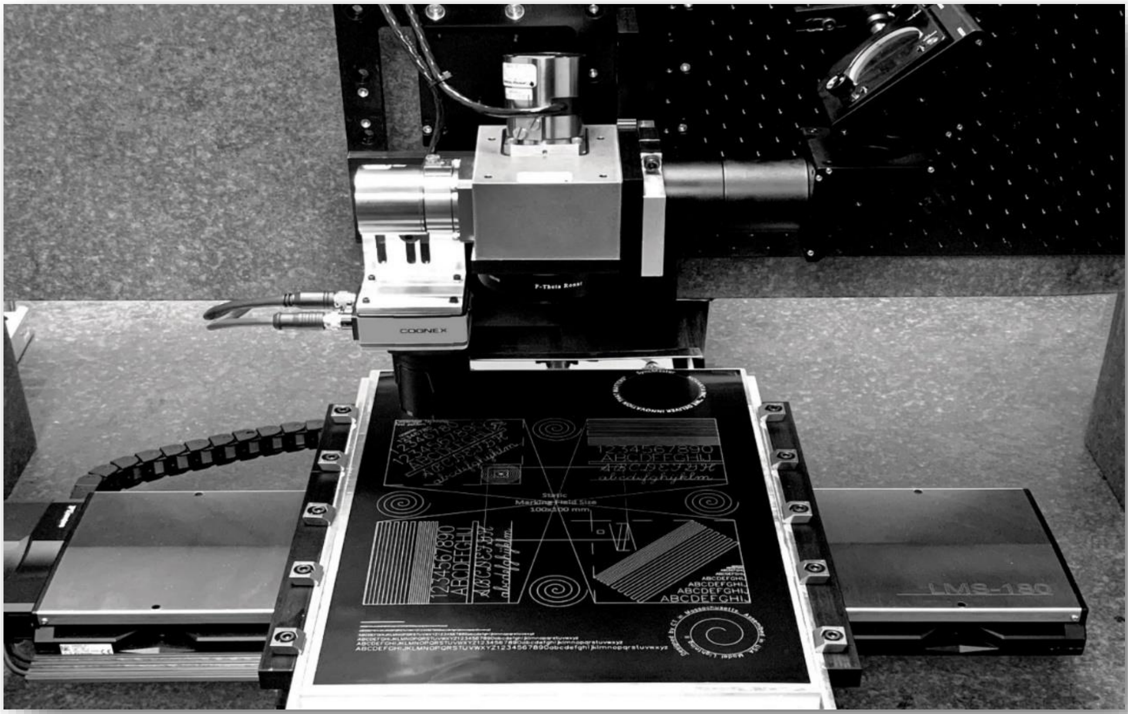
SyncMaster

Configuration and Operational Manual

Read carefully before using.
Retain for future reference.



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CAMBRIDGE TECHNOLOGY

Novanta PHOTONICS

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1 IMPORTANT INFORMATION

For your protection, carefully read these instructions before installing and operating the scan head.
Retain these instructions for future reference.

Novanta reserves the right to update this user manual at any time without prior notification.

If product ownership changes, this manual should accompany the product.

1.1 PURPOSE

This manual provides directions to help users safely and effectively install and operate the ScanMaster Controller (also known as SMC) for various laser processing applications using Galvanometer based laser scanning head and laser. The manual also includes material such as system specifications and optimization guidelines. It is assumed that the reader has a general knowledge of Galvos and command controllers.

1.2 SAFETY SYMBOLS

This manual uses the following symbols and signal words for information of importance.

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

WARNING

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

CAUTION

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

IMPORTANT

Indicates information considered important but not directly hazard related (e.g., security, hygiene, or equipment or property damage).

1.3 SAFETY LABELS

DANGER

Laser radiation

can cause severe retinal and corneal burns, burns on the skin, and may pose a fire risk.

- To avoid injury and reduce risk of fire, please follow the control measures and safety guidelines provided by the laser's manufacturer, and those established by your Laser Safety Officer (LSO), Radiation Safety Officer (RSO), or safety department of your business or institution.

ESD WARNING

Electrostatic discharge and improper handling
can damage MOVIA scan head's electronics.

- Keep the equipment sealed until it is located at a proper static control station.

1.4 CUSTOMER SUPPORT

Before contacting Novanta for assistance, review appropriate sections in the manual that may answer your questions.

After consulting this manual, please contact one of our worldwide offices between 9 AM and 5 PM local time.

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2 INTRODUCTION

This section provides you with general information about the ScanMaster Controller's SyncMaster feature.

2.1 PRODUCT DESCRIPTION

SyncMaster is a feature of Novanta's ScanMaster Controller (SMC). It is designed to coordinate and control the motion of a Galvanometer based scan head with an external XY motion subsystem for the purpose of extending the marking field of the scan head to very large areas. This feature enables continuous marking of geometry over a large area without the need for tiling or stitching.

SyncMaster feature highlights include the following:

- External motion controller independence
  - No need to commit to single supplier of external motion control hardware
  - Uses industry standard TCP/IP communications and digital quadrature encoder inputs
- Simple job layout using ScanMaster Designer
  - Importing and editing externally defined artwork, e.g. DXF files or other 2D graphic file formats
  - Job design in a global coordinate system that is 256 times the field of the scan head
  - Support for all shape types including point and shoot, circular and spiral via hole trepanning
  - Sophisticated directional path optimization to maximize system throughput
- Simple system configuration
  - Uses only basic system geometry and external motion subsystem parameters
  - Does not require tight time-base coupling between the scan control system and external motion system

2.2 SYSTEM REQUIREMENTS

Refer to Performance Specifications for general specifications.

SyncMaster is currently designed to work with Lightning II digital scan heads and a third-party external motion controller. The external motion controller manipulates the work-piece positioning system that can be a two-axis XY stage assembly, or a two-axis gantry system where the work-piece is positioned in one axis and the scan head is moved in the other axis. Novanta provides the SMC, customer chosen laser adapters and cables to facilitate integration, and all required software. Novanta does not supply the third party controller or mechanical systems.

NOTE: The operation and performance of SyncMaster is dependent upon the type and tuning of the Lightning II scanner hardware being used. Smaller aperture mirror system will tend to perform well at high speeds and accelerations, while larger aperture systems may have somewhat reduced performance. This will affect the maximum eternal motion system speed that can be used. SyncMaster currently runs in SMC Traditional mode marking and the attached Lightning II scanners are expected to be using a Vector tune.

2.3 REFERENCE DOCUMENTS

- SMC Hardware Reference Manual
- SMD Software Reference Manual
- AN00002 Cambridge Technology Software Suite Setup

2.4 SYNCMASTER OVERVIEW

SyncMaster uses marking job information created in ScanMaster Designer or by a customer application using ScanMaster API (SMAPI) to drive the coordinated motions of a Lightning II scan head and an external motion system. The job is created as if that the scan head can reach the entire field required to mark the work-piece. When the job is sent to the SMC for execution, it is automatically divided up between the external motion control system and the scan head.

SyncMaster is implemented in firmware entirely contained in the SMC. SyncMaster is enabled and configured using configuration files stored on the SMC that can be edited using the SMC Device Configuration Editor. Job flow is controlled using a ScanScript script that runs as part of the scan job.

In Figure-1 shows a typical connection scenario for SyncMaster. Communications from the host application to the SMC is done through SMAPI via TCP/IP transactions over Ethernet to load job data, start and stop the job, and to monitor status. SyncMaster specific communication to the external motion controller, in this case ACS, is also done via Ethernet TCP/IP transactions, but these transactions are done directly by the SMC without host involvement.

The protocol of the transactions between the SMC and the external motion controller defined by the manufacturer of the external motion controller. SMC provides different communications interfaces for each of the external motion controllers it supports. All that is required of these interfaces is to be able to connect, optionally home the motion system, move the system to a defined location with confirmation, and to move the motion system to a series of locations without confirmation.

The SMC communicates with the Lightning II digital servos directly over GSBus and interfaces to various laser types using manufacturer specific adapter cards.

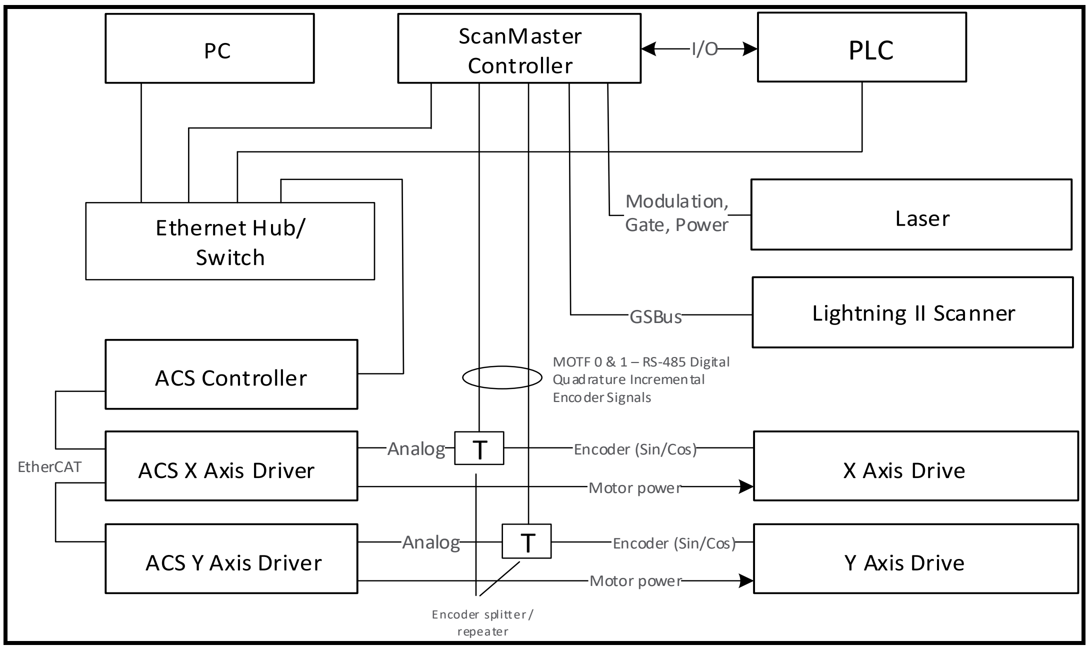


Figure 1 - Typical SyncMaster Physical Configuration

2.5 TECHNICAL SPECIFICATION

The overall performance specifications of the SyncMaster system are highly dependent on the accuracy and precision of the external motion system. The external motion system determines the accuracy of the grid over the full process area. In addition, if it is used to help calibrate the scan head by positioning a marked artifact under a CCD measurement camera, it will also affect the accuracy in the scan area.

As a rule-of-thumb, best overall system performance is obtained by using an external motion system that can provide an absolute accuracy and precision that is 5-10X better that the *expected* overall system performance. This is because the system error budget is spread across the motion control system, the scanner system, and the laser pointing stability, the total of which determine the boundaries of the *system* accuracy.

Performance Specifications defines the basic performance specifications that are achievable if care is taken in the construction of the system.

Table 1 - Performance Specifications

Specification	Value
Marking Area	256 times the scan head field size Limited by the construction of the external motion system used to position the work piece.
Accuracy	< +/- 10um Accuracy depends on the accuracy of the external positioning system and the calibration quality of the scan head. With external motion systems known to have an accuracy of < +/-2um, calibration accuracy of the scan head using integrated CCD camera metrology has been shown to be < +/-5um.
Repeatability	< +/- 5um Directionally independent but is dependent on the encoder resolution. The encoder linear resolution should be at least 10X better than the expected system repeatability.

2.6 SYNCMASTER CURRENT HARDWARE SUPPORT AND CONFIGURATION

SyncMaster currently supports external motion subsystems that are controlled by ACS. The ACS SPiiPlus family of controllers is supported through direct Ethernet TCP/IP communication using published interfacing methods and commands as defined in the manual "SPiiPlus Command and Reference Variable Guide v2_50". No PC-based control is used at run-time. Standard ACS supplied software tools such as that described in the "SPiiPlus MMI User Guide v2.50" can be used to help configure the ACS motion system and to diagnose integration issues.

NOTE: Additional motion controller vendor support will be added in *future* releases of the SMC firmware.

3 INSTALLATION

This section provides guidelines for the installation of the ScanMaster Designer (SMD) that provides convenient access to the SyncMaster feature, and the ScanMaster Controller (SMC) SDK that provides tools for testing the SMC and upgrading the SMC firmware.

3.1 SYSTEM REQUIREMENTS

The following are the minimum requirements for installing and running SMD on a desktop computer or personal laptop.

- Operating systems: Windows 10
- Processor: Intel or AMD 64-bit, 2GHz or greater
- RAM memory: 8GB minimum
- Hard disk space: 256GB or greater

3.2 SCANMASTER DESIGNER AND SMC SDK INSTALLATION

Please see application note: AN00002 Cambridge Technology Software Suite Setup for details on how to download and install all of the required software components for SyncMaster operation.

For furthermore instruction and technical help please refer to the ScanMaster Designer User Guide.

3.3 SCANMASTER CONTROLLER INSTALLATION

The ScanMaster Controller is sensitive to ESD. Handle it with care; improper handling can damage to these electronics.

	Novanta has implemented procedures and precautions for handling these components, and we encourage our customers to do the same. Upon receiving your components, note that they are packaged in an ESD-protected container with the appropriate ESD warning labels. Keep the components sealed until they are located at a proper static control station.

A proper static control station includes:

- A soft grounded conductive tabletop or grounded conductive mat on the tabletop.

- A grounded wrist strap with the appropriate (1Meg) series resistor connected to the tabletop mat and ground.
- An adequate earth ground connection such as a water pipe or alternating current (AC) ground.
- Conductive bags, trays, totes, racks, or other containers for storage of ESD-sensitive components.
- Properly grounded power tools.
- Personnel handling ESD items should wear ESD protective garments and ground straps.

NOTE: Equipment returned to the factory must be shipped in antistatic packaging.

3.4 MECHANICAL LAYOUT

The SMC uses standard 0.1" pitch connectors to permit direct attachment of ribbon cables or discrete terminated cables. An optional Auxiliary I/O module can be attached in a daughter-card or cable arrangement to expose signals in Phoenix Contact industrial automation connectors. Lasers are connected via a 50-pin connector located at the edge of the SMC module. Various laser adapter cards can be attached to this connector, either directly or by a ribbon cable. The Figure-2 shows a fully assembled SMC with Auxiliary I/O and the High-power Laser Adapter for industrial laser system integration.

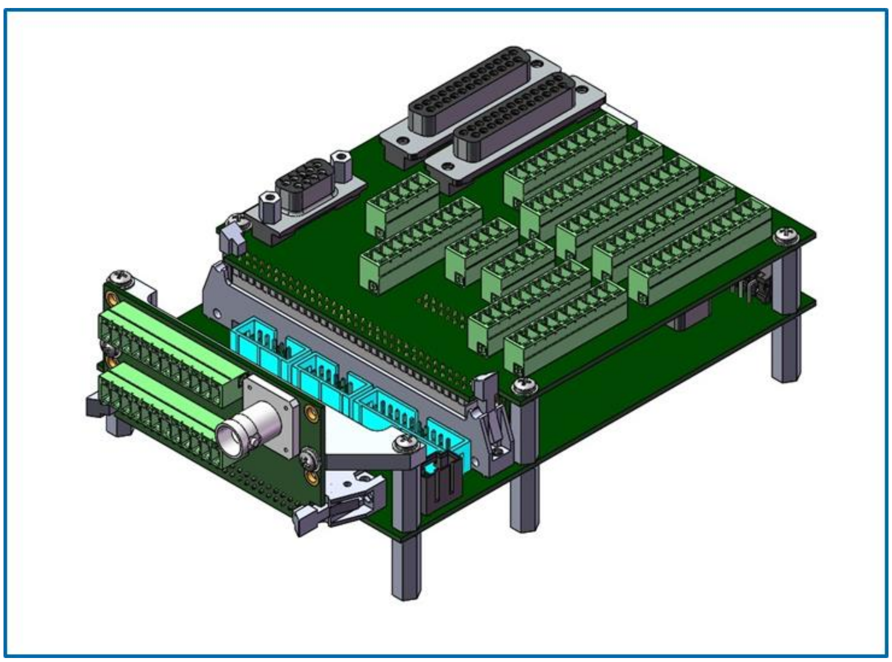


Figure 2 - SMC with laser adaptor and auxiliary I/O module

Optional hardware handshaking signals can be accessed from the system control and status port. Ethernet and power must also be connected along with the scanner communications, either XY2-100 or GSBus direct or via CameraLink extension. Figure-3 shows all of the connector identifications, locations and dimensions of the SMC main module. It is not necessary to use the auxiliary I/O module shown in Table-1 for basic ScanMaster operation. It is only necessary if the additional I/O beyond that supported by the main module is required.

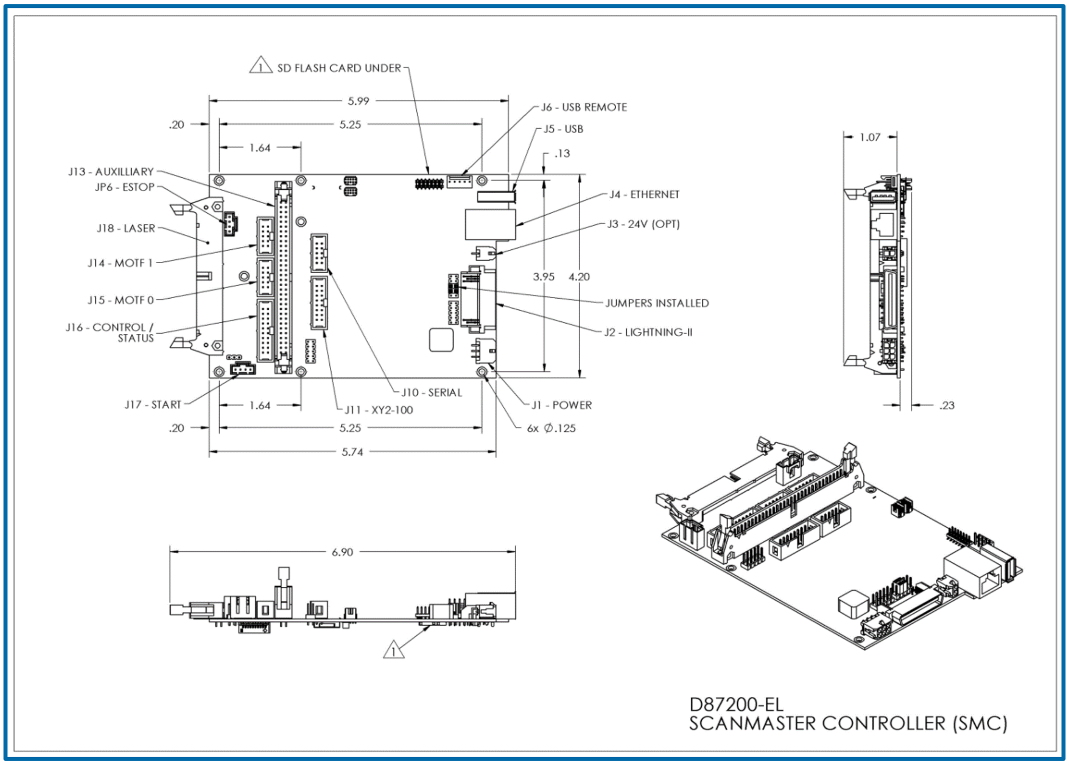


Figure 3 - SMC connector layout and dimensions

3.5 MARK-ON-THE-FLY ENCODER CONNECTIONS

For SyncMaster operation, the external motion control system RS-422/485 digital quadrature signals must be connected to the SMC “MOTF” ports. Full signal assignments of these ports are defined in the SMC Hardware Reference Manual. Minimal connection requirements for the MOTF ports are shown in the MOTF Port Connections.

Table 2 - MOTF Port Connections

SMC Signal	**MOTF Port / Pin**	**Purpose**
Encoder input for affecting X Galvo tracking		
AUX_AMOTF0_DP	MOTF 0, J15 Pin 1	RS-422/485 Encoder A-Phase Plus
AUX_AMOTF0_DN	MOTF 0, J15 Pin 2	RS-422/485 Encoder A-Phase Minus
AUX_BMOTF0_DP	MOTF 0, J15 Pin 3	RS-422/485 Encoder B-Phase Plus
AUX_BMOTF0_DN	MOTF 0, J15 Pin 4	RS-422/485 Encoder B-Phase Minus
GND	MOTF 0, J15 Pin 8	Digital ground reference
CHASSIS	MOTF 0, J15 Pin 10	System Chassis
Encoder input for affecting Y Galvo tracking		
AUX_AMOTF1_DP	MOTF 1, J14 Pin 1	RS-422/485 Encoder A-Phase Plus
AUX_AMOTF1_DN	MOTF 1, J14 Pin 2	RS-422/485 Encoder A-Phase Minus
AUX_BMOTF1_DP	MOTF 1, J14 Pin 3	RS-422/485 Encoder B-Phase Plus
AUX_BMOTF1_DN	MOTF 1, J14 Pin 4	RS-422/485 Encoder B-Phase Minus
GND	MOTF 1, J14 Pin 8	Digital ground reference
CHASSIS	MOTF 1, J14 Pin 10	System Chassis

3.6 VERIFYING ENCODER OPERATION

Once the MOTF ports are properly connected, they should be tested for proper operation. The ScanMaster Designer I/O monitoring tool can be used for this purpose. Before using this, the MOTF count scaling should be defeated so raw encoder counts can be observed.

1. Open ScanMaster Designer:

    Start→Cambridge Technology SMD→ScanMaster Designer

2. Connect to the SMC and then open the device configuration editor

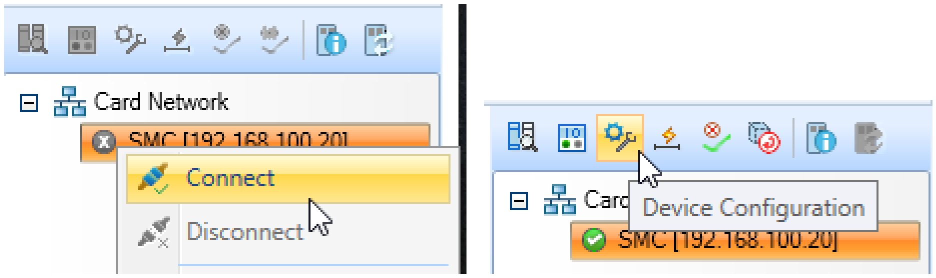


Figure 4 - SMC connection via ScanMaster Designer

3. Select the ControlConfig file, the Galvo Control Configuration tab, and ensure that SyncMaster is **not** enabled.

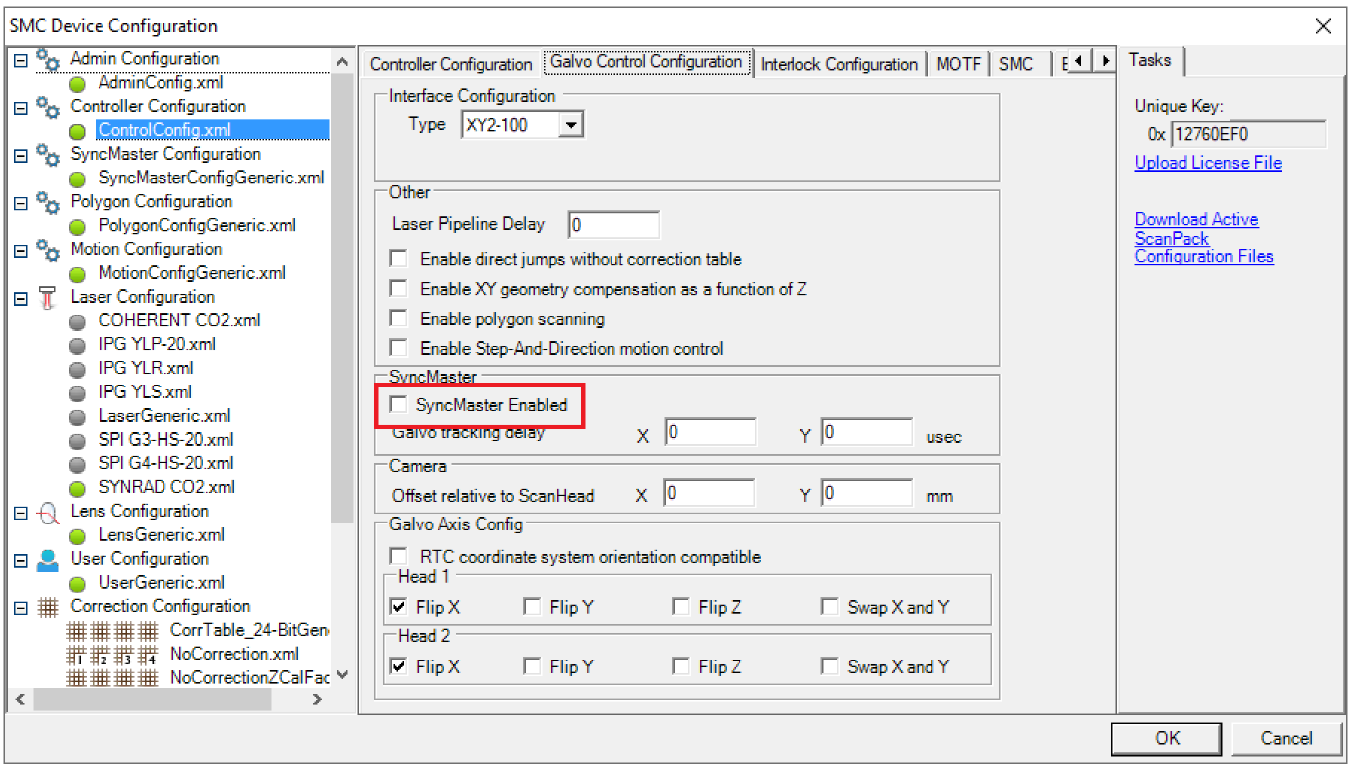


Figure 5 - SMC Device Configuration

4. Select the MOTF tab and set the MOTF properties as shown below. The MOTF Calibration Factor of 1.0 eliminates scaling of the encoder values. Press OK to activate the settings.

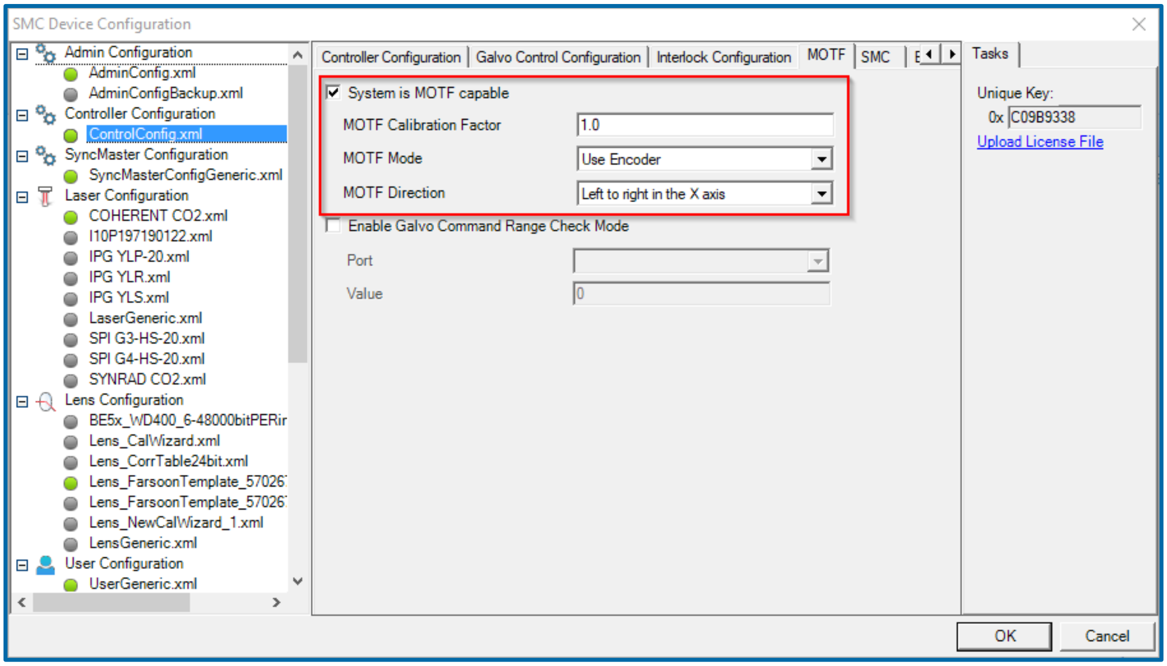


Figure 6 - SMC Device Configuration – ControlConfig

5. Open the I/O monitor

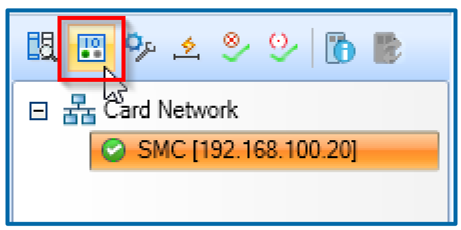


Figure 7 - SMC I/O icon

6. While moving the external motion system, monitor the MOTF values for expected changes. The values shown are raw encoder counts.

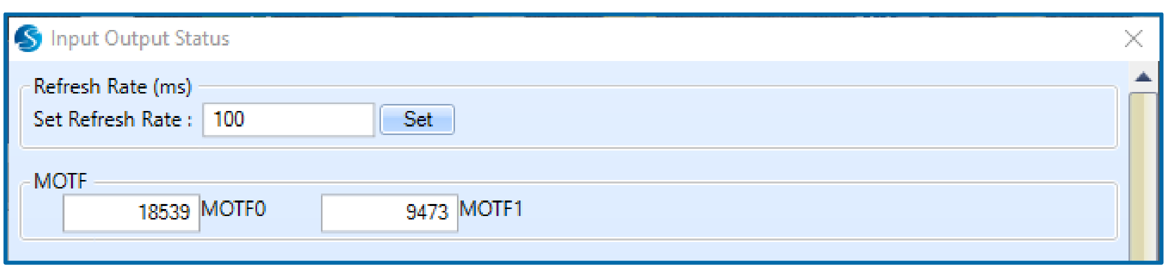


Figure 8 - SMC I/O status

4 SYNCMASTER SETUP

This section provides guidelines for the SyncMaster licensing and configuration with currently supported external motion controllers.

4.1 ENABLING SYNCMASTER

SyncMaster is a major feature that affects the run-time behavior of the SMC. For it to be operational, it must be enabled and licensed. To enable it you must edit the SMC Control Config file:

1. Open ScanMaster Designer:

   Start→Novanta SMD→ScanMaster Designer

2. Connect to the SMC and then open the device configuration editor as shown in Figure 4 SMC connection via ScanMaster Designer
3. Select the ControlConfig file, the Galvo Control Configuration tab, and ensure that SyncMaster is **enabled**.
4. Set the Galvo tracking delay values to numbers recommended by CT technical support for the scan head configuration being used and press OK.

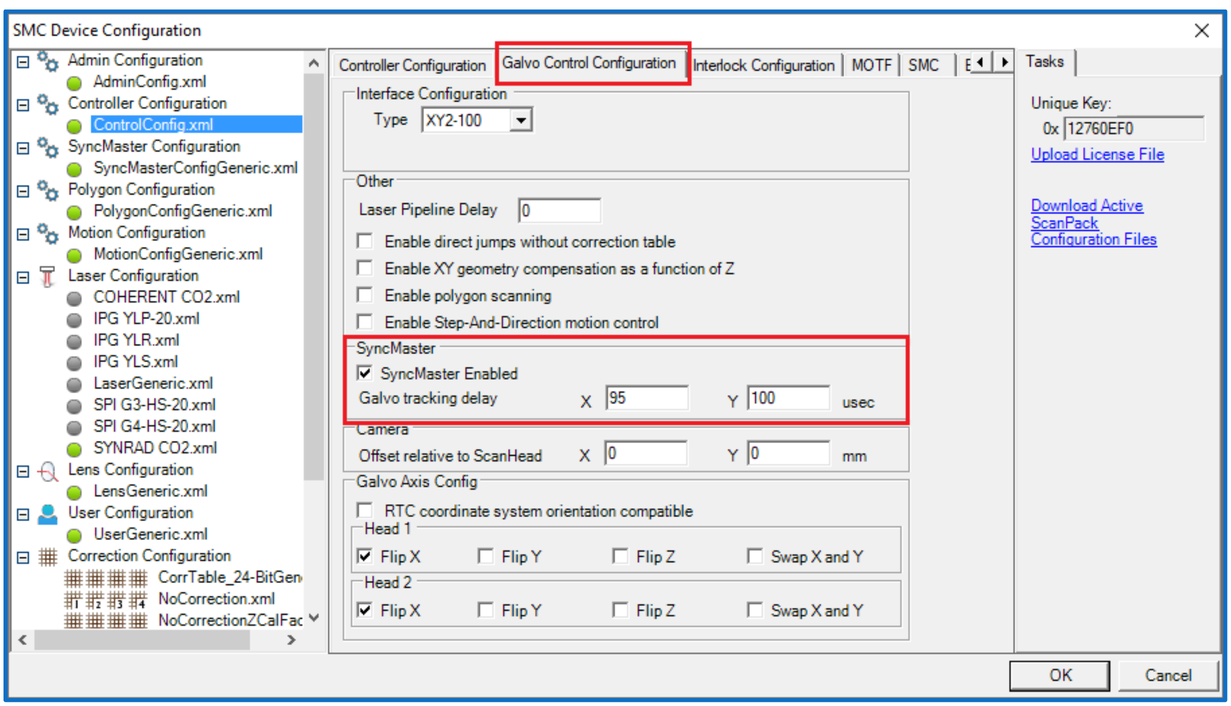


Figure 9 - SMC Device Configuration – Galvo Control Configuration

4.2 SYNCMASTER LICENSE

SyncMaster is a licensed feature of SMC. You will not be able to access the SyncMaster process setup interface of SMD, or be able to run SyncMaster jobs without a proper license. Licensing information is stored on the SMC in a license file that is preconfigured at the factory. Field upgrades of the license are possible.

Please contact Novanta sales representatives for details.

5 SYNCMASTER CONFIGURATION

SyncMaster is a feature whose behavior is defined by configuration items in the SMC SyncMaster configuration file. This file is edited using software tools that are part of SMD and the SMC SDK.

5.1 DEVICE CONFIGURATION

The device configuration editor can be accessed from SMD once you are connected to a target SMC. Press the highlighted tool Icon to open the editor.

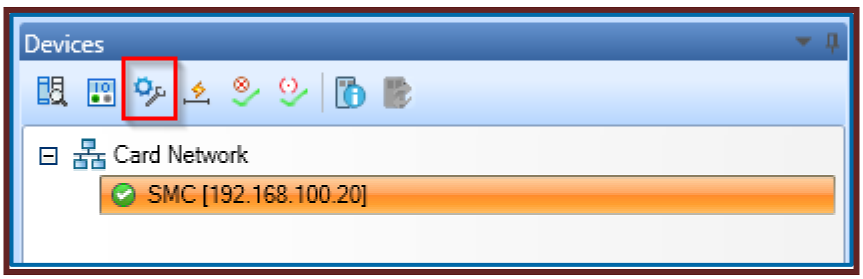


Figure 10 - SMC Device Configuration

An alternate method to open the editor is from the Windows start menu:

Start→Cambridge Technology SMC→Device Config Editor

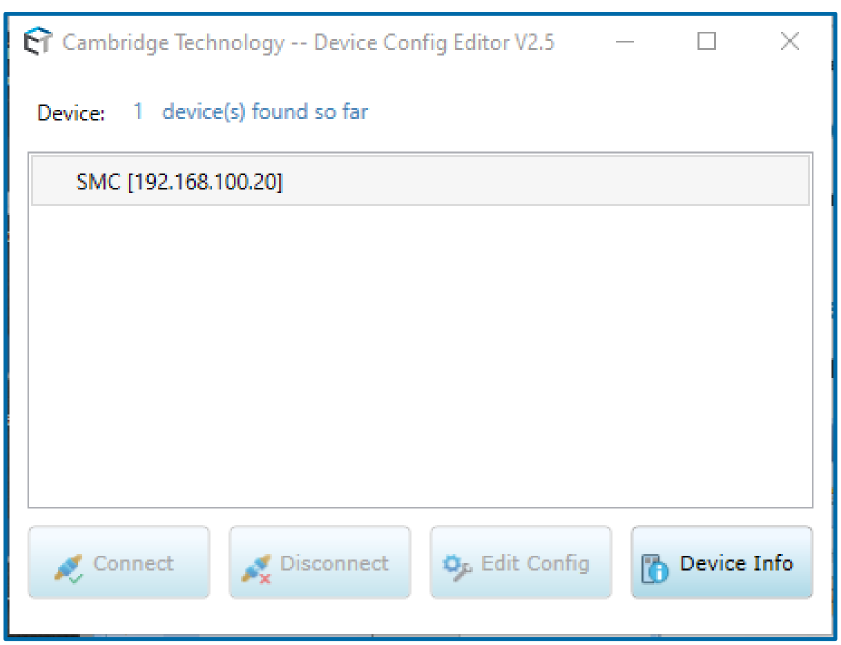


Figure 11 - SMC Device Config Editor

Select the SMC by clicking on it, press “Connect” and then “Edit Config”

Both methods will bring up the configuration editor tool:

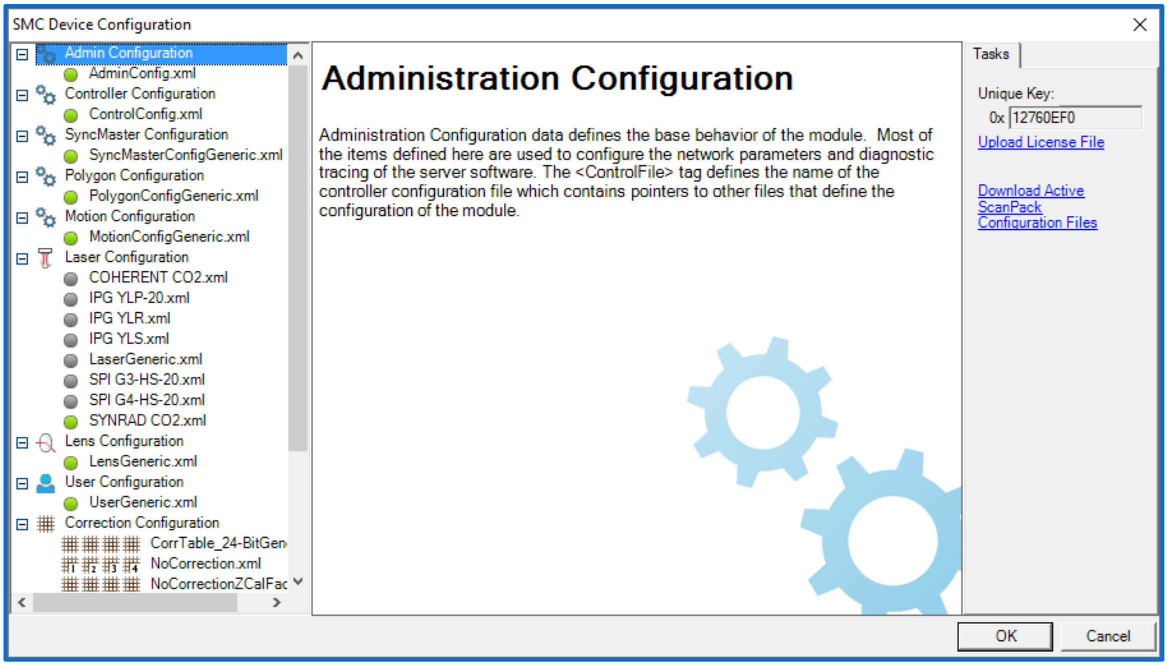


Figure 12 - SMC Device Configuration – AdminConfig

The SyncMaster configuration file is divided into sections accessed by tabs. To edit the SyncMaster configuration file, select it as shown below.

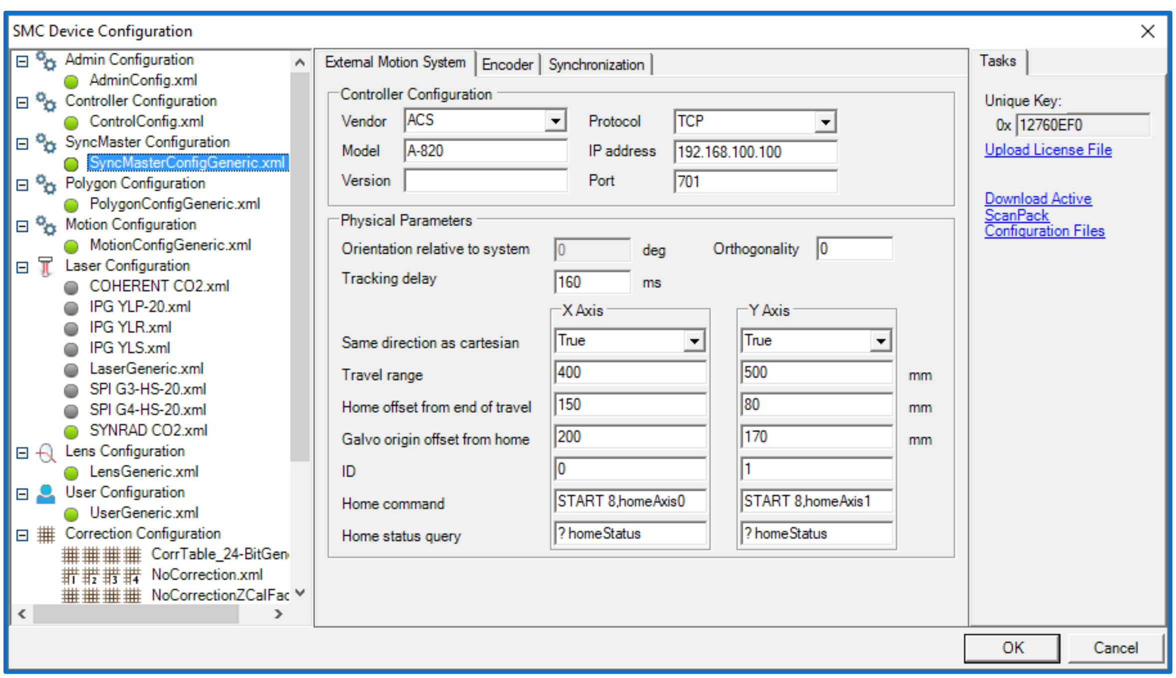


Figure 13 - SyncMaster Configuration – Motion System

5.2 EXTERNAL MOTION SYSTEM TAB

The External Motion System tab has two subsections: Controller Configuration and Physical Parameters.

The Controller Configuration section defines the third-party external motion controller that is used to move the work-piece in an XY stage configuration, or the work-piece and scan head in an gantry type configuration.

Table 3 - Controller Configuration

Parameter	Setting	Comment
Vendor	Selects the vendor of the external motion system controller	Configures the SMC to use the selected vendor-specific interface firmware. Each vendor uses different methods to communicate.
Model	Identifies the particular controller model	If the communication requirements differ between a vendor's products, then this would allow the SMC to differentiate between them. **NOTE:** Not currently used
Version	Controller SW/FW version if known	If the communication requirements differ between a vendor product SW/FW versions then this would allow the SMC to differentiate between them. **NOTE:** Not currently used
Protocol	Selects the protocol to be used to communicate with the controller	Expected to be accessible over Ethernet **NOTE:** Only TCP/IP is currently supported
IP address	The IP address of the controller	Must be configured to match the external motion controller
Port	The IP port number of the controller	Must be configured to match the external motion controller

The Physical Parameters section defines the essential physical configuration of the external work-piece positioning system.

Table 4 - Physical Parameters

Parameter	**Setting**	**Comment**
Orientation relative to system (degrees)	0, 90, 180, 270	The positioning system axis orientation relative to the entire system coordinate system. Normally these are aligned, i.e. 0 degrees. **NOTE:** Only 0 degrees is supported at this time.
Orthogonality (degrees)	< +/-1.0	Orthogonality refers to angular difference from 90 degrees of the X-Y Stage axes. This is to address the small mechanical assembly errors in the X-Y stage that would affect the galvo calibration and system stitching accuracy.
Tracking delay (ms)	> 0	The empirically measured average delay from the controller receiving a series of equally spaced-in-time coordinates to when the motion system physically moves there.
Travel range (mm) - X	> 0	The maximum travel range in the X axis from the home (0) position
Travel range (mm) - Y	> 0	The maximum travel range in the Y axis from the home (0) position
Home Offset from end of Travel (mm) - X	+/-	The distance from the X stage home sensor position to the actual X home defined position
Home Offset from end of Travel (mm) - Y	+/-	The distance from the Y stage home sensor position to the actual Y home defined position
Galvo origin offset from home (mm) - X	+/-	The distance between the X Stage home offset position to the X galvo origin
Galvo origin offset from home (mm) - Y	+/-	The distance between the Y Stage home offset position to the Y galvo origin
ID – X, Y	Number	The number refers the X Stage and Y Stage for identification when communicating with the stage controller
Home Command – X, Y	String	The ASCII command that will home the X stage or Y stage
Home Status – X, Y	String	The ASCII command query to check whether the stage is in position or not

The diagram in Figure-14 defines the relationship the stage travel range, the stage home offsets and the galvo origin offsets.

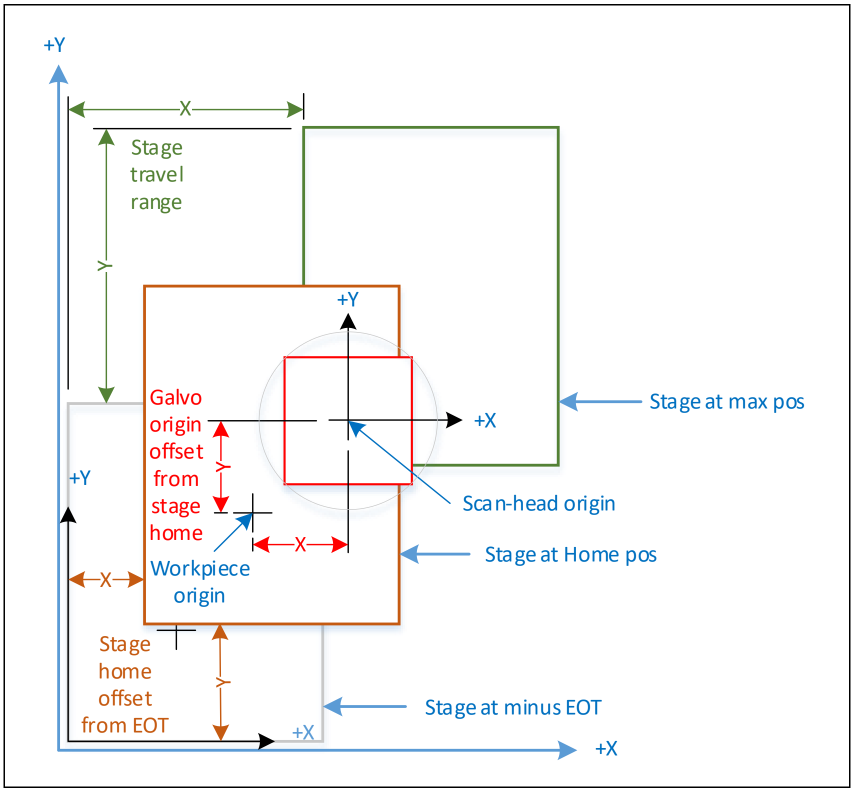


Figure 14 - Typical Coordinate system

5.3 ENCODER TAB

The Encoder tab parameters are explained in Encoder Parameters.

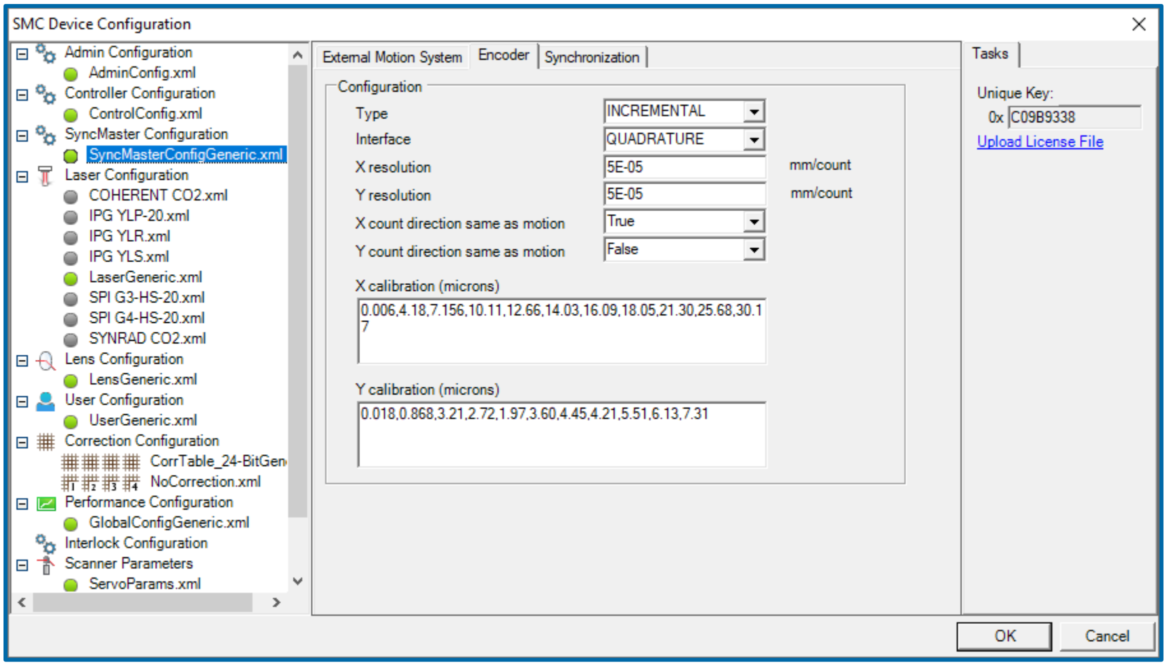


Figure 15 - SyncMaster Configuration - Encoder

Table 5 - Encoder Parameters

Parameter	Setting	Comment
Type	Selects the encoder type	**NOTE:** Currently only incremental encoders are supported
Interface	Selects the encoder physical interface	**NOTE:** Currently only RS-485 digital quadrature is supported
X resolution (mm/count)	The linear resolution of the X axis encoder	Should be at least 0.5um per count for proper performance. Higher resolution is possible up to the maximum counting rate of 25MHz.
Y resolution (mm/count)	The linear resolution of the Y axis encoder	Should be at least 0.5um per count for proper performance. Higher resolution is possible up to the maximum counting rate of 25MHz.

X count direction same as motion	True or False	Set to True is the encoder counts increment up as the axis moves in the positive X direction Set to false if the encoder counts decrement as the axis moves in the positive X direction
Y Count direction same as motion	True or False	Set to True is the encoder counts increment up as the axis moves in the positive Y direction Set to false if the encoder counts decrement as the axis moves in the positive Y direction
X Calibration	Comma separated values in micron (µm)	Raw encoder data has to be corrected to find the actual location of the stage position. Usually stage manufacturer will provide this data. Depends on the Travel Range of the particular axis and from the number of points the grid size can be calculated. E.g.: 400 mm Travel Range, 11 data points Grid size will be 400/ 11-1 = 40 mm Encoder data will be provided by XY stage supplier.
Y Calibration	Comma separated values in micron (µm)	Same as above

5.4 SYNCHRONIZATION TAB

The Synchronization tab has two sections that specifies key information that helps keep the execution of the Galvos and external motion system in sync. Synchronization Parameters identifies the parameters that affect the behavior of the system and Table specifies characteristics of the built-in data logging facility that helps refine the choice of various properties.

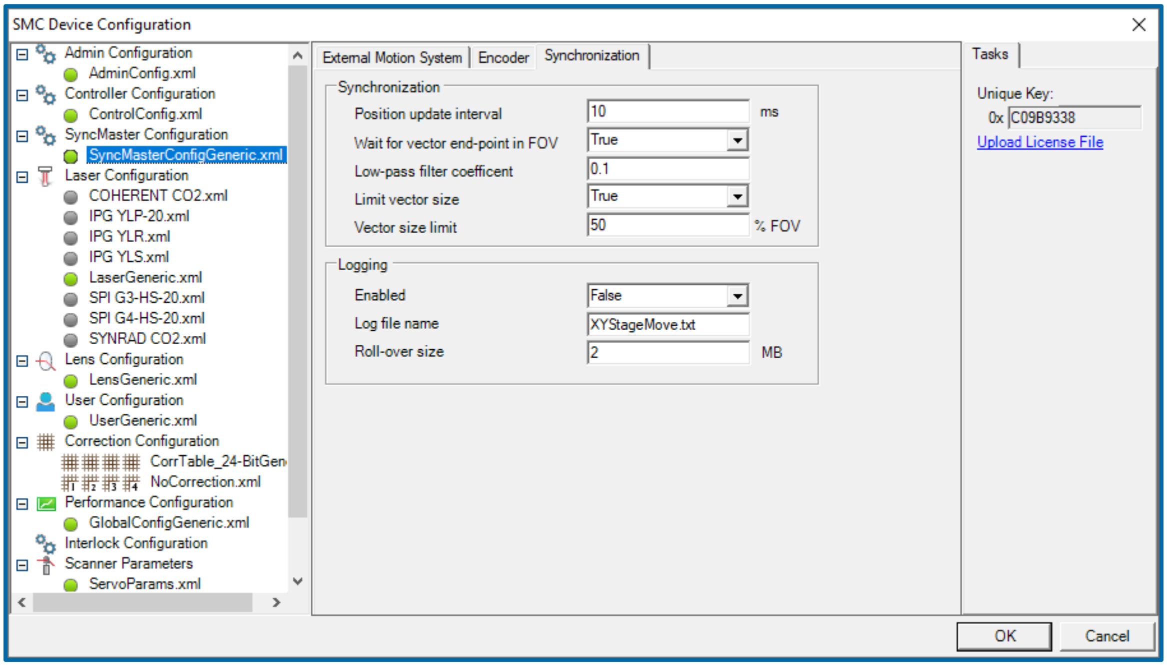


Figure 16 - SyncMaster Configuration - Synchronization

Table 6 - Synchronization Parameters

Parameter	Setting	Comment
Position update interval (milli-sec)	Numeric (1 – 10)	The rate at which position update commands are issued to the external motion controller. This value is limited by how fast the external motion control can accept and process position set-point commands. These commands are sent to the external motion controller without waiting for completion. The expectation is that the motion controller will be able to re-profile the motion commands to the axis servos in a smooth fashion and that this can be done regardless of the current state of the axis motion.
Wait for vector end-point in FOV	True or False	Sets whether or not scanning will pause until the next vector's end-point is in the field of view of the scan head. This should always be true unless debugging under the guidance of CT technical support.

Low-pass filter coefficient	Numeric (0.1 – 0.5)	Used to set the degree of filtering of the position data delivered to the external motion system.
Limit vector size	True or False	Set whether or not long vectors are partitioned into continuous linear segments. Should normally be true.
Vector size limit	Numeric (10 - 100) % Field of View	If Limit vector size is True, then automatically partition long vectors (Jumps and Marks) into a series of connected shorter vectors of this length.

Table 7 - Logging Parameters

Parameter	**Setting**	**Comment**
Enabled	True or False	If true, an ASCII log file is created on the SMC Data folder
Log file name	File name	If logging is enabled, then write to the file with this name.
Roll-over size	Numeric (Mbytes)	To avoid the creation of very large files, the log file is over-written if it gets larger than this size.

6 SYNCMASTER CONTROL

This section describes the basic operations of SyncMaster.

6.1 OVERVIEW

At the beginning of job execution, the stage is moved to align the coordinate systems of the work-piece with the coordinate system of the scanner, and then real-time tracking is enabled which causes the scanners to continuously follow the motion of the positioning system. As the job is executed, the path the laser is to traverse in the global coordinate system is divided into a low-frequency set of coordinates destined for the external motion system while the scanner system receives all of the job data including the low frequency components.

At every scanner command update interval (approximately 10usec), the external motion system physical position is measured by the SMC via the attached encoders and the position is subtracted from the global data the scanners are to execute. This results in the scanner command that is within the accessible field of the scan head.

The command delivery to the external motion controller and the scanners is synchronized but loosely coupled in the time-domain. This permits a degree of freedom for the positioning system controller to use appropriate acceleration and velocity parameters when computing the incremental trajectories. Commands to the external motion system are sent at a deterministic rate without waiting for the motion to complete. All that is required is a relatively constant tracking delay from command delivery to the motion system controller to the motion system arriving on a path *near or at* requested positions. Exact path traversal is not required because the actual path is measured and compensated for.

6.2 SYNCMASTER MASTER SCRIPT

SyncMaster operation is orchestrated using ScanScript which is part of every job that runs on the SMC. The script is automatically created when the SyncMaster process is selected on SMD. It is shown in Figure-18 for reference to illustrate the basic operational sequence.

```
-- The script units are in mm
SetUnits(Units.Millimeters)
-- MOTF & Stage Initialization part
MOTF.Direction = Direction.DualAxisPlusDirection
MOTF.Mode = Encoder.ExternalDualAxis
MOTF.Initialize()
-- SyncMaster initialization
SyncMaster.Connect()
SyncMaster.Initialize()
-- Optional stage homing.
-- Argument "false" means home the stage if not already done
-- Argument "true" means always home the stage
Stage.Home(false)
-- Move the stage so that a defined workspace origin on the stage surface
-- is underneath the scan-head origin
-- The actual stage location relative to the stage home position is defined in
-- the SyncMasterConfig file on the SMC
Stage.MoveAbsolute(0,0)
-- Enable SyncMaster operation
SyncMaster.Enable()
-- Enable SMC tracking of the XY stage
MOTF.ResetTracking()
MOTF.StartTracking(Tracking.Continuously)        -- continuous tracking
-- Start marking the job data described on the SMD canvas
ScanAll()
-- When scanning is completed, disable the stage tracking and return the Galvos
-- to the scan-head origin
MOTF.StopTrackingAndJump(0,0,0,500)
-- Pause here and wait for all marking operations to finish
Laser.WaitForEnd()
-- Disable SyncMaster operation

SyncMaster.Disable()
```

Figure 17 - SyncMaster Master Script

7 JOB DESIGN AND OPTIMIZATION

This section describes optimization guidelines that allow you to fully realize the performance potential of SyncMaster system.

ScanMaster Designer provides a very convenient way to create SyncMaster jobs. Job data can be created using powerful CAD-like shape creation and editing tools, or can be imported from vector graphic files or in the case of via-hole drilling, from Excelon format drill files.

The job design process begins with launching SMD: Start→Novanta SMD→ScanMaster Designer. When SMD is open, create a new job by selecting the "New" icon.

7.1 VECTOR MARKING EXAMPLE

To import a vector graphic file, select the vector file import tool from the left tool-bar. You can import the file in absolute units, or interactively by selecting a location and size.

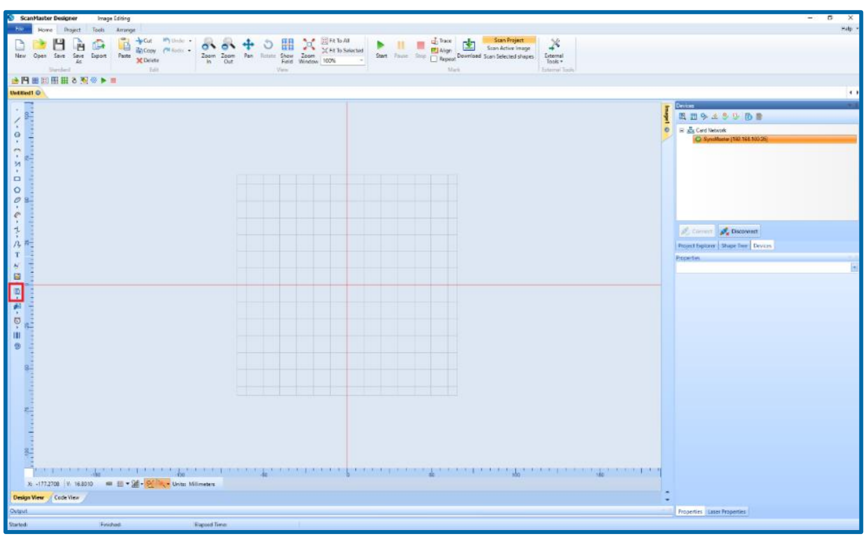


Figure 18 - ScanMaster Designer

The file selection dialog allows to navigate to the vector file. Several vector file formats are supported. In the example below, a DXF file is chosen, will be placed and scaled when inserted onto the SMD canvas.

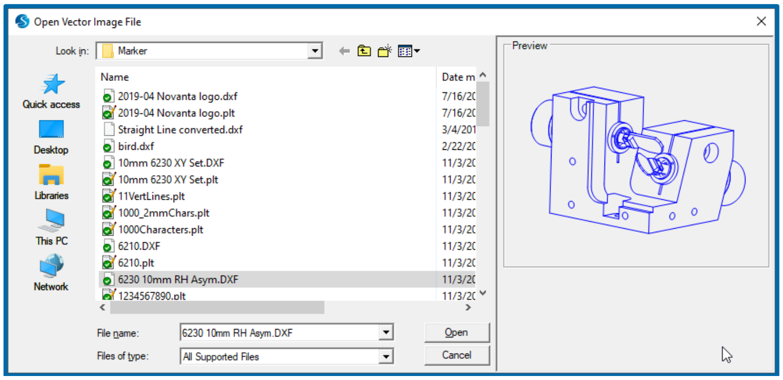


Figure 19 - File Importing

When the image is placed, all of the vertex points will be highlighted. This also happens when clicking on the canvas and typing CTRL-A to select all shapes.

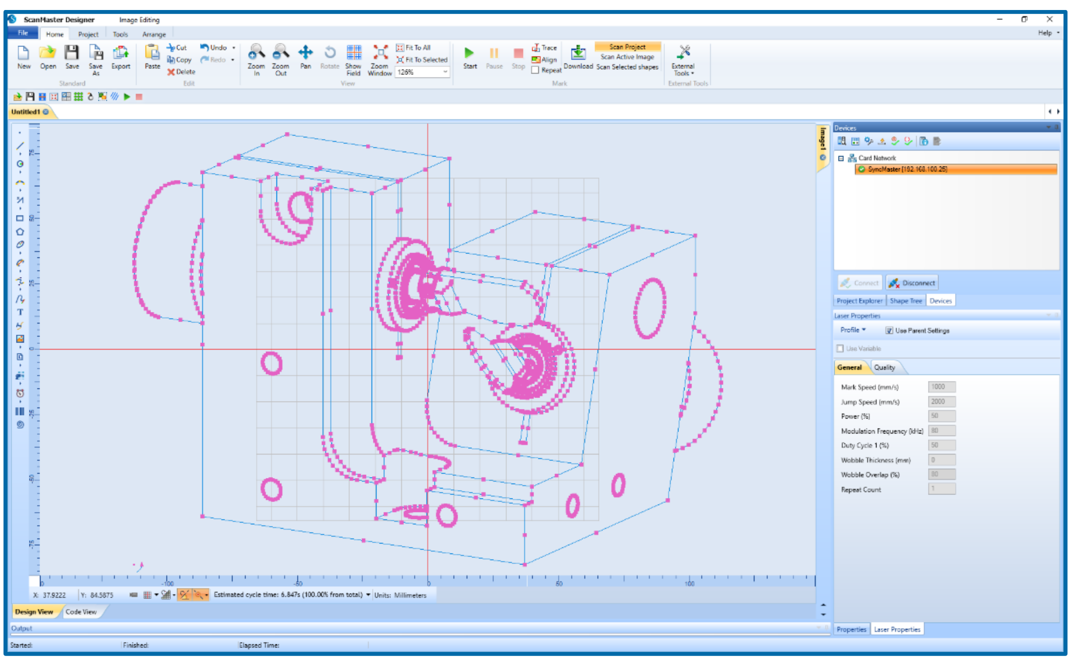


Figure 20 - ScanMaster Designer canvas view

Imported vector files are rarely designed for efficient scanner-based imaging. SMD can show the path the Galvos will follow by selecting the “Show Jumps” tool as shown in Figure-22.

The usual process is optimize the paths for efficient scanner operation. SMD provides sophisticated path optimization tools to re-order the paths. With SyncMaster, not only must the scanner paths be optimized, but the work-piece positioning system should be also be considered. This is done using the “Path Optimize” tool.

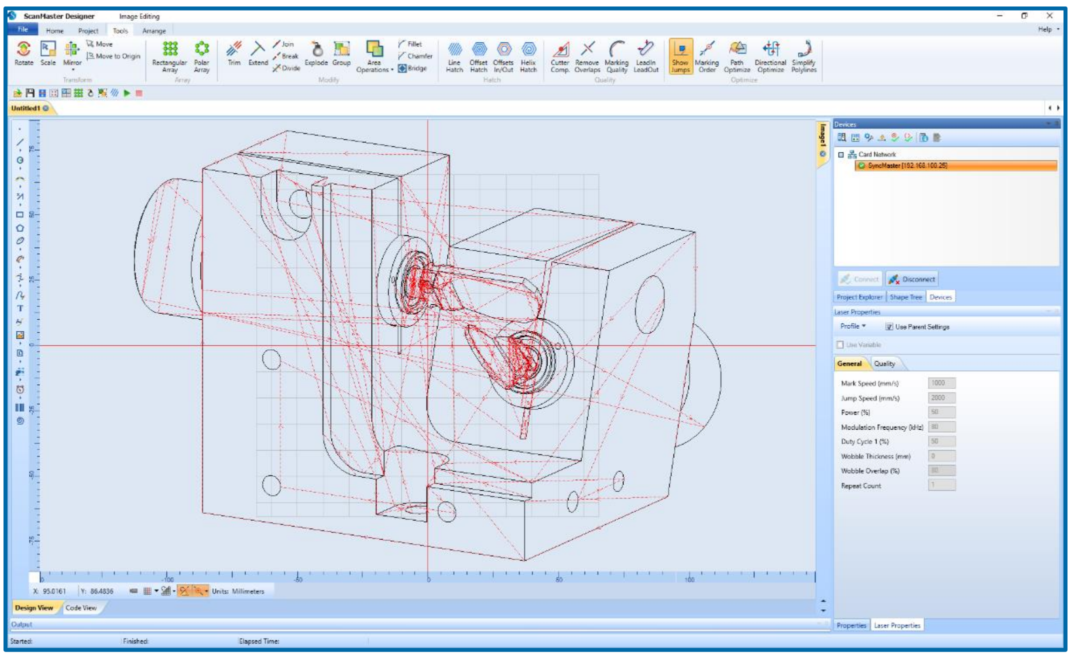


Figure 21 - Unoptimized Jump

The following image shows the dialog box that appears when all off the shapes are selected by clicking on the canvas and typing CTRL-A, and then selecting the "Path Optimize" tool.

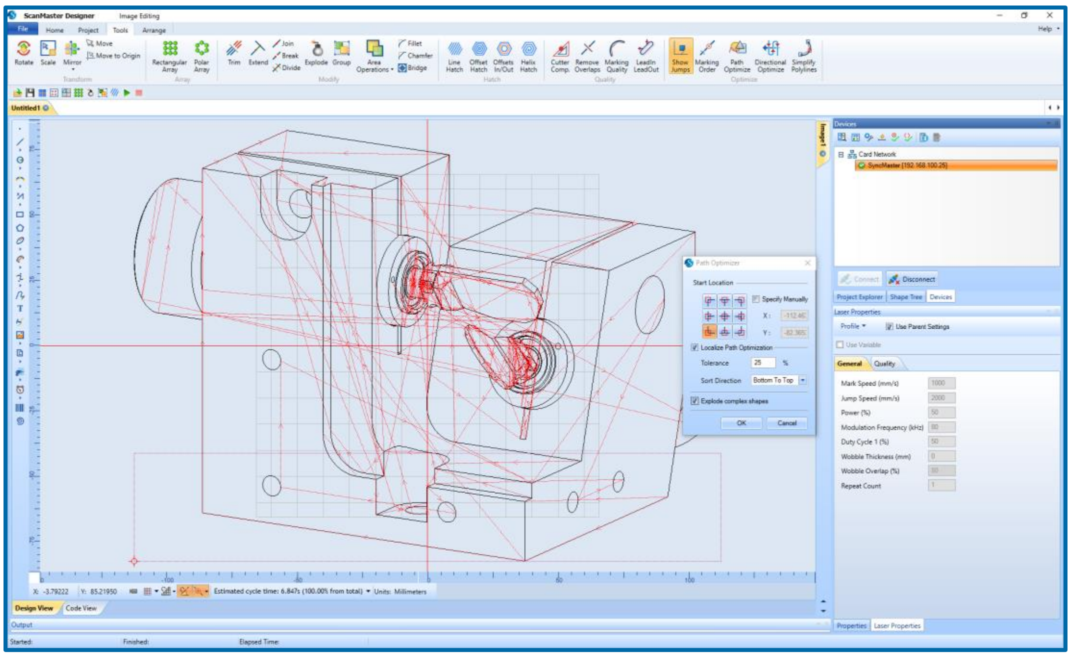
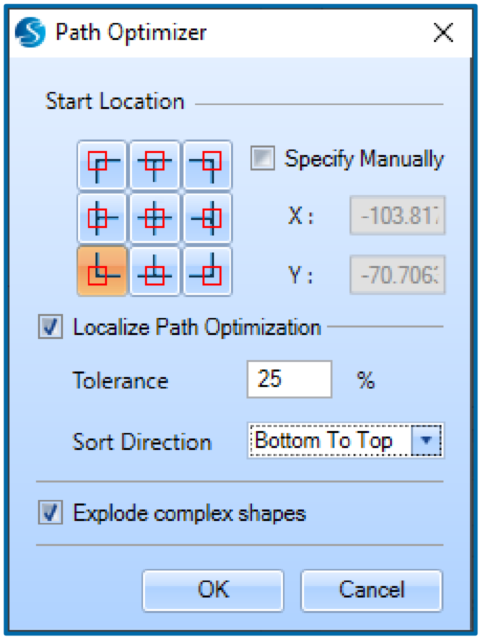


Figure 22a - Optimization tool

In this example, the optimization will start in the lower left corner of a localized moving window that is set to 25% of the aggregate of the selected shapes. As the paths are re-ordered in the window, the window is moved up and additional paths are considered and re-ordered. This process repeats until all of the vectors are re-ordered.



The purpose of the localized window optimization is to minimize the amount of motion the work-piece positioning system needs to do in order to keep the scan-head field of view over the appropriate location. This permits managing the motion between a heavier and slower axis versus a lighter and faster axis.

The best optimization strategy is an empirical process and depends on the density of the artwork, the speed of the work-piece positioning system, and the desired marking speed. The tools provided in SMD should facilitate the creation of an efficient job layout.

The result of the optimization chose in this example is show in the next image.

Figure 22b - Optimization tool

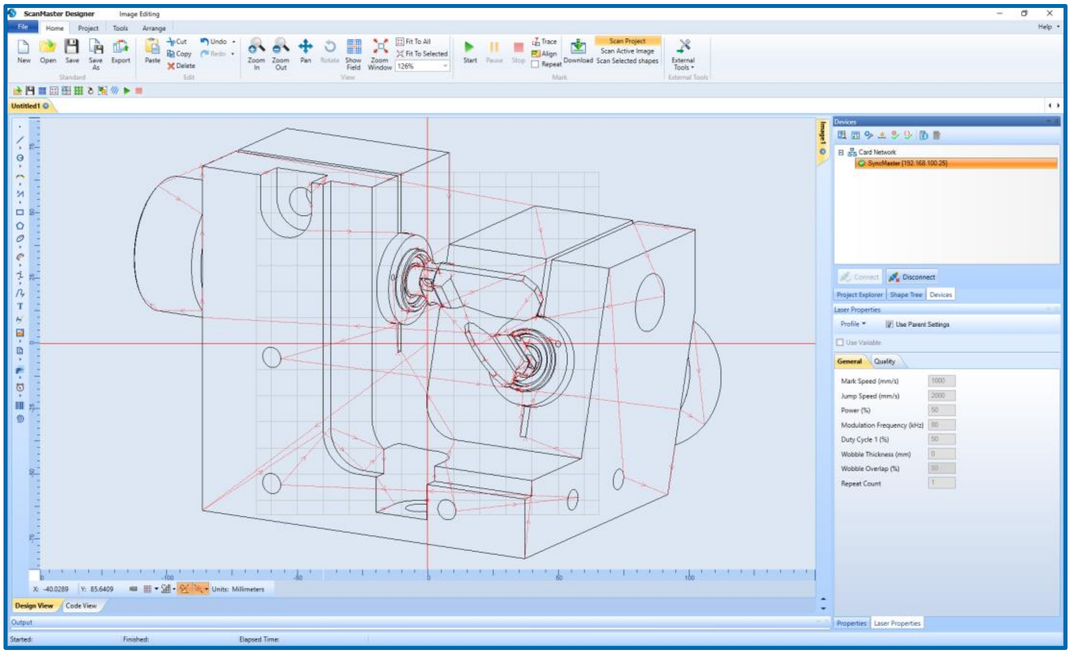


Figure 23 - Optimized Jump

Note the dramatic reduction of random jumps and bottom to top nature of the marking path sequence.

7.2 VIA-HOLE DRILLING EXAMPLE

SyncMaster can be used to improve system throughput in via-hole drilling jobs over traditional step-and-repeat style job partitioning. Excelon format drill files can be imported into drill shapes that can have special properties specific to the drilling process. Point and shoot, circle, and spiral drill patterns can be specified by groups determined by tool assignments in the drill file.

From the SMD shape tool-bar, select the drill file import tool:

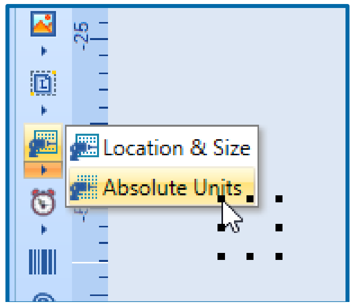


Figure 24 - Drill file import tool

Note that the import units may be selected at the lower-right part of the dialog. In addition, the shape can be centered, and multiple drill shapes can be created based on the tool assignments in the drill file. A preview of the drill file content is shown on the right. After import, the drill data is displayed on the SMD main canvas.

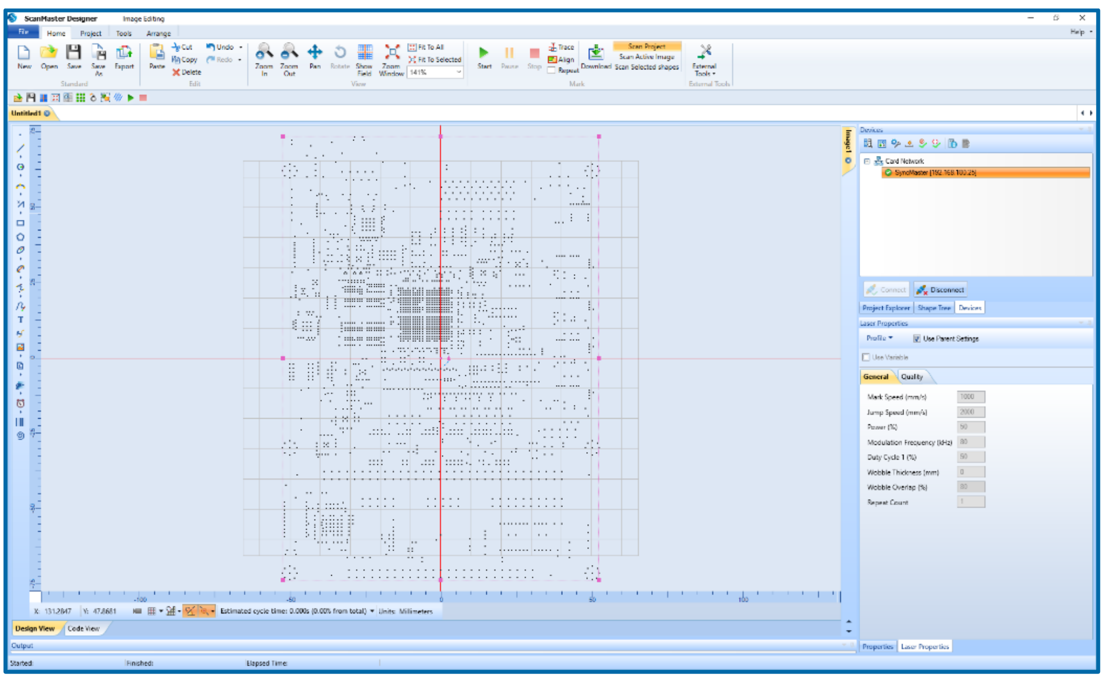


Figure 25 - ScanMaster Designer with drilling pattern

Select the Tools menu from the top ribbon bar and click the "Show Jumps" tool. This presents how the drill file will be process before path optimization. Note the random nature of the jumps.

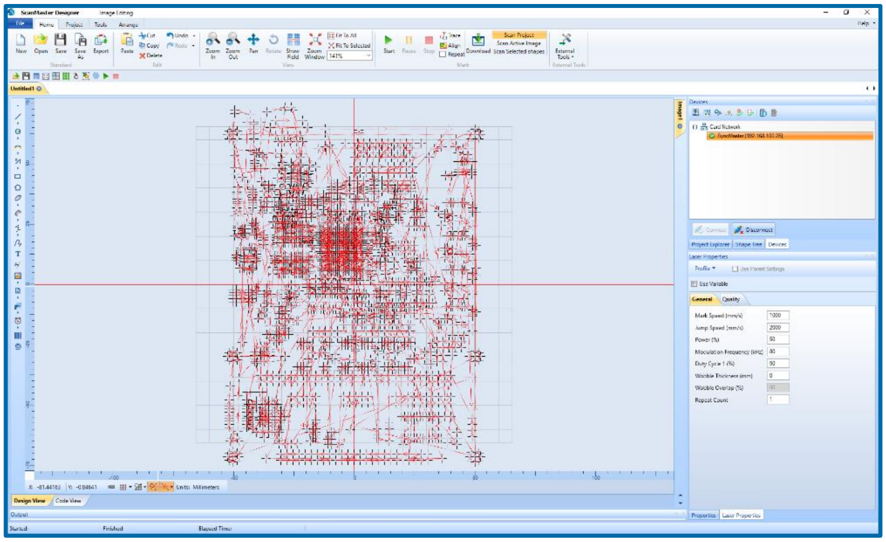


Figure 26 - Unoptimized Jump

Unselect “Show Jumps”, and then type CTRL-Z to restore the original drill shape. Click on the drill shape again, press the “Path Optimize” tool, and set the options as shown below:

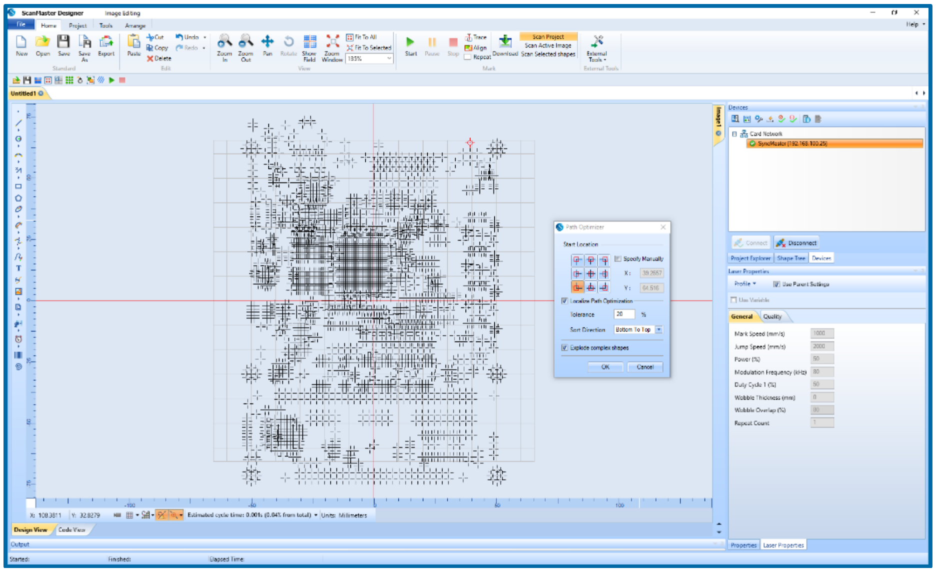


Figure 27 - Optimization tool

After pressing OK, select the drill shape once again, right-click and “Explode” and then press the “Show Jumps” tool. Note that the jump sequence is much more ordered and progresses from left-to-right in windows that are 20% of the shape height progressively moving from bottom to top. Use the scroll wheel to zoom in to see the detail.

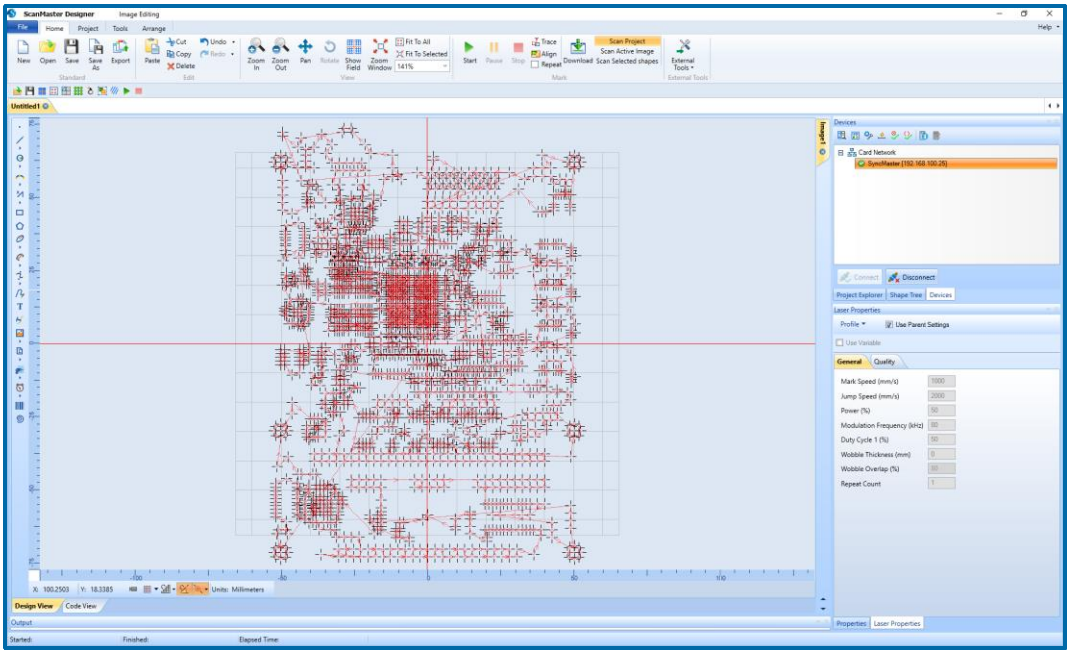


Figure 28 - Optimized Jump

After viewing the results, unselect the “Show Jumps”, and type CTRL-Z to restore the drill shape. The drill shape properties are set in the properties tab in the lower right corner of SMD. Please see the SMD User Guide for detail on how to set these properties.

8 TROUBLESHOOTING AND ERROR CODES

This section describes the error codes that user may run into when running in SyncMaster jobs. If the indicated resolution is not working, please contact your Novanta support personnel with the error code and the job causing the problem.

Table 8 - Error Codes

Error code	**Description**	**Remarks/Resolution**
9135	Galvo and Stage are out of Sync	As a rule of thumb in SyncMaster, if vectors in the job (marks or jumps) are longer than the scan-head field size, then the mark/jump speeds for those vectors should be equal or less than the stage speed. Higher speeds are possible however depending on the job. If the job has denser marking in a localized region then the galvos will be able to run at higher speeds. At these higher speeds, it may be possible that at some point the stage may not be able to keep up with the galvos. In this case the SMC will generate a “EXCEPT_STAGE_GALVO_SYNC_ERR” Resolution: Reduce the job speed and see whether the problem goes away Make sure the job is optimized for “SyncMaster” operation Contact Cambridge for the enabling the debug tools to analyze the galvo,stage profiles to locate the problem.
9134	Stage encoder overflow	Encoder counts yields a value more than the travel range Resolution: Re-run the job with homing the stage Stage.Home(True)

501	Stage Not Initialized	SyncMaster operations are called without establishing the communication to the stage. Resolution: Make sure to call the following routines SyncMaster.Initialize() SyncMaster.Connect()
502	Stage Sync Update Failed	Failed to generate stage position update coordinates. Resolution: Restart the controller.
503	SyncMaster Configuration not enabled	SyncMaster operations are called without enabling the SyncMaster operation. Resolution: Enable the SyncMaster operation the Control Configuration file in the SMC using the SMC Device Configuration Editor.
504	Stage communication failed	Cannot establish the communication with the stage controller. Resolution: Make sure the stage controller is powered on. If the communication is via TCP/IP ensure the IP address specified in the SyncMaster configuration file matches the configuration of the stage controller.
505	Stage update data copying failed	The stage position dispense buffer went out of sync. Resolution: Restart the controller.
506	Stage update data memory creation failed	The stage data memory creation failed. Resolution: Restart the controller.

507	Stage connection timed out	Similar to 504 but communication timed out while expecting a reply from the controller. This may happen when there is already established connection drops out. Resolution: Check the stage is connected in such a way as to accept the commands from the SMC.
508	Stage homing failed	Stage failed to reply while performing the homing routine. Resolution: Check for any errors in the stage/home switches. Check it from any alternative ways that homing can be performed.
509	SyncMaster tracking is not enabled	SyncMaster operation is performed without enabling stage tracking. Resolution: Make sure "SyncMaster.Enable()" is called before the ScanAll() function is called in ScanScript
510	Invalid Stage Reply	SMC is receiving a reply that cannot be decoded. Resolution: Contact your support personnel at Novanta.
3065	Command cannot be executed while the current motion is in progress	Apart from the above error codes any stage errors will be reported as it is. Refer the Stage Controller error codes for the details. This specific error code is applicable to "ACS Controller" where the stage is receiving a command which cannot be executed under the current context. Resolution: Contact your support personnel at Novanta.

9 REVISION HISTORY

The following table shows the Revision History for this document.

Revision History

REVISION	DATE	Changes from previous revision
A	02/21/2020	Initial Release
B	03/03/2023	Updated diagrams and text with current information

Revision History

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