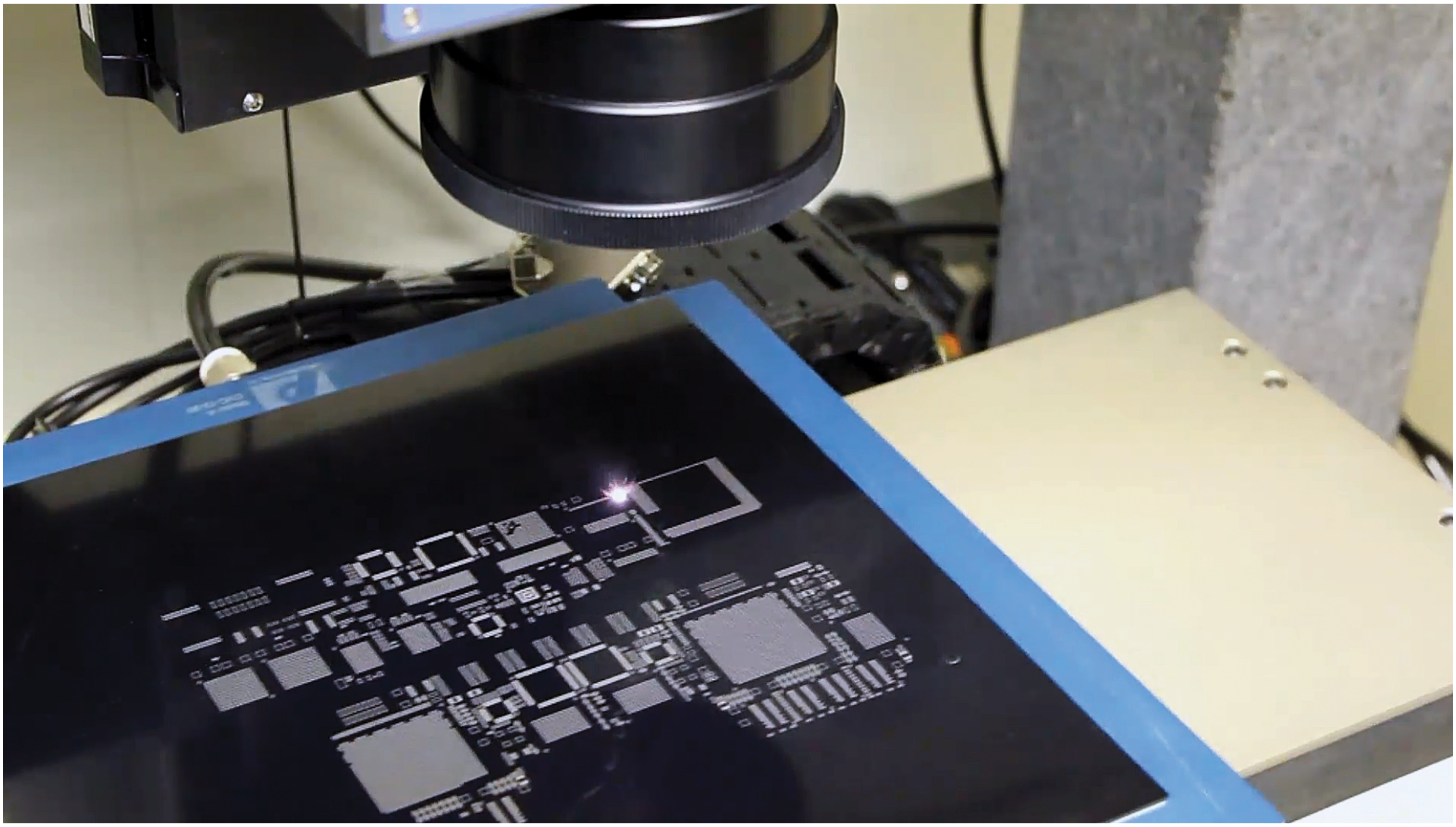
How to Configure IFOV

Revision: 1.01



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United States (World Headquarters)	
Phone: +1-412-967-6440 Fax: +1-412-967-6870 Email: service@aerotech.com	101 Zeta Drive Pittsburgh, PA 15238-2897 www.aerotech.com
United Kingdom	**Japan**
Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649 Email: service@aerotech.co.uk	Phone: +81 (0)50 5830 6814 Fax: +81 (0)43 306 3773 Email: service@aerotechkk.co.jp
Germany	**China**
Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720 Email: service@aerotechgmbh.de	Phone: +86 (21) 6126 1058 Email: service@aerotech.com
France	**Taiwan**
Phone: +33 2 37 21 87 65 Email: service@aerotech.co.uk	Phone: +886 (0)2 8751 6690 Email: service@aerotech.tw

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Chapter 1: IFOV Configurations Overview

NOTE: For warning and safety information and other important information about your drives, refer to the hardware manuals.

The Aerotech Infinite Field of View (IFOV) feature operates with one Aerotech two-axis galvo drive and a maximum of two Aerotech servo drives. IFOV supports many configurations. Two typical examples are as follows.

Figure 1-1: Stationary Galvo That Has a Moving Substrate

This example shows a stationary two-axis galvo scanner mounted on a bridge over XY servo stages that carry the moving marked substrate.

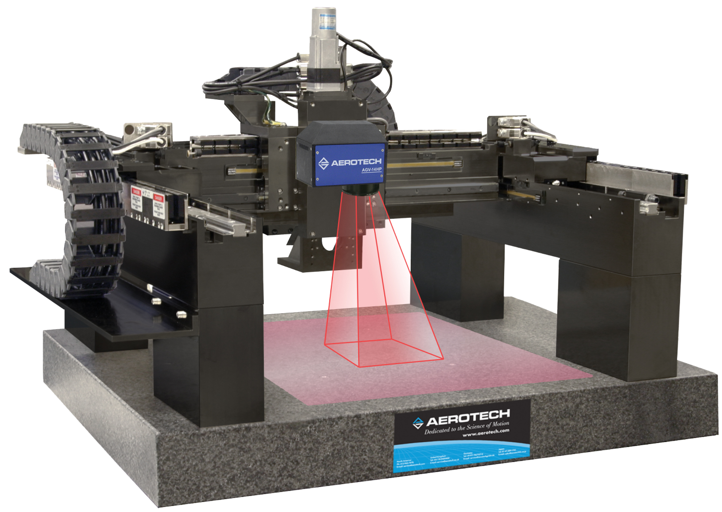

Figure 1-2: Moving Galvo That Has a Stationary Substrate

This example shows a two-axis galvo scanner that moves on a gantry system over a stationary marked substrate.

Drive-Specific: The information in this guide is limited to these two types of configurations. In order to show you the configuration process, this guide supplies specific instructions and examples that use Ndrive HPe servo drives with -MXH feedback, Npaq servo drives, and the Nmark GCL galvo drive. It also supplies information that is necessary for other IFOV drive configurations.

Many configuration options are available for IFOV applications. For example, the Aerotech Nservo drive supplies an interface between the Aerotech control system and third-party servo drives.

If your IFOV configuration is not discussed here or you have questions about your configuration, contact Aerotech Global Technical Support.

IFOV supplies seamless marking over a field of view that is wider than the field of view of the galvo scan head. Aerotech calls it infinite, but it creates a marking field of view that is effectively as large as your galvo field of view and your servo travel combined.

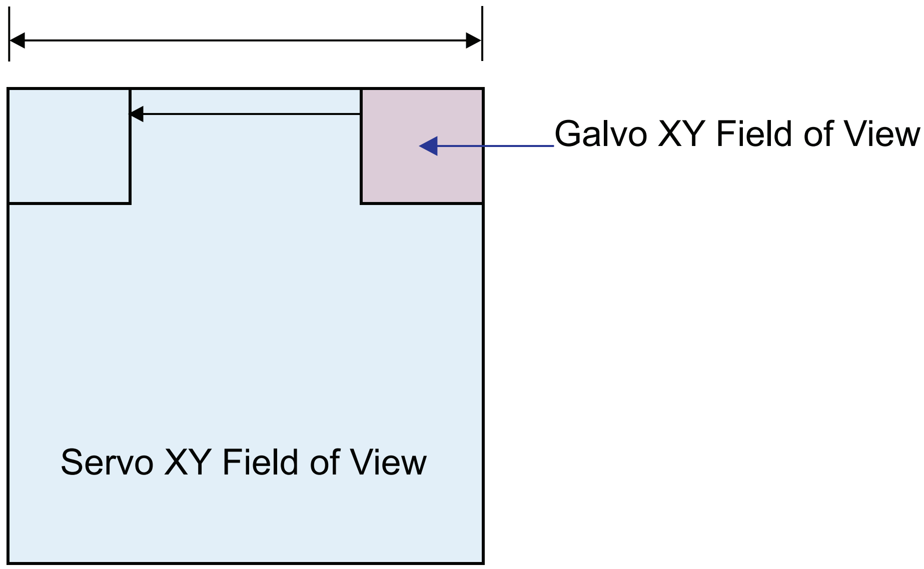

Figure 1-3: Combined Galvo and Servo Fields of View

Because the A3200 controller combines the motion of the galvo axes with the motion of traditional servo axes to extend the field of view of the galvo axes, the “stepping” part of stepping and scanning is replaced with constant motion of the servo axes. As a result, your pattern is always in the field of view of the galvo scan head.

With IFOV, you command motion to the galvo axes over a field of view that is larger than the field of view of the galvo scan head, but within the field of view of the servo axes. Refer to Figure 1-3. When the A3200 controller is configured correctly, it automatically commands motion to the servo and galvo axes to prevent the galvo axes from going out of their limited field of view. The servo stages are not required to do step-and-scan operations.

Steps to Configure IFOV:

1. Get the Correct System Configuration
2. Verify the Direction of Positive Motion
3. Configure Important Parameters
4. Test and Verify the IFOV System
5. Write Your IFOV Program

Chapter 2: Get the Correct System Configuration

The first step to correctly configure an IFOV application is to make sure that you have the correct equipment, which includes **mechanics**, **drives**, **cables**, **PC**, and **software**.

This equipment is complex. Please discuss your requirements with your Aerotech Applications Engineer or Aerotech Field Sales Engineer.

Mechanics

For the mechanics, you must have two servo axes and a two-axis galvo scanner.

Servo Axes

Use two servo axes that you can control through an Aerotech Ndrive or Npaq drive.

Two-axis Galvo Scanner

Aerotech recommends the Nmark AGV-HP or Nmark AGV-HPO two-axis galvo scanner. If you must use a third-party scanner, make sure that it communicates on the XY2-100 protocol.

Drives

Hardware: This information does not apply to the Npaq MR.

You must use two servo axes and two galvo axes.

Servo Drives

Hardware: Servo drives that have -MXU feedback cannot be used with IFOV.

You can use a maximum of two servo drives. Each drive must be an Aerotech Ndrive or Npaq drive. An IFOV system typically uses two Ndrive servo drives or one Npaq servo drive which has six available axes.

The feedback device and the properties of the motor that is connected to the servo stage might limit the types of Ndrive or Npaq servo drives that you can use.

Galvo Drive

You can use a maximum of one galvo drive, which can be an Aerotech Nmark GCL or Nmark SSaM. The two galvo axes must be from the same galvo drive.

- Use an Nmark GCL to control the Nmark AGV-HP or Nmark AGV-HPO two-axis galvo scanner.
- Use an Nmark SSaM to control a third-party galvo scanner that is XY2-100 compliant.

For more information about the Nmark GCL and Nmark SSaM, refer to **Nmark Overview** in the A3200 Help file.

Cables

To connect the drives, scanners, and stages in your system, use only the cables specified by the equipment manuals and cable guides. Aerotech offers standard cables for all Aerotech drive-and-servo-stage combinations, cables to network multiple axes, and cables to send encoder channel signals from one axis to the next axis.

Use the NCONNECT cables for the FireWire high-speed serial bus. These cables connect, through a daisy chain, the drive electronics to the FireWire card of the computer. For more information, refer to the **PC and Software** section that follows.

Use the correct cables to connect the encoder output port of each servo drive to the corresponding encoder input port of the galvo drive. For information about cable part numbers, refer to the table that follows.

Table 2-1: Servo Drive Cable Part Numbers

Servo Drive Type	Cable Part Number	
	Nmark GCL	Nmark SSaM
Ndrive CP, HLe, and HPe	C25481-xx	C23161-xx
Ndrive ML and MP	C25483-xx	C23940-xx
Npaq(1)	C25482-xx	C23320-xx
(1) This information does not apply to the Npaq MR.		

If you purchased an integrated system from Aerotech, it includes interconnect cables and a system interconnect drawing. Refer to the system interconnect drawing and use the interconnect cables to connect the motors, stages, and scanners to the drives.

If you have questions about the cables that are necessary to make these connections, contact your Aerotech Applications Engineer or Aerotech Field Sales Engineer.

PC and Software

Use the A3200 software-based machine controller on an industrial-grade Windows PC. Minimum specifications for this PC are available at www.aerotech.com. A FireWire PCI card or FireWire PCI Express card is required for communication to the drives over a FireWire high-speed serial bus.

Chapter 3: Verify the Direction of Positive Motion

Drive-Specific: The information in this chapter uses these axis configurations.

- **X** and **Y** are servo axes.
- **A** and **B** are galvo axes.
- **X** and **A** move in the same direction.
- **Y** and **B** move in the same direction.

Before you configure IFOV-related parameters, each servo axis and galvo axis must be correctly configured and tuned.

Also make sure that positive motion goes in the same direction on the servo and galvo axes. For this to occur, the conditions that follow must be true.

- If you command a positive move to the **X** servo axis and you command a positive move to the **A** galvo axis, the laser pointer must move along the substrate in same direction.
- If you command a positive move to the **Y** servo axis and you command a positive move to the **B** galvo axis, the laser pointer must move along the substrate in same direction.

To verify that you have correctly configured the scaling of the galvo axes and the move direction, do the procedure that follows.

TO VERIFY THE SCALING OF THE GALVO AXES AND THE MOVE DIRECTION

1. Move the (**A**,**B**) galvo axes to some point, such as (15,15).
2. Measure this move by using the most accurate tool available.
3. Verify that the value of the CountsPerUnit Parameter is correct for the two galvo axes. For more information about this parameter, refer to **CountsPerUnit Parameter** in the A3200 Help file.

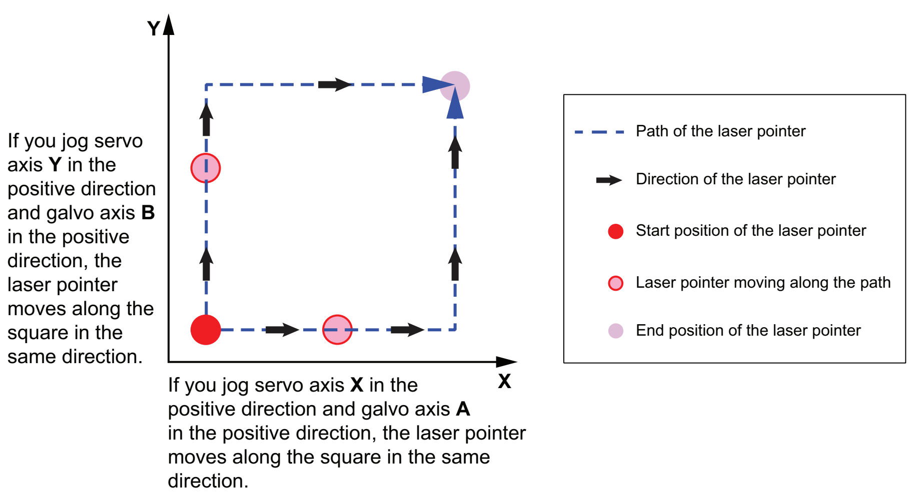

Figure 3-1: Positive Motion Goes in the Same Direction

If positive motion on the servo axes moves the laser pointer in the opposite direction of positive motion on the galvo axes, then you must change the value of the ReverseMotionDirection Parameter for the servo axes.

For Example

The image that follows shows positive motion for the ReverseMotionDirection Parameter, which is set to the default value of **0**.

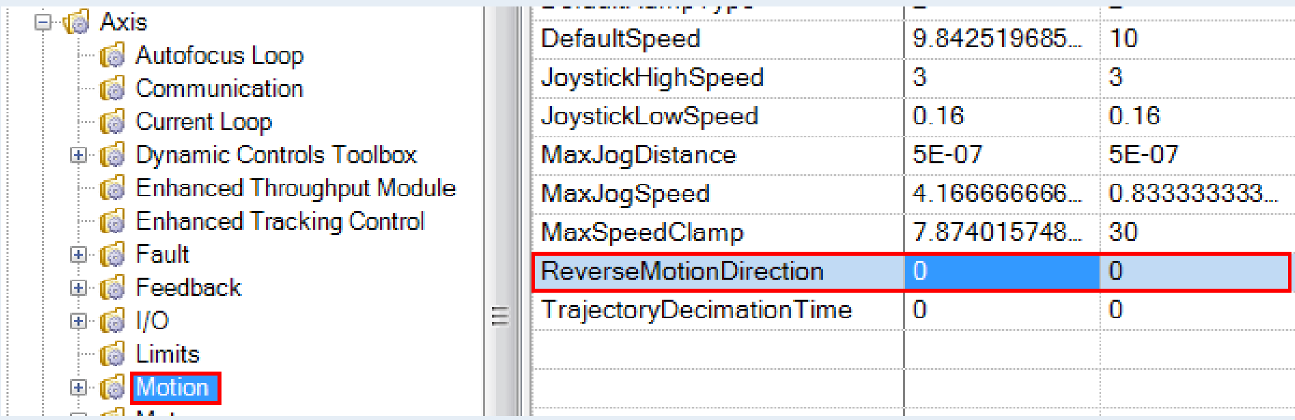

Figure 3-2: Positive Motion on the ReverseMotionDirection Parameter

For more information about this parameter, refer to **ReverseMotionDirection Parameter** in the A3200 Help file.

Chapter 4: Configure Important Parameters

Before the encoder channel signals of the servo axes can be output by the servo drives and read by the galvo drive, you must configure parameters that are important to IFOV. Make sure that you configure these parameters correctly so the operations that follow can occur.

1. The servo drives know how and where to output the encoder channel signals.
2. The galvo drive knows how and where to input the encoder channel signals.
3. The data rate of each encoder channel signal does not exceed the maximum permitted data rate of each port.

How and Where to Output the Encoder Channel Signals

You must echo the encoder channel signal from each servo drive to the Nmark GCL or Nmark SSaM drive.

The table that follows refers to the first operation - the servo drives know how and where to output the encoder channel signals. Apply these instructions to each servo axis that you use in IFOV.

Table 4-1: Configure Parameters and Encoder Output Ports for IFOV Servo Drives

Servo Drive Electronics	Encoder Output Ports(1)	Parameters That Enable Encoder Output
All Ndrive CP, HLe, HPe, ML, and MP drives that use Quadrature(2)	Auxiliary Output	Set the EncoderDivider Parameter to a value that is greater than or equal to 1.(3)
Ndrive HLe with -MXH, HPe with -MXH, and ML with -MXH	Auxiliary Output	Set the EncoderDivider Parameter to a value of 1. Set the EmulatedQuadratureDivider Parameter to a value that is greater than or equal to 1.
Ndrive HLe with -MXH and -IO, and HPe with -MXH and -IO	SSINet1 Output (J302) SSINet2 Output (J303)	Set the SSINet1Setup or SSINet2Setup Parameter to a value of 2. Set the EncoderDivider Parameter to a value of 1. Set the EmulatedQuadratureDivider Parameter to a value that is greater than or equal to 1.
Npaq(4) with Quadrature	High-Speed Outputs (J8)	Use the ENCODER OUT ON/OFF Command to echo the encoder channel signals to the J8 high-speed outputs of the Npaq.
Npaq(4) with -MXR	High-Speed Outputs (J8)	Set the EmulatedQuadratureChannel Parameter to output quadrature to the applicable PSO channel. Set the EmulatedQuadratureDivider Parameter to a value that is greater than or equal to 1. Use the ENCODER OUT ON/OFF Command to echo the encoder channel signals to the J8 high-speed outputs of the Npaq.

(1) Connect the encoder output port of each servo drive to the corresponding encoder input port of the galvo drive. For information about cable part numbers, refer to the Cables section of this guide.
(2) All of these drives use quadrature. None of these drives use the -MXH or -MXR feedback option.
(3) For more information, refer to the Make Sure Data Rates Are Not Exceeded section of this guide.
(4) This information does not apply to the Npaq MR.

At the end of this chapter, Table 4-4 is a worksheet. It shows you the equations you must use to correctly configure the EmulatedQuadratureDivider Parameter or EncoderDivider Parameter based on the parameters that you set for the servo drives in Table 4-1.

How and Where to Input the Encoder Channel Signals

The table that follows refers to the second operation - the galvo drive knows how and where to input the encoder channel signals. Apply these instructions to each galvo axis that you use in IFOV.

Table 4-2: Configure Parameters and Encoder Input Ports for the IFOV Galvo Drive

Galvo Drive Electronics	Encoder Input Ports(1)	Parameter That Enables Encoder Input
Nmark GCL	TB103A and TB103B	Set the EncoderDivider Parameter to a value of 0.
Nmark SSaM(2)	TB108A and TB108B	Set the EncoderDivider Parameter to a value of 0.

(1) Connect the encoder output port of each servo drive to the corresponding encoder input port of the galvo drive. For information about cable part numbers, refer to the Cables section of this guide.
(2) PSO is not available on the Nmark SSaM.

Make Sure Data Rates Are Not Exceeded

This section refers to the third operation - the data rate of each encoder channel signal does not exceed the maximum permitted data rate of each port.

In the figure that follows, the encoder channel signal must move to the Nmark electronics so the Nmark GCL can use the signal in IFOV. The encoder channel signal is generated at the servo stage. The letters **A**, **B**, **C**, and **D** show different locations along the path of the encoder channel signal.

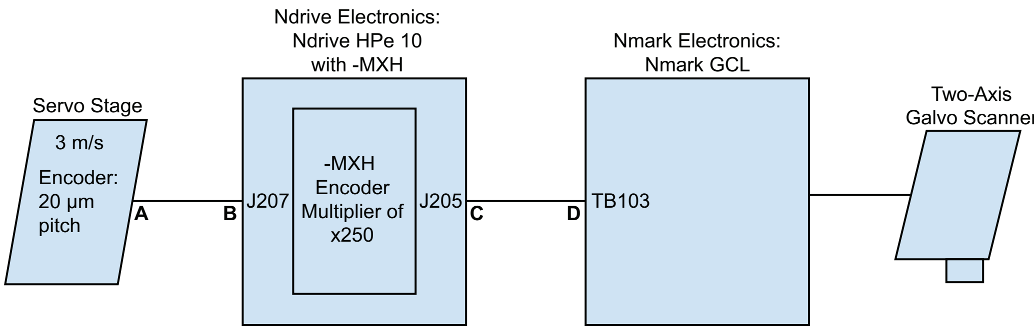

Figure 4-1: Encoder Channel Signal Moves from the Servo Stage to the Nmark GCL

Table 4-3: Maximum Permitted Encoder Channel Frequency for Encoder Ports in Figure 4-1

Drive Electronics	Encoder Port	Maximum Permitted Encoder Channel Frequency
Ndrive HPe 10	J207	40 MHz input(1)
Ndrive HPe 10	J205	25 MHz output(2)
Nmark GCL	TB103	40 MHz input(3)

(1) For more information about this frequency, refer to the **Encoder Interface** section of the hardware manual for the drive.
(2) For more information about this frequency, refer to the **EmulatedQuadratureDivider Parameter** in the A3200 Help file.
(3) For more information about this frequency, refer to the **Encoder Input** section of the hardware manual for the drive.

For Locations A, B, C, and D

This information is important and applies to each location on the path of the encoder channel signal. Figure 4-1 shows an example of this path and Locations **A**, **B**, **C**, and **D**.

- Each encoder channel has four signals, which are sin+, sin-, cos+, and cos-.
- The encoder channel frequency is the combined data rate of the four signals.
- The encoder signal frequency is the frequency of each sin+, sin-, cos+, or cos- signal.

Location A

Stage motion generates the encoder channel signal. The encoder channel frequency is based on the conditions that follow.

- The speed at which the stage travels.
- The encoder resolution of the encoder signal pitch.
- The quadrature multiplication factor of x4.

To calculate the maximum encoder channel frequency that is generated by the encoder electronics, use **Equation 1**.

Equation 1:
Max Stage Velocity (µm/s) x (Counts/µm) x 4 (quad) = *Max Encoder Channel Frequency* (MHz)

To see how you can calculate this equation, refer to the example that follows.

For Example

A stage moves at 3 m/s. It has an encoder resolution of 20 µm per encoder channel signal and a quadrature multiplication factor of x4. The encoder channel carries a signal at 0.60 MHz. For this example, **Equation 1** uses these values to calculate the maximum encoder channel frequency that is generated by the encoder electronics.

Equation 1:
(3 m/s x 1,000,000 µm/m) x (1 count/20 µm) x 4 (quad) = 0.60 MHz

Location B

The 0.60 MHz encoder channel signal that was calculated for **Equation 1** in the previous section is input into the Ndrive servo electronics at **Location B**. Drives that read standard quadrature encoders can get resolutions that are equal to the value that you calculated for **Equation 1**.

Aerotech drives that include the -MXH or -MXR feedback option can interpolate the encoder channel signal at higher levels. It is possible for these drives to interpolate the signal at levels as high as x65,536.

Hardware: Servo drives that have -MXU feedback cannot be used with IFOV.

To configure interpolation, set the EncoderMultiplicationFactor Parameter to a value that is greater than 4. For information about how to set this parameter, refer to **EncoderMultiplicationFactor Parameter** in the A3200 Help file. You must set this parameter in the active parameter file of Configuration Manager. For information about how to configure the active parameter file, refer to **Selecting a Parameter File** in the A3200 Help file.

If the drive you are using **has** a multiplication factor that you can specify, refer to **Equation 2** that follows. In this equation, multiply the value that you calculated in **Equation 1** by the value of the EncoderMultiplicationFactor Parameter divided by the quadrature factor value of x4. As a result, the new value that you calculate is the maximum-interpolated encoder channel signal that is used by the drive.

Equation 2:

$$\text{Equation 1 Value} \times \frac{\text{EncoderMultiplicationFactor}}{4\ \text{(quad)}} = \text{Max Interpolated Encoder Channel Signal}$$

NOTE: The interpolated encoder-channel signal is also the electrical resolution of the servo drive.

If the drive you are using **does not have** a multiplication factor that you can specify, the EncoderMultiplicationFactor Parameter is always set to the default value of 1.

Location C

In this location, the encoder channel signal is output from the servo drive. For information about how to enable the output of the encoder channel signal, refer to Table 4-1.

Figure 4-1 shows an example of when an EncoderMultiplicationFactor of 250 is used for an Ndrive HPe that has -MXH feedback. Thus in **Equation 2**, use an EncoderMultiplicationFactor Parameter value of 250 to get a 37.5 MHz output signal. Refer to the equation that follows.

Equation 2:

$$0.60\ \text{MHz} \times \frac{250}{4\ \text{(quad)}} = 37.5\ \text{MHz}$$

In Figure 4-1, the Ndrive HPe with -MXH feedback has a maximum permitted output frequency of 25 MHz. The 37.5 MHz output frequency is higher than the permitted output. Because this output frequency is higher, it causes signal loss and cannot be used. Thus, the output frequency that you use must not exceed the maximum permitted output frequency of the drive. To see the maximum permitted output frequencies for all supported drives, refer to **Table: Maximum Quadrature Encoder Output Frequencies** in the **Maximum Quadrature Encoder Output Frequencies** section of the **PSO Specifications** topic in the A3200 Help file.

For most of the servo drives in Table 4-1, you set the EmulatedQuadratureDivider or EncoderDivider Parameter to a value that is greater than or equal to 1. When you calculate the value of this parameter, make sure it does not exceed the maximum permitted encoder-channel output frequency that is generated by the encoder electronics.

The **Drive-Specific** section that follows gives specific instructions that you can use to calculate the EmulatedQuadratureDivider or EncoderDivider Parameter. It includes equations and other important information that is necessary for you to successfully configure your IFOV system. To fully show each calculation, this procedure is specific to the Ndrive HPe with -MXH feedback. But you can use this procedure to calculate the value of one of these parameters for your IFOV drives.

Drive-Specific

TO CALCULATE THE EMULATEDQUADRATUREDIVIDER PARAMETER

1. Set the EncoderDivider Parameter to a value of **1** to echo the encoder channel signal out of the Ndrive HPe with -MXH feedback.

   NOTE: If your drive uses the optional -IO board, Aerotech recommends that you echo the encoder channel signal out of the SSINet1 output port (J302) or SSINet2 output port (J303).

2. Calculate the value of the EmulatedQuadratureDivider Parameter, which can be an integer value or a floating-point decimal. To calculate this value, you must know the information that follows.

   Maximum Permitted Output Frequency for the encoder channel of the servo drive electronics. Refer to **Location C**.

   Maximum Permitted Input Frequency for the encoder channel of the Nmark drive electronics. Refer to **Location D**.

   A. Calculate the value of the maximum permitted servo-to-galvo encoder channel frequency.

   Equation 3:
   MIN(*Max Frequency Location C*, *Max Frequency Location D*) = *Max Permitted Servo-to-Galvo Encoder Channel Frequency*

   To fully show this calculation, **Equation 3** uses these values.

   Equation 3:
   MIN(25 MHz, 40 MHz) = 25 MHz

   PSO NOTE: If you use IFOV and PSO together, it is possible for the maximum-permitted input data rate to be lower than other data rates. For example, the maximum-permitted input data rate of the PSO encoder is 15 MHz for each encoder channel when you do -DUALPSO firing through the Nmark GCL. Thus you must use **IFOV and PSO Equation 3** that follows.

   IFOV and PSO Equation 3:
   MIN(*Max Frequency Location C*, *Max Frequency Location D*, *Max PSO Frequency*) = *Max Permitted Servo-to-Galvo Encoder Channel Frequency*

   B. Divide the maximum-interpolated encoder channel signal from **Equation 2** (in Location C) by the value that you calculated for **Equation 3**. To do this, use **Equation 4** that follows. The result of **Equation 4** becomes the value of the EmulatedQuadratureDivider Parameter.

   Equation 4 and this procedure continue onto the next page.

Equation 4:

$$\frac{\textit{Max Interpolated Encoder Channel Signal}}{\textit{Max Permitted Servo-to-Galvo Encoder Channel Frequency}} = \textit{Minimum EmulatedQuadratureDivider Parameter}$$

To fully show this calculation, **Equation 4** uses these values.

Equation 4:

$$\frac{37.5 \text{ MHz}}{25.0 \text{ MHz}} = 1.5$$

3. Make sure the value that you calculated for the EmulatedQuadratureDivider Parameter is greater than the minimum permitted value that Table 4-1 shows for this parameter based on the servo drives.

4. Optional. To include some error tolerance on the maximum velocity, add a buffer to the value of the EmulatedQuadratureDivider Parameter. To fully show this calculation, a **.5** buffer changes the value of the EmulatedQuadratureDivider Parameter to **2**. Thus, the maximum permitted output frequency at **Location C** changes from 25 MHz to 18.75 MHz. Refer to **Equation 5**.

   Equation 5:

   $$\frac{\textit{Max Interpolated Encoder Channel Signal}}{\textit{EmulatedQuadratureDivider Parameter}} = \textit{Maximum Permitted Output Frequency}$$

   For this calculation, **Equation 5** uses these values.

   Equation 5:

   $$\frac{37.5 \text{ MHz}}{2} = 18.75 \text{ MHz}$$

   A new maximum permitted output frequency of 18.75 MHz changes **Equation 4** to use these values.

   Equation 4 with Buffer:

   $$\frac{37.50 \text{ MHz}}{18.75 \text{ MHz}} = 2$$

   PSO NOTE: If you use IFOV and PSO with the Nmark GCL and you use the EmulatedQuadratureDivider or EncoderDivider Parameter to decrease the encoder channel frequency at **Location C**, the effective resolution for PSO firing also decreases on the Nmark GCL.

5. Make sure the value that you calculate for the EmulatedQuadratureDivider Parameter does not exceed the maximum permitted encoder-channel output frequency that is generated by the encoder electronics.

   To see the maximum permitted output frequencies for all supported drives, refer to **Table: Maximum Quadrature Encoder Output Frequencies** in the **Maximum Quadrature Encoder Output Frequencies** section of the **PSO Specifications** topic in the A3200 Help file.

Location D

For the Nmark GCL, encoder input port TB103 has a maximum permitted input frequency of 40 MHz. Thus when you use the EmulatedQuadratureDivider Parameter in the Drive-Specific section of **Location C**, the encoder-channel-signal frequency stays in the limits of the Nmark GCL.

In the worksheet that follows, record the values that you calculated for your specific IFOV configuration.

Table 4-4: Worksheet to Calculate the EmulatedQuadratureDivider or EncoderDivider Parameter

	Calculated Maximum Encoder Channel Frequency(1)	Maximum Permitted Input Frequency for Servo Drives(2)	Calculated Maximum Frequency of Encoder Channel Multiplied Signal	Maximum Permitted Servo-to-Galvo Encoder Channel Frequency	EmulatedQuadratureDivider or EncoderDivider Parameter(3)
Resource:	Value of **Equation 1**	Refer to the hardware manual for your drive.	For quadrature drives, use the value of **Equation 1**. **OR**: For drives with the -MXH or -MXR feedback option, use the value of **Equation 2**.	Value of **Equation 3** **OR**: For PSO, use the value of **IFOV and PSO Equation 3**.	Value of **Equation 4** **OR**: Value of **Equation 4 with Buffer**
Value:					

(1) For information about how to calculate the maximum encoder channel frequency, refer to **Location A**.
(2) Refer to **Location B** for more information.
(3) The smallest value that you can use for this parameter is the minimum value.

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Chapter 5: Test and Verify the IFOV System

Hardware: If your system uses an Npaq, refer to the ENCODER OUT ON Command section of this guide before you test your system.

Drive-Specific: Examples, procedures, and some information in this chapter use these axis configurations.

- **X** and **Y** are servo axes.
- **A** and **B** are galvo axes.
- **X** and **A** move in the same direction.
- **Y** and **B** move in the same direction.

Before you enable the axes, open Configuration Manager and the Status Utility. In Configuration Manager, make sure that the drives in your IFOV system are connected to the PC. After you enable the axes, you can use the **Diagnostics** tab of the Status Utility to look for some jitter on the position feedback.

If you do not see jitter, make sure the FireWire high-speed serial bus is connected correctly. Then make sure that Firmware Loader loaded the correct firmware onto all of the drives. For information about how to load firmware onto the drives, refer to **Firmware Loader Overview** in the A3200 Help file.

This chapter shows you how to test and verify each part of your IFOV system to make sure it operates correctly and is configured correctly. As part of this chapter, you verify:

1. That you are correctly tracking encoder counts.
2. The hardware configuration is correct.
3. The wiring polarity is correct.
4. The galvo mounting is correct.
5. The servo and galvo axes are collinear.

The Status Utility shows the status of many drive signals. In the **Diagnostics** tab, you must monitor the drive signals that follow.

NOTE: Position Feedback on the galvo axes is configured at the factory. Thus, it is not necessary to monitor the **Pos Fdbk** signal on the galvo axes.

Pos Fdbk - On the servo axes, this signal shows the multiplied position feedback from the servo stage.

Aux Pos Fdbk - On the servo axes, the status of this signal is based on the drive type that you use.

For **servo drives with -MXH or -MXR feedback**, this signal shows the multiplied position feedback divided by the value of the EmulatedQuadratureDivider Parameter.

For **all other servo drives**, this signal shows the multiplied position feedback divided by the value of the EncoderDivider Parameter.

Aux Pos Fdbk - On the galvo axes, this signal must show one count from the auxiliary encoder port of the servo drive as one count on the auxiliary encoder port of the galvo drive, which makes it a one-to-one count.

For more information about the Status Utility, refer to **System Diagnostics Overview** in the A3200 Help file.

Verify Correct Tracking of Encoder Counts

TO VERIFY THAT YOU ARE CORRECTLY TRACKING ENCODER COUNTS

1. In the **Diagnostics** tab of the Status Utility, the **Pos Fdbk** signal on the servo axes shows multiplied encoder counts. Make sure that the multiplied encoder counts correctly correspond to the actual distance that the stage travels.

For Example

You have a servo stage connected to an encoder that has a 20 µm pitch. To move this stage at a sufficiently large distance, you manually move it 100 mm at a 1,000x multiplication factor. Then you see a 5,000,000 encoder counts difference between the start position and end position. Refer to **Equation 6** that follows.

Equation 6:

$$\frac{100\text{ mm} \times 1\text{ count}}{20\ \mu\text{m}} \times \frac{1{,}000\ \mu\text{m}}{1\text{ mm} \times 1{,}000\text{ (multiplication factor)}} = 5{,}000{,}000\text{ encoder counts}$$

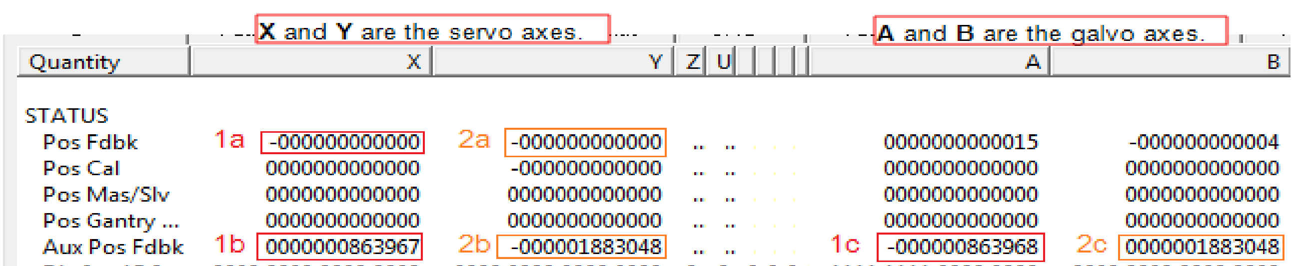
2. Look at the **Aux Pos Fdbk** signal on the servo and galvo axes. Make sure the encoder counts are divided correctly based on the drive type you are using.

For Example

The EncoderDivider Parameter is set to a value of 1 for the **X** and **Y** servo axes. Then you manually move the **X** axis to 1,722,650 counts and the **Y** axis to -1,848,570 counts. You can see this move at locations **1a** and **2a** in Figure 5-1 and Figure 5-2. This move causes the same number of counts to be added to the **Aux Pos Fdbk** signal on the **X** and **Y** servo axes, which you can see at locations **1b** and **2b** in Figure 5-1 and Figure 5-2.

Thus the **Aux Pos Fdbk** signal on the **A** and **B** galvo axes at locations **1c** and **2c** changes at a one-to-one count with the **Aux Pos Fdbk** signal on the **X** and **Y** servo axes at locations **1b** and **2b**.

When you see all of this occur, then you know your IFOV system is wired correctly.



Quantity	X	Y	Z	U	A	B
STATUS						
Pos Fdbk	-000000000000	-000000000000	..	..	0000000000015	-000000000004
Pos Cal	0000000000000	-000000000000	..	..	0000000000000	0000000000000
Pos Mas/Slv	0000000000000	0000000000000	..	..	0000000000000	0000000000000
Pos Gantry ...	0000000000000	0000000000000	..	..	0000000000000	0000000000000
Aux Pos Fdbk	0000000863967	-000001883048	..	..	-000000863968	0000001883048

Figure 5-1: Start of Move - EncoderDivider Parameter Set to 1

X and Y are the servo axes. | A and B are the galvo axes.

Quantity		X		Y	Z	U		A		B
STATUS										
Pos Fdbk	1a	0000001722650	2a	-000001848570	..	..		-000000000013		-000000000007
Pos Cal		0000000000000		-000000000000	..	..		0000000000000		0000000000000
Pos Mas/Slv		0000000000000		0000000000000	..	..		0000000000000		0000000000000
Pos Gantry ...		0000000000000		0000000000000	..	..		0000000000000		0000000000000
Aux Pos Fdbk	1b	0000002586617	2b	-000003731618	..	..	1c	-000002586617	2c	0000003731618
Dig In 15:0		0000 0000 0000 0000		0000 0000 0000 0000	0.	0.		1111 1111 0000 0000		0000 0000 0000 0000

Figure 5-2: End of Move - EncoderDivider Parameter Set to 1

It is not necessary for the **Aux Pos Fdbk** signal on the servo axes to have the same number of counts as the **Aux Pos Fdbk** signal on the galvo axes. Figure 5-1 and Figure 5-2 show these signals with the same number of counts as the result of a machine reset. But it is important for these signals to increase or decrease at the same rate. If this does not occur, do an inspection of the wiring and make sure that you set the correct parameters.

In Figure 5-2, the counts at location **1b** are inverted from the counts at location **1c**. The counts at location **2b** are inverted from the counts at location **2c**. If the counts are inverted for your IFOV system, you can correct this by changing the **Auxiliary Feedback Direction** setting of the FeedbackSetup Parameter from **Normal** to **Inverted**. When you change this setting, the direction of the encoder channel signal changes after the signal is input into the galvo drive. For information about how to change this setting, refer to the Verify the Wiring Polarity section of this guide.

Verify the Hardware Configuration

At this time, you configured the necessary parameters and commands and connected the servo drives to the Nmark GCL or Nmark SSaM galvo drive. You also started to test your IFOV system.

Now you must verify that the hardware configuration is correct before you try to run a program in IFOV mode.

TO VERIFY THE HARDWARE CONFIGURATION

1. Open Motion Composer.
2. Open the Status Utility. Then select the **Diagnostics** tab.
3. Npaq Only. If you are using an Npaq, issue the ENCODER OUT ON/OFF Command.

   NOTE: For more information about this command, refer to the ENCODER OUT ON Command section of this guide and **ENCODER OUT ON/OFF Command** in the A3200 Help file.

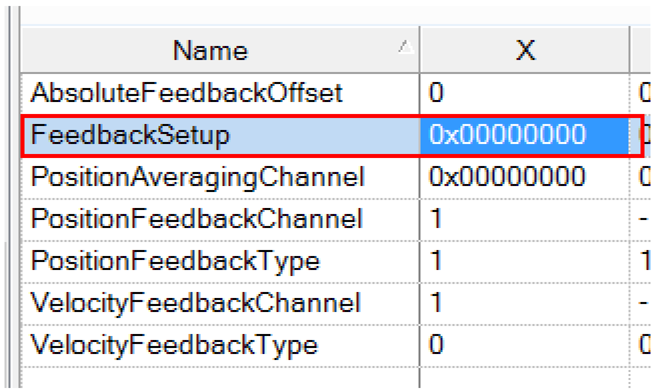
4. In Motion Composer, enable the servo axes.
5. Jog the servo axes.
6. In the Status Utility, look at the **Aux Pos Fdbk** signal on the galvo axes for the Nmark GCL or Nmark SSaM.
7. Verify that the **Aux Pos Fdbk** signal on the galvo axes counts in the same direction as the **Pos Fdbk** signal on the servo axes.
   - If the value of the counter does not change, then there is a problem with the hardware configuration or the wiring.
   - If the **Aux Pos Fdbk** signal on the galvo axes counts in the opposite direction of the **Pos Fdbk** signal on the servo axes, then the wiring polarity is reversed. Refer to the Verify the Wiring Polarity section of this guide for more information.

Verify the Wiring Polarity

The wiring polarity is correct when the **Aux Pos Fdbk** signal on the galvo axes counts in the same direction as the **Pos Fdbk** signal on the servo axes. If the **Aux Pos Fdbk** signal on the galvo axes counts in the opposite direction of the **Pos Fdbk** signal on the servo axes, the wiring polarity is reversed.

NOTE: You can correct reversed wiring polarity without making changes to the wire configuration. To do this, set the **Auxiliary Feedback Direction** setting of the FeedbackSetup Parameter to **Inverted** on the galvo axes. You must set this parameter in the active parameter file of Configuration Manager.

If the counts are inverted for your IFOV system and the **Auxiliary Feedback Direction** setting of the FeedbackSetup Parameter is currently set to **Inverted**, change this setting back to **Normal** to correct the inverted counts.



Name	X
AbsoluteFeedbackOffset	0
FeedbackSetup	0x00000000
PositionAveragingChannel	0x00000000
PositionFeedbackChannel	1
PositionFeedbackType	1
VelocityFeedbackChannel	1
VelocityFeedbackType	0

Figure 5-3: FeedbackSetup Parameter

For more information about this setting, refer to **FeedbackSetup Parameter** in the A3200 Help file.

Verify the Galvo Mounting

Verify that the programming direction of the galvo axes is the same as the programming direction of the servo axes. Also make sure that the CountsPerUnit Parameter is set to the correct value on the galvo axes.

TO VERIFY THE GALVO MOUNTING

1. Connect a laser pointer to the galvo scan head.
2. Open Motion Composer.
3. Power on the laser. Do one of the steps that follow.
   - Enable the guide laser.
   - Use the GALVO LASEROVERRIDE ON Command to enable the laser.
4. Jog the **X** servo axis in the positive direction and the **A** galvo axis in the positive direction. Based on the results, do one of the steps that follow.
   - If the two axes move in the same direction, the parameter configuration is correct. Continue to the next step.
   - If the two axes move in opposite directions, change the value of the ReverseMotionDirection Parameter on the axis that moves in the incorrect direction.

This procedure continues onto the next page.

5. Jog the **Y** servo axis in the positive direction and the **B** galvo axis in the positive direction. Based on the results, do one of the steps that follow.
   - If the two axes move in the same direction, the parameter configuration is correct. Continue to the next step.
   - If the two axes move in opposite directions, change the value of the ReverseMotionDirection Parameter on the axis that moves in the incorrect direction.
6. Verify that the CountsPerUnit Parameter is set correctly for the **A** and **B** galvo axes. Do the steps that follow.
   A. Draw a small part that includes only these two galvo axes.
   B. Measure the part to make sure that the dimensions are correct.

Verify That the Servo and Galvo Axes Are Collinear

For IFOV to work correctly, the X/Y coordinate system of the galvo axes must be accurately aligned with the X/Y coordinate system of the servo axes. Thus, motion in the X direction of the galvo coordinate system must be collinear with motion in the X direction of the servo coordinate system, and must not result in motion in the Y direction of the servo coordinate system.

It might be difficult to accurately align the galvo scan head to the servo coordinate system. Make gross alignment corrections by mechanically rotating the galvo axes relative to the servo axes. Make fine alignment corrections by using the GALVO ROTATION Command. This command specifies an angle of rotation that is applied to galvo axes. For more information about this command, refer to **GALVO ROTATION Command** in the A3200 Help file.

TO VERIFY THAT THE SERVO AND GALVO AXES ARE COLLINEAR

1. Mark a line that has only one galvo axis.
2. Mark an identical line that goes in the opposite direction and has the corresponding servo axis.
3. Measure the distance between the start point of the first line and the end point of the second line.
4. Use the distance that you measured in **Step 3** to calculate the rotation angle. Refer to **Equation 7** and Figure 5-4 that follow.

Equation 7:

$$\text{Angle } \theta = \text{acos}\left[1 - 0.5\left(\frac{\text{distance between points}}{\text{length of line}}\right)^2\right]$$

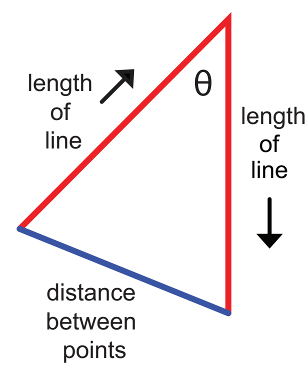


Figure 5-4: Measure Alignment Error

If the coordinate systems are accurately aligned, the distance between the two points is zero. You can do the **To Verify That the Servo and Galvo Axes Are Collinear** procedure again to improve the angle measurement and to verify that the measurement is correct.

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Chapter 6: Write Your IFOV Program

Drive-Specific: Examples, procedures, and some information in this chapter use these axis configurations.

- **X** and **Y** are servo axes.
- **A** and **B** are galvo axes.
- **X** and **A** move in the same direction.
- **Y** and **B** move in the same direction.

The sections that follow show you how to write your IFOV program.

Calculate the Maximum Permitted Speed

The controller requires you to command motion that does not exceed the maximum permitted speed in IFOV mode. To calculate the maximum permitted speed that you can command to the galvo axes, refer to **Equation 8** that follows.

Equation 8:
Maximum Permitted Speed = 100.0 x *Field of View Size*

For Example

If you specify 100.0 mm to the IFOV SIZE Command, you can command a maximum permitted speed of 10,000 mm/s to the galvo axes in your IFOV program. If you command motion that exceeds this speed, a task error occurs.

Configure the IFOV Software

TO CONFIGURE THE IFOV SOFTWARE

NOTE: For more information about the commands and parameters in this procedure, refer to the A3200 Help file.

1. In Configuration Manager, set the IFOVConfigurations Parameter to **1** or **2**.
2. Reset the controller.
3. Set the task-based speeds and ramp rates. Do the steps that follow.
   A. To set the task-based acceleration and deceleration rates, use the RAMP RATE Command. To get the best performance from your IFOV system, use a large ramp rate or an infinite ramp rate of RAMP RATE 0.
   B. To set the task-based acceleration and deceleration modes to rate-based ramping, use the RAMP MODE Command. Rate-based ramping is the default.
   C. To set the coordinated speed, use the F Command. To calculate the maximum permitted speed, refer to the Calculate the Maximum Permitted Speed section of this guide.

This procedure continues onto the next page.

4. Set the axis-based speeds and ramp rates on each of the two galvo axes. Do the steps that follow.

NOTE: You can use IFOV without changing the axis-based speeds and ramp rates of the servo axes. In IFOV mode, when you program motion on the galvo axes the controller automatically limits the speed and acceleration of the servo axes.

A. To set the ramp rate for each of the two galvo axes, use the RAMP RATE Command with the *<Axis>* argument. To get the best performance from your IFOV system, use a large ramp rate or an infinite ramp rate of RAMP RATE 0.

B. To set the axis-based acceleration and deceleration modes to rate-based ramping for each of the two galvo axes, use the RAMP MODE Command with the *<Axis>* argument.

C. To set the axis-based speed command for each of the two galvo axes, use the *<AxisName>*F*<Speed>* syntax. To calculate the maximum permitted speed, refer to the Calculate the Maximum Permitted Speed section of this guide.

For Example

If one of the galvo axes has the name **A**, then AF*<Speed>* sets the axis-based speed on the **A** axis. If the other galvo axis has the name **B**, then BF*<Speed>* sets the axis-based speed on the **B** axis.

5. Configure IFOV by issuing the commands that follow.

Table 6-1: IFOV Configuration Commands

Command	Description
IFOV AXISPAIR	Issue this command two times to map the two galvo axes to the corresponding servo axes. Refer to the Configure the IFOV AXISPAIR Program Lines section of this guide for more information.
IFOV SYNCAXES	Specify more axes to command in IFOV. If you do not want to synchronize more axes, specify NONE for this command.
IFOV SIZE	Specify, in user units, the field-of-view size of the galvo scan head.
IFOV TIME	Specify the maximum search time, in milliseconds, that the controller looks ahead. Aerotech recommends that you start with a value of 200 milliseconds for the *<SearchTime>* argument.
IFOV TRACKINGSPEED	Specify the maximum speed of the servo axes.
IFOV TRACKINGACCEL	Specify the maximum acceleration of the servo axes.

Configure the IFOV AXISPAIR Program Lines

NOTE: For a full description of each argument and more information about this command, refer to **IFOV AXISPAIR Command** in the A3200 Help file.

In your IFOV program, you must issue the IFOV AXISPAIR Command two times.

The IFOV AXISPAIR Command has four arguments, which includes an optional *<EncoderScaleFactor>* argument. You can use this argument to specify the scale factor for this command as an alternative to using the default scale factor. If you do not specify this argument, the controller automatically calculates the scale factor by using **Equation 9** that follows.

Equation 9:

$$\text{Default Scale Factor} = \left(\frac{\textit{CountsPerUnit}\text{ of the galvo axis}}{\textit{CountsPerUnit}\text{ of the servo axis}}\right)$$

If the scale factor that you want to specify for the *<EncoderScaleFactor>* argument is the **same** as the value of **Equation 9**, then it is not necessary to specify a value for this argument.

But if the value of the scale factor that you want to specify for the *<EncoderScaleFactor>* argument is **different** from the value of **Equation 9**, you must specify this value for the *<EncoderScaleFactor>* argument.

Configure the *<EncoderScaleFactor>* Argument

If you specify an incorrect value for the *<EncoderScaleFactor>* argument and try to run your IFOV program, the controller can generate a software limit fault on the galvo scan head. To prevent this from occurring, make sure you do the operations that follow when you use this argument in the Configure the Encoder Feedback for Ndrive Drives or the Configure the Encoder Feedback for Npaq Drives section of this guide.

- ✔ Multiply the scale factor by the value of the EmulatedQuadratureDivider or EncoderDivider Parameter.
- ✔ Use the UNITSTOCOUNTS keyword.

Configure the Encoder Feedback for Ndrive Drives

NOTE: The encoder feedback of each servo axis (**X** and **Y**) must be connected to the galvo drive.

The procedures and example programs in this section show you how to use the IFOV AXISPAIR Command in your IFOV program based on the type of Ndrive drives you are using. For more information about this command, refer to the Configure the IFOV AXISPAIR Program Lines section of this guide.

For information about how to use the IFOV AXISPAIR Command and the ENCODER OUT ON Command for an Npaq drive, refer to Configure the Encoder Feedback for Npaq Drives section of this guide.

TO CONFIGURE ENCODER FEEDBACK FOR THE NDRIVE CP, HLE, HPE, ML, AND MP WITH QUADRATURE

NOTE: On Ndrive CP and MP drives, this procedure is applicable only for quadrature encoders. An external hardware box is necessary for encoders that generate an amplified sine output.

1. Connect the auxiliary output ports of the servo drives to the encoder input ports on the Nmark GCL or SSaM. Refer to Table 4-2 to find the applicable encoder input ports.

2. Set the EncoderDivider Parameter to echo the encoder channel signals out of the auxiliary output ports. You must set this parameter on the two servo axes that you are using on the Ndrive drives. Do the applicable step that follows.
   - If the output frequency **is more than** 40 MHz, set the EncoderDivider Parameter to a value that is > **1**.
   - If the output frequency **does not exceed** 40 MHz, set the EncoderDivider Parameter to a value of **1**.

3. Based on the value that you set for the EncoderDivider Parameter, refer to one of the example programs that follow.
   - If EncoderDivider > 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EncoderDivider > 1 Example

```
' Horizontal axis pair.
' Map the galvo axis (A) to the servo axis (X).
IFOV AXISPAIR 0, A, X, (UNITSTOCOUNTS(A, 1) / UNITSTOCOUNTS(X, 1) * EncoderDivider.X)

' Vertical axis pair.
' Map the galvo axis (B) to the servo axis (Y).
IFOV AXISPAIR 1, B, Y, (UNITSTOCOUNTS(B, 1) / UNITSTOCOUNTS(Y, 1) * EncoderDivider.Y)
```

   - If EncoderDivider = 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EncoderDivider = 1 Example

```
' Horizontal axis pair.
' Map the galvo axis (A) to the servo axis (X).
IFOV AXISPAIR 0, A, X

' Vertical axis pair.
' Map the galvo axis (B) to the servo axis (Y).
IFOV AXISPAIR 1, B, Y
```

TO CONFIGURE ENCODER FEEDBACK FOR THE NDRIVE HLE, HPE, AND ML WITH -MXH FEEDBACK

1. Connect the auxiliary output ports of the servo drives to the encoder input ports on the Nmark GCL or SSaM. Refer to Table 4-2 to find the applicable encoder input ports.

2. Set the EncoderDivider Parameter to a value of **1** to echo the encoder channel signals out of the auxiliary output ports. You must set this parameter on the two servo axes that you are using on the Ndrive drives.

3. Set the value of the EmulatedQuadratureDivider Parameter. You must set this parameter on the two servo axes that you are using on the Ndrive drives. Do the applicable step that follows.
   - If the output frequency **is more than** 25 MHz, set the EmulatedQuadratureDivider Parameter to a value that is > **1**.
   - If the output frequency **does not exceed** 25 MHz, set the EmulatedQuadratureDivider Parameter to a value of **1**.

4. Based on the value that you set for the EmulatedQuadratureDivider Parameter, refer to one of the example programs that follow.
   - If EmulatedQuadratureDivider > 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EmulatedQuadratureDivider > 1 Example

```
' Horizontal axis pair.
' Map the galvo axis (A) to the servo axis (X).
IFOV AXISPAIR 0, A, X, (UNITSTOCOUNTS(A, 1) / UNITSTOCOUNTS(X, 1) * EmulatedQuadratureDivider.X)

' Vertical axis pair.
' Map the galvo axis (B) to the servo axis (Y).
IFOV AXISPAIR 1, B, Y, (UNITSTOCOUNTS(B, 1) / UNITSTOCOUNTS(Y, 1) * EmulatedQuadratureDivider.Y)
```

   - If EmulatedQuadratureDivider = 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EmulatedQuadratureDivider = 1 Example

```
' Horizontal axis pair.
' Map the galvo axis (A) to the servo axis (X).
IFOV AXISPAIR 0, A, X

' Vertical axis pair.
' Map the galvo axis (B) to the servo axis (Y).
IFOV AXISPAIR 1, B, Y
```

Configure the Encoder Feedback for Npaq Drives

NOTE: The encoder feedback of each servo axis (**X** and **Y**) must be connected to the galvo drive.

The procedures and example programs in this section show you how to use the IFOV AXISPAIR and ENCODER OUT ON Commands in your IFOV program based on the type of Npaq you are using. For more information about these commands, refer to Configure the IFOV AXISPAIR Program Lines and ENCODER OUT ON Command sections of this guide.

For information about how to use the IFOV AXISPAIR Command for Ndrive drives, refer to Configure the Encoder Feedback for Ndrive Drives section of this guide.

TO CONFIGURE ENCODER FEEDBACK FOR AN NPAQ WITH QUADRATURE

Hardware: This information does not apply to the Npaq MR.

1. Connect the J8 high-speed output ports of the Npaq to the encoder input ports on the Nmark GCL or SSaM. Refer to Table 4-2 to find the applicable encoder input ports.

2. Use the IFOV AXISPAIR Command. Refer to the example program that follows.

IFOV AXISPAIR Example

```
' Horizontal axis pair.
' Map the galvo axis (A) to the servo axis (X).
IFOV AXISPAIR 0, A, X

' Vertical axis pair.
' Map the galvo axis (B) to the servo axis (Y).
IFOV AXISPAIR 1, B, Y
```

3. Use the ENCODER OUT ON Command to echo the encoder channel signals out of the J8 high-speed output ports on the Npaq.

ENCODER OUT ON Example

```
ENCODER OUT X ON <Channel1>, <Channel2>, <Channel3>

' For Example:
' <Channel1> Argument=1: Echo encoder channel 0 to J8 (outputs 8 and 9)
' <Channel2> Argument=2: Echo encoder channel 1 to J8 (outputs 10 and 11)
' <Channel3> Argument=0: Unused
ENCODER OUT X ON 1, 2
```

TO CONFIGURE ENCODER FEEDBACK FOR AN NPAQ WITH -MXR FEEDBACK

Hardware: This information does not apply to the Npaq MR.

1. Connect the J8 high-speed output ports of the Npaq to the encoder input ports on the Nmark GCL or SSaM. Refer to Table 4-2 to find the applicable encoder input ports.

2. Set the EmulatedQuadratureChannel Parameter to output quadrature to the applicable PSO channel. You must set this parameter on the two servo axes that you are using on the Npaq drive. Typically, this parameter is set to **6** on the **X** servo axis and **7** on the **Y** servo axis.

3. Set the value of the EmulatedQuadratureDivider Parameter. You must set this parameter on the two servo axes that you are using on the Npaq drive. Do the applicable step that follows.
   - If the output frequency **is more than** 16 MHz, set the EmulatedQuadratureDivider Parameter to a value that is > **1**.
   - If the output frequency **does not exceed** 16 MHz, set the EmulatedQuadratureDivider Parameter to a value of **1**.

4. Based on the value that you set for the EmulatedQuadratureDivider Parameter, refer to one of the example programs that follow.
   - If EmulatedQuadratureDivider > 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EmulatedQuadratureDivider > 1 Example

     ```
     ' Horizontal axis pair.
     ' Map the galvo axis (A) to the servo axis (X).
     IFOV AXISPAIR 0, A, X, (UNITSTOCOUNTS(A, 1) / UNITSTOCOUNTS(X, 1) * EmulatedQuadratureDivider.X)

     ' Vertical axis pair.
     ' Map the galvo axis (B) to the servo axis (Y).
     IFOV AXISPAIR 1, B, Y, (UNITSTOCOUNTS(B, 1) / UNITSTOCOUNTS(Y, 1) * EmulatedQuadratureDivider.Y)
     ```

   - If EmulatedQuadratureDivider = 1, use the IFOV AXISPAIR Command. Refer to the example program that follows.

     EmulatedQuadratureDivider = 1 Example

     ```
     ' Horizontal axis pair.
     ' Map the galvo axis (A) to the servo axis (X).
     IFOV AXISPAIR 0, A, X

     ' Vertical axis pair.
     ' Map the galvo axis (B) to the servo axis (Y).
     IFOV AXISPAIR 1, B, Y
     ```

This procedure continues onto the next page.

5. Use the ENCODER OUT ON Command to echo the encoder channel signals out of the J8 high-speed output ports on the Npaq.

ENCODER OUT ON Example

```
ENCODER OUT X ON <Channel1>, <Channel2>, <Channel3>

' For Example:
' <Channel1> Argument=7: Echo encoder channel 6 to J8 (outputs 8 and 9)
' <Channel2> Argument=8: Echo encoder channel 7 to J8 (outputs 10 and 11)
' <Channel3> Argument=0: Unused
ENCODER OUT X ON 7, 8
```

ENCODER OUT ON Command

Hardware: This command applies only when used with the Npaq. It does not apply to the Npaq MR. For more information about this command, refer to **ENCODER OUT ON/OFF Command** in the A3200 Help file.

When you use an Npaq in your IFOV system, the encoder channel signals from the servo axes echo out of the J8 high-speed input/output port. The J8 port is on the Rear Panel Interface board of the Npaq. To send the correct encoder channel signals to the correct pins on this port, you must include a program line that uses the ENCODER OUT ON Command in your IFOV program. On this program line, you must specify only the first axis of the Npaq. This line looks as follows.

```
ENCODER OUT <Axis> ON <Channel1>, <Channel2>
```

Important Connection Information

You must connect the J8 output port on the Npaq to the correct encoder input port on the galvo drive. Refer to Table 4-2 to find the applicable encoder input ports.

For Example

You use a C25482-XX cable to connect the J8 high-speed input/output port on the Npaq to the TB103 port on the Nmark GCL. Pins 1 to 8 on the Npaq send the two quadrature encoder channel signals to pins 1 to 4 on the TB103A port and pins 1 to 4 on the TB103B port of the Nmark GCL.

The **ENCODER OUT ON** Command continues onto the next page.

For an Npaq with -MXR Feedback

To configure the values for the *<Channel1>* and *<Channel2>* arguments of the ENCODER OUT ON Command, refer to Table 6-2. This table shows you how the value of the EmulatedQuadratureChannel Parameter maps to the *<ChannelX>* argument of the ENCODER OUT ON Command. For more information, refer to **EmulatedQuadratureChannel Parameter** and **ENCODER OUT ON Command** in the A3200 Help file.

NOTE: Before you use the information in Table 6-2, you must set the EmulatedQuadratureChannel Parameter.

Table 6-2: IFOV Configurations for the Npaq with -MXR Feedback

EmulatedQuadratureChannel Setting(1)	*<ChannelX>* Argument Value(2)	Instructions for the IFOV Servo Axes
To PSO Channel 6	7 (for *<Channel1>*)	Set the **X** servo axis to this channel.
To PSO Channel 7	8 (for *<Channel2>*)	Set the **Y** servo axis to this channel.
To PSO Channel 8	9 (for *<Channel3>*)	This channel is not used.

(1) Aerotech recommends that you do not change the value of the EmulatedQuadratureChannel Parameter programmatically because this might require the Npaq to internally reprogram the -MXR hardware. Unexpected quadrature outputs might also occur during the programming cycle. If you must change the value of this parameter in a program, change the value at a time when the quadrature outputs are not being used. You must also examine the state of the **Programming MXH** bit of the Drive Status status item to make sure that programming has completed before you continue.

(2) This column shows the *<Channel1>*, *<Channel2>*, and *<Channel3>* arguments of the ENCODER OUT ON Command and their applicable values.

For Example

Your Npaq uses -MXR feedback and you specify **X** and **Y** as the servo axes. Both servo axes use the -MXR board to multiply the encoder channel signals. For the **X** servo axis, you set the EmulatedQuadratureChannel Parameter to **To PSO Channel 6**. For the **Y** servo axis, you set this parameter to **To PSO Channel 7**.

The line that contains the ENCODER OUT ON Command in your IFOV program looks as follows. On this program line, you must specify only the first axis of the Npaq. For this example, **X** is the first axis of the Npaq.

```
ENCODER OUT X ON 7, 8
```

Table 6-3: IFOV Axis Configurations for an Npaq with -MXR Feedback

Axis Configurations	X Servo Axis	Y Servo Axis	Z Servo Axis
The Npaq axis that you use in IFOV. You can select axes 1 - 6.	1	2	Not Used
The setting of the EmulatedQuadratureChannel Parameter.	To PSO Channel 6	To PSO Channel 7	Not Used
The *<ChannelX>* argument(1) that you use.	*<Channel1>*	*<Channel2>*	*<Channel3>* (Not Used)
The value of the *<ChannelX>* argument(1).	7	8	Not Used
High-Speed differential output numbers for the J8 port.	8 and 9	10 and 11	Not Used
High-speed differential output pins on the J8 port.	1, 2, 3, 4	5, 6, 7, 8	Not Used
Input Pins for TB103A and TB103B ports on the Nmark GCL.	Input Pins 1 - 4 for the TB103A Port	Input Pins 1 - 4 for the TB103B Port	NA

(1) These rows show the *<Channel1>*, *<Channel2>*, and *<Channel3>* arguments of the ENCODER OUT ON Command and their applicable values.

The **ENCODER OUT ON** Command continues onto the next page.

For an Npaq without -MXR Feedback

You must specify a value from 1 to 6 for the *<Channel1>* and *<Channel2>* arguments of the ENCODER OUT ON Command. Each of these values maps directly to one of the six drive channels on the Npaq.

For Example

Your Npaq does not use -MXR feedback and you specify **X** and **Y** as the servo axes. For the **X** servo axis, you specify a value of **1** for the *<Channel1>* argument of the ENCODER OUT ON Command. For the **Y** servo axis, you specify a value of **2** for the *<Channel2>* argument of the ENCODER OUT ON Command.

The line that contains the ENCODER OUT ON Command in your IFOV program looks as follows. On this program line, you must specify only the first axis of the Npaq. For this example, **X** is the first axis of the Npaq.

```
ENCODER OUT X ON 1, 2
```

Table 6-4: IFOV Axis Configurations for an Npaq without -MXR Feedback

Axis Configurations	X Servo Axis	Y Servo Axis	Z Servo Axis
The Npaq axis that you use in IFOV. You can select axes 1 - 6.	1	2	Not Used
The setting of the EmulatedQuadratureChannel Parameter.	None	None	Not Used
The *<ChannelX>* argument(1) that you use.	*<Channel1>*	*<Channel2>*	*<Channel3>* (Not Used)
The value of the *<ChannelX>* argument(1).	1	2	Not Used
High-Speed differential output numbers for the J8 port.	8 and 9	10 and 11	Not Used
High-speed differential output pins on the J8 port.	1, 2, 3, 4	5, 6, 7, 8	Not Used
Input Pins for TB103A and TB103B ports on the Nmark GCL.	Input Pins 1 - 4 for the TB103A Port	Input Pins 1 - 4 for the TB103B Port	NA

(1) These rows show the *<Channel1>*, *<Channel2>*, and *<Channel3>* arguments of the ENCODER OUT ON Command and their applicable values.

IFOV SIZE Command

The IFOV SIZE Command specifies a square field of view for the scanning axes, which are the galvo axes, to use during IFOV. This field of view is centered about (0,0), which is the default center of travel position of the galvo scanner. Before you specify the *<FOVSize>* argument, you must know the conditions that follow.

- On the galvo axes, the IFOV SIZE Command does not exceed the difference in the boundaries of the SoftwareLimitLow and SoftwareLimitHigh Parameters.
- After you specify the IFOV SIZE Command, the controller requires you to command motion that does not exceed the maximum permitted speed that you calculated for IFOV mode. For more information, refer to the Calculate the Maximum Permitted Speed section of this guide.

For more information, refer to **IFOV SIZE Command**, **SoftwareLimitLow Parameter**, and **SoftwareLimitHigh Parameter** in the A3200 Help file.

Programming Motion

TO PROGRAM MOTION

1. Issue the ENABLE and HOME Commands to enable and home all of the servo and galvo axes. You must do this before you use IFOV.
2. Use the RAPID Command to move the servo axes to the initial position.
3. Use the RAPID Command to move the galvo axes to (0,0), which is the center of the galvo scan head.
4. Issue the WAIT MODE AUTO Command to set your task to the automatic wait mode.
5. In your IFOV program, set the MotionUpdateRate Parameter on the task to one of the values that follow.
   - To decrease the workload of the controller, set the value of this parameter to **24**.
   - To use the higher trajectory rate of the galvo scan head, set the value of this parameter to **48**.
6. Issue the VELOCITY ON Command to turn on the velocity profiling mode for the task.
7. Issue the IFOV ON Command to enable Infinite Field of View (IFOV) on the task.
8. In your IFOV program, program all motion on the galvo axes. The controller automatically allocates the motion to the galvo axes and the servo axes to make the correct profile in X-Y space.
   - If you command a marking move such as BEZIER, CCW, CW, or LINEAR on the galvo axes, the controller activates the laser output.
   - If you command a non-marking move such as RAPID on the galvo axes, the controller deactivates the laser output.
9. Optional. For more information, refer to **Scanning and Marking** in the A3200 Help file.
10. When you are done commanding IFOV motion, issue the IFOV OFF Command to disable IFOV on the task.

Summary

You have now configured IFOV for your drives. If problems occur with your IFOV configuration or you have questions about your configuration, contact Aerotech Global Technical Support.

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