setting Default NUC and DPR table to empty strings prevents tables from loading by default.



6 Additional Features

6.1 Debugging

For debugging purposes, the *Gain*, *Offset*, and *Dead Pixel* calculations can be viewed as images.

To view these images, click on the corresponding radio button in the *Show* field (Figure 12) to replace the live image feed from the camera with the calculation image of your choice.

The whiter the pixel is the larger the corresponding calculation is. When finished, click on the *Live* button to return to the live image feed. After calculation both the NUC and DPR are automatically active. To turn one or both off, uncheck the boxes.



Figure 12: Debugging

6.2 Using Multiple Calibration Tables

For some applications, more than one NUC or dead pixel calibration may be needed. To help facilitate this, SightLine systems have the capability of saving and loading calibration calculations. These tables currently are saved to the microSD card.

To save a file, enter the filename and click *Save*. To load a filename, enter a filename of a previous saved calibration and then click the *Load* button.

To load a saved calculation as default on startup, enter the name of the saved calculation and then click the *Set as Default* button. This will automatically load the calculation when power is applied to the SLA hardware.

Use an FTP client to review what calibration tables are already on the system.

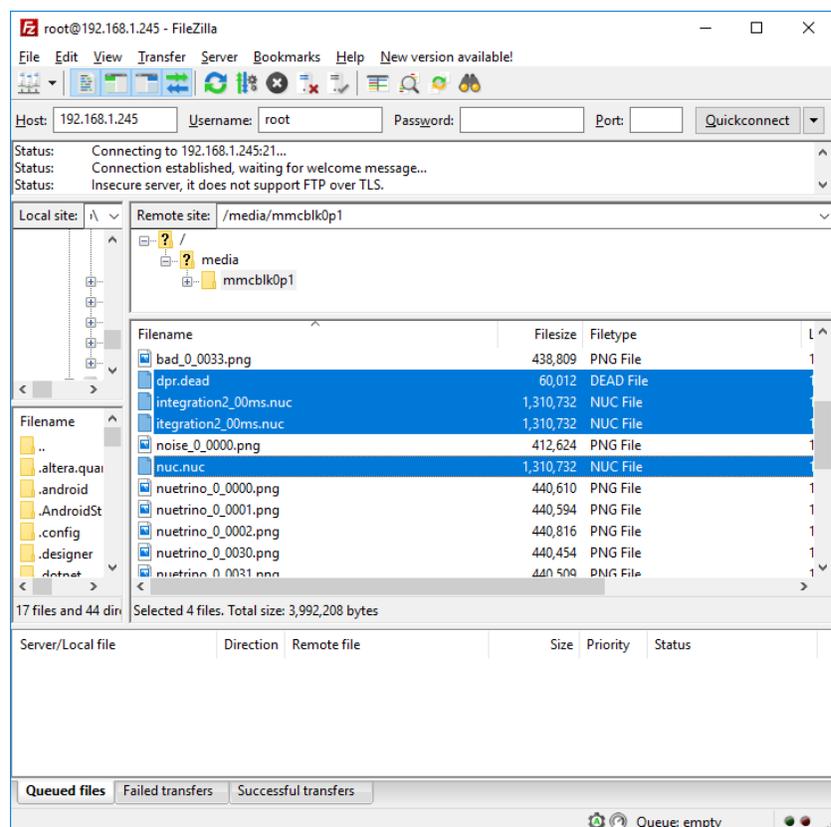


Figure 13: Managing NUC and DPR Tables with FTP Client



6.3 1-Point NUC

The 1-Point NUC is a more efficient way to update the offset of each pixel to improve image quality with less calibration hardware.

A common practice for this type of calibration would be to close the shutter of the camera to obtain a flat field during designated periods, perform a 1-Point NUC, and then open the shutter. This is used more often in non-cooled IR cameras since the function that dictates NUC varies with time more often than with cooled cameras.

Substituting 1-Point NUC for the 2-Point NUC calibration process is not recommended. Use it as an additional option if a reduction in pixel quality is noticed over time during normal camera use.

1-Point NUC example:

1. Close shutter or obtain a flat field.

2. Add a frame:

```
1E,35,<XX>,01,01,<YY>,4B,00,7D,00,D0,07,B0,36,68,C5,FF,FF,98,3A,00,00,90,5F,01,00,10,27,00,00
```

<XX> = camera index (e.g., 02 for cam2)

<YY> = number of frames in Hex (e.g., 01 for 1 frame)

3. Perform 1-point NUC:

```
1E,35,<XX>,01,07,00,4B,00,7D,00,D0,07,B0,36,68,C5,FF,FF,98,3A,00,00,90,5F,01,00,10,27,00,00
```

<XX> = camera index (e.g., 02 for cam2)

6.4 Storage of NUC / Dead Table

The filenames shown in [Table 2](#) are specified in the NUC and DPR Panel Plus window when saving.

Table 2: NUC and DPR File Storage

Filename Format	Description
<filename>.nuc	The NUC table is stored in binary.
<filename>.dead	The dead pixel table is stored in binary.

 *If the first command sent to the unit is to read the table, the table may be overwritten with default values. However, these default values are not 0 because the table that is read will be overwritten and not applied. Sending the command to read the table again will result in the proper values and apply the NUC as expected.*



6.5 FIP Commands

See [Interface Command and Control \(IDD\)](#).

- NucParameters (0x35)** Set Nuc and DPR parameters $y=mx+b$ line of best fit calculated for NUC and DPR.
- ReadWriteNuc (0x36)** Used to save or load Nuc/DPR tables as well as set a table to be applied on startup.
- DeadPixelStats (0xA1)** Statistics from DPR calibration process.

6.6 Performance

NUC and DPR adds a latency of less than 5 milliseconds.

7 Troubleshooting

7.1 Dead Pixel Issues

In most cases the default values for DPR ensure that dead pixels are detected and replaced. If a dead pixel is still visible after performing the DPR process it may require adjusting the *Min* and *Max* values in the *Pixel Offset* section of the NUC and DPR configuration window in Panel Plus.

7.2 Example:

Dead Pixel Replacement:

Pixel Value	Pixel Gain	Pixel Offset
Max Value: 14000	Max Gain: 125 %	Max Offset: 15000
Min Value: 2000	Min Gain: 75 %	Min Offset: -15000

Max Standard Deviation: 90000 Max # of Dead Pixels: 10000

Calculate Dead Pixels Reset Dead Pixels

dead Save Load Set as Default

Show:

Live Apply NUC Gain Offset Dead Pixel

Apply Dead

Adjust Min and Max Values

Figure 14: DPR Pixel Offset Adjustment

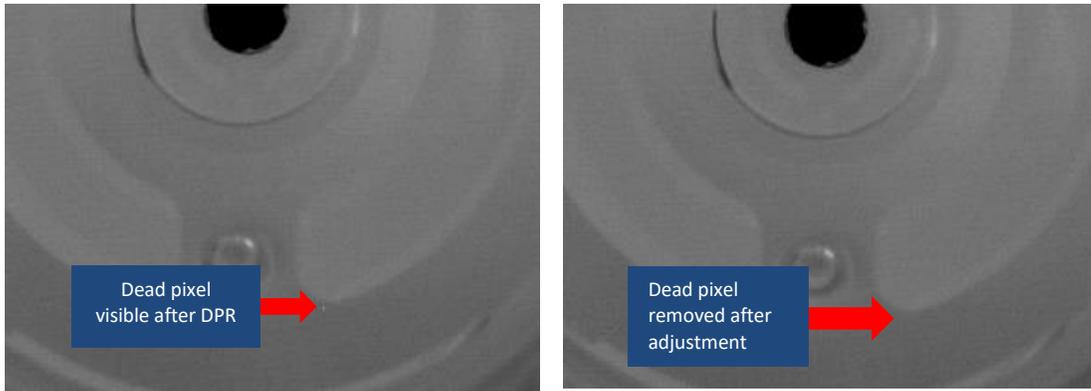


Figure 15: Before and After Min and Max Adjustment

7.3 Number of Dead Pixels

To help with the adjustment of DPR calculation values, we have provided the capability to see how many dead pixels are currently being replaced. In the NUC and DPR window, click on the *Request* button and the window will be updated with the current number of dead pixels being replaced.

This can be used when adjusting values to see if the change in values had any effect or if the change in value caused too many pixels to be replaced.

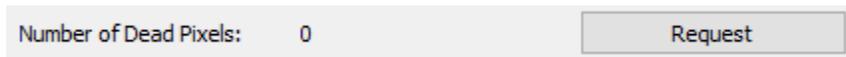


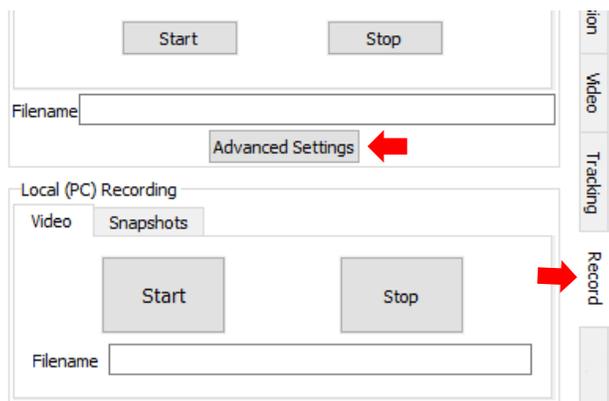
Figure 16: Dead Pixels Replaced

Continue to adjust the *Min* and *Max* offsets until the pixels are removed.

7.4 Capture Raw Images

To facilitate additional trouble shooting, it is helpful to have the raw capture image to work from. See [EAN-File Recording](#) for additional details.

1. Prepare camera with a hot calibration target.
2. Insert microSD card into target hardware.
3. Power up target hardware.
4. Connect the target with Pane Plus.
5. In Panel Plus select the *Record* tab.
6. Click the *Advanced Settings* button.





7. Configure the snapshot settings as shown. Leave all other settings as default
8. Click *Send*.
9. Close the *Configure Snapshot Settings* dialog.

10. Enter a filename for the snapshot. The PNG extension is added automatically.

11. Click *Start* to capture the image.

12. Click *Refresh List* to verify the images were collected. It is not important if all the images were not captured. A sample of images over time is all that is necessary.

Filename	Size
mwirRaw50c_2_0130.png	1.03 MB
mwirRaw50c_2_0131.png	1.03 MB
mwirRaw50c_2_0132.png	1.02 MB
mwirRaw50c_2_0133.png	1.02 MB
mwirRaw50c_2_0136.png	1.02 MB
mwirRaw50c_2_0137.png	1.02 MB
mwirRaw50c_2_0138.png	1.03 MB



13. Repeat the procedure with a cold calibration target.
14. Repeat procedure again pointing the camera at a normal scene.
15. Transfer files from microSD card to the PC.
16. Send images along with any other details to SightLine [Support](#).

8 Questions and Additional Support

For questions and additional support, please contact [Technical Support](#). Additional support documentation and Engineering Application Notes (EANs) can be found on the Support pages of the SightLine Applications [website](#).