StarFire™ SG1024/A Printheads

StarFire SG1024/A Printheads
Product Manual

FUJIFILM Dimatix™

1.0 About this Manual

Throughout this manual a variety of conventions are used to highlight essential information that is important for the overall safety and understanding of issues in using this product. These include:

1.1 Warnings

WARNING 	Identifies information about practices or circumstances that can result in personal injury, damage to the product or economic loss.

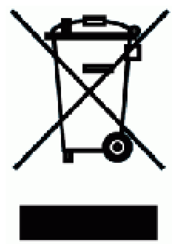
1.2 Cautions

CAUTION 	Identifies information about practices or circumstances that may lead to damage to the product.

1.3 ESD Advisory

	Identifies where there may be a risk of Electro-Static Discharge (ESD).

1.4 Wheelie Bin Symbol



This symbol identifies parts that should be reclaimed as part of the Waste Electrical and Electronic Equipment (WEEE) Directive.

1.5 Important

IMPORTANT Identifies information that is essential to the understanding and correct use of this product.

1.6 Notes

Note: Used for emphasizing additional information that aids in the understanding and use of the product.

2.0 Safety Information

CAUTION

Hazardous voltages and temperatures are required for printhead performance. Therefore, it is essential that the printhead and its application environment provide for protection of the operator and service personnel, both via safe design and by warnings where necessary. Additional expanded labeling within the OEM equipment may also be desirable, since the functional information content of the labels on the product itself is limited by the space available on its surfaces.

3.0 Compliances

The SG1024/A printheads are compliant with the Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) directives as they pertain to electrical and electronic products.

StarFire™ SG1024/A Printheads

Chapter 1 – Product Overview

Chapter 2 – Mechanical Interface & Mounting

Chapter 3 – Thermal Interface

Chapter 4 – Fluid Interface

Chapter 5 – Electrical Interface

Chapter 6 – Maintenance

Appendix A – Interface Control Drawings

Appendix B – Specifications

Appendix C – SG1024/A Performance

Chapter 1 – Product Overview

1.0 Product Description

The StarFire™ SG1024/A family of printheads include the one color SG1024/XSA, the SG1024/SA, and the SG1024/MA printheads and the two color SG1024/XSA-2C, the SG1024/SA-2C, the SG1024/MA-2C, and the SG1024/LA-2Ci printheads. They are recirculating printheads that feature 400 dpi with a native drop ranging from 6 to 80 ng depending upon the printhead, the waveform (single pulse or multi pulse), and fluid being jetted. The SG1024 printheads have four actuator assemblies and a single nozzle plate with eight rows of 128 nozzles.

Figure 1 - 1 StarFire SG1024/A printhead

These SG1024 nozzle printheads are high performance, robust, and reliable drop-on-demand industrial printheads designed for single pass applications. The printhead uses RediJet technology to maximize the dual ported ink interface to facilitate recirculation of jetting fluids through the refill chambers and across the nozzles. They are down spitting printheads with the fluid and electrical connections at their top.

1.1 SG1024/LA-2Ci

The SG1024/LA-2Ci printhead is a two color, large drop (80 ng) printhead. It is not a drop on drop printhead where the drops of the second color land on top of the drops of the first color. Rather it is interlaced so that the drops of the second color land between the drops of the first color.

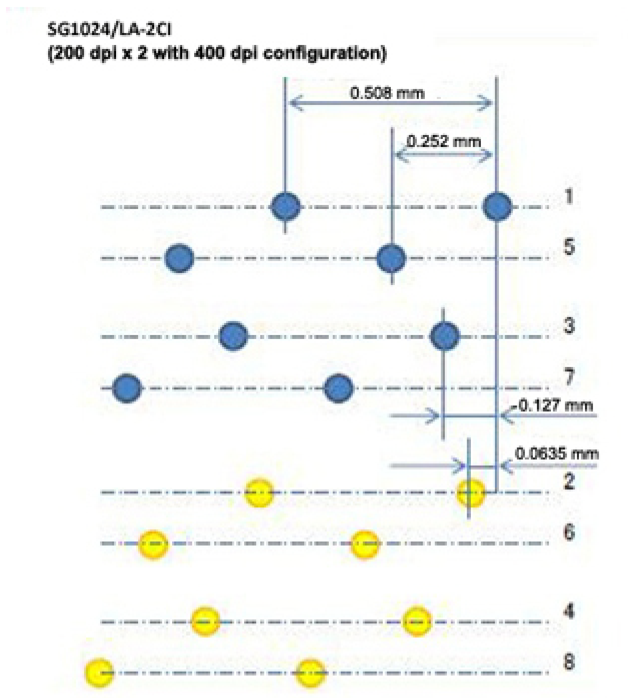


Figure 1 - 2 SG1024/LA-2Ci lay down diagram

The SG1024/LA-2Ci offers large drop size and productivity in a two color platform. The interlace versus not interlaced is generally not important. If lay down is important, as it is in UV printing, the interlace design permits bi-directional printing but, in so doing it requires 400 dpi index accuracy.

When used as a one color printhead it can support a higher flow rate by taking advantage of the two ink inlets and outlets with the same color.

1.2 RediJet™ Technology

RediJet technology is a jetting technology encompassing several innovations designed to unlock the full potential of the printhead. It is a compilation of nozzle plate design, special conformal and non-wetting surface coatings, enhanced on head electronics, continuous ink recirculation at the nozzle, and waveforms tailored to specific fluids. RediJet increases the productive capacity by lowering recurring service costs by minimizing initial startup and ongoing maintenance times and associated fluids.

2.0 Related Documentation for StarFire SG1024/A Printheads

The following list of documents relate to the SG1024/A printheads. Many of these documents are referenced throughout this manual. All of these manuals are available from the FujiFilm Dimatix TeamSupport site. If you do not have a TeamSupport account, please contact Customer Service Engineering.

AN000011 – *Ink Delivery System Design for Ink Jet Printers*

AN000026 – *Using Membrana Superphobic® Membrane Contactors*

AN000058 – *Binary Single Pulse and Binary Multi Pulse Waveform Development*

AN000062 – *Multi Pulse Waveform Development*

IN000046 – *PQ, QE, QS AAA and SG1024 Materials Compatibility Kit*

PM000065 – *StarFire SG1024/C Printhead Product Manual*

PM000069 – *SG1024 Mercury Development Kit Product Manual*

PM000070 – *Recirc – Ink Tending Interface Product Manual*

3.0 SG1024/A Printhead Product Labeling

There are two labels associated with the SG1024/MA printhead. They are:

- Printhead Serial Number
- Package label

3.1 SG1024/A Printhead Serial Number

The serial number for the SG1024/A printhead is etched into the nozzle plate. It has the serial number in both human readable and bar code scannable formats.

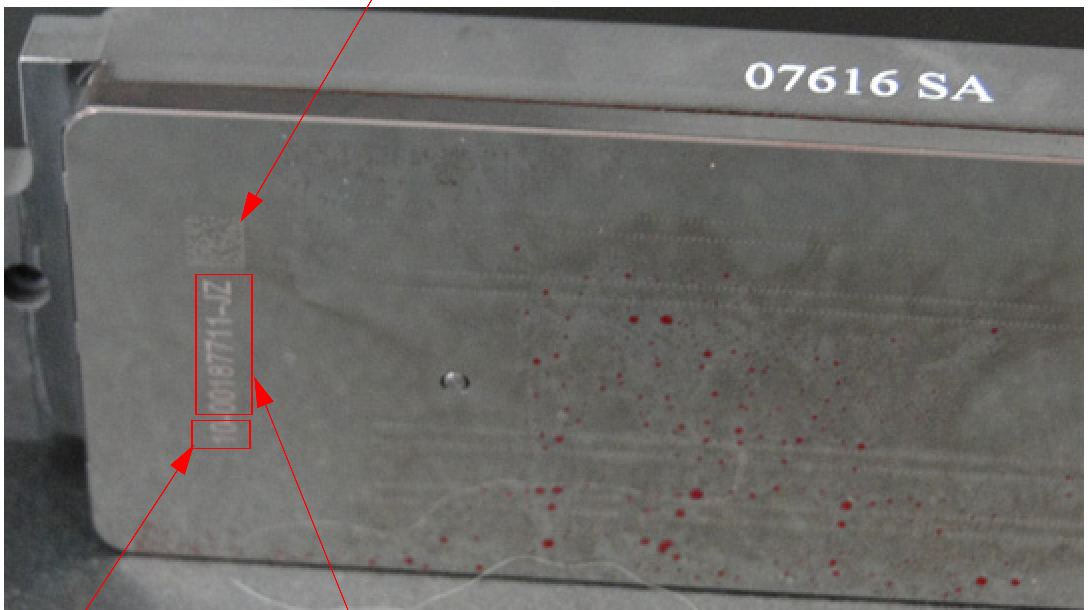


Figure 1 - 3 Nozzle plate showing location of serial numbers

The serial number is in three parts. The first part is two numbers that are the size designation of the SG1024 printhead. Numbers that fall between 6 and 9 indicate that it is an extra small drop printhead, numbers between 10 and 19 indicate that it is a small drop printhead, numbers between 30 and 39 indicate that it is a medium drop printhead, and numbers between 80 and 89 indicate that it is a large drop printhead.

The size designation is followed by eight numbers and two letters. The eight numbers and two letters serve as the serial number for the printhead.

The small square to the right of the human readable serial number is the bar code of the serial number, which can be scanned.

When communicating with FujiFilm Dimatix about particular printheads, please give the entire serial number including the size designation and the two letters at the end.

3.2 Package Product Label

The package product label (located on the printhead package) is different from the product label that is on the printhead. The part number on the package product label is the one to use when placing orders. The package product label contains additional information in both human and machine readable (bar code) formats. The following is a sample of the label.

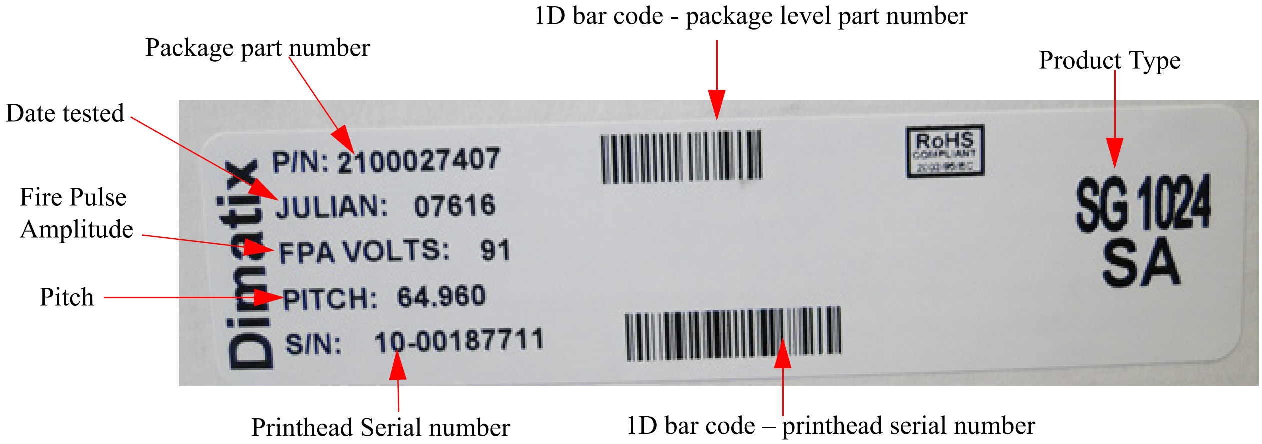


Figure 1 - 4 Sample of package product label for the SG1024/MA printhead

The following information is available on the label in human readable format:

Package Part Number – the part number used when ordering.

Date Tested – the date the printed passed testing in Julian numbering where the first three digits represent the day of the year (076), the next two digits represent the year (16).

FPA Volts – the fire pulse amplitude in volts.

Pitch – the measured pitch of the printhead.

Printhead Serial Number – the serial number of the printhead that is etched into the nozzle plate.

Product Type – the descriptive printhead designation.

> **Printhead** – the generic type of printhead i.e. SG1024
>
> **Drop Size** – the printhead's drop size – XS for extra small, S for small, M for medium, and L for large.
>
> **Application or Ink Type** – the printhead application or ink type – C for Ceramic, A – for all other types and applications
>
> **Color Support** – the number of colors the printhead supports – 2C for two color.

The package label also has two bar codes (machine readable). Both bar codes are linear bar codes (type: code 128). The top bar code contains the package level part number and the bottom bar code has the printhead serial number.

4.0 Operation

The SG1024/A printheads are piezoelectric devices operating in shear mode. The jets are driven by a PZT array (Lead Zirconate Titanate), a piezoelectric ceramic. The shear mode of PZT actuation allows individual jets to be fired while simultaneously firing adjacent jets.

Prior to jet actuation, a serial data stream is clocked into the driver chips via the LVDS receiver chip. The Head Interface Board (HIB), located inside the cover, converts the signals to standard driver chip compatible signals to set up the desired jetting pattern for each fire pulse. The fire pulse voltage is applied to the selected PZT channels. The excitation of the PZT deflects the wall of the pumping chamber outward, creating a negative pressure wave that draws ink into the chamber. After a fixed pulse duration, the fire pulse voltage is removed. As the pumping chamber wall relaxes, the resultant positive pressure wave propagates forward and causes drop ejection at the nozzle.

The printhead has eight rows of 128 nozzles with a PZT for each row. A high-voltage fire pulse is applied, which actuates the PZT pumping chambers within each channel. All 1024 nozzles can be fired simultaneously or individually.

5.0 Recommended Operating Conditions

For best results and to avoid damage, operate the printhead within the minimum and maximum ratings.

5.1 Coupon

SG1024/A printheads are shipped with a test coupon. The coupon shows a print sample and the test values for the printhead. In order to enable customers to optimize the uniformity of performance from our printheads, we calibrate each unit as part of the final test procedure.

5.1.1 SG1024 Final Acceptance Testing Coupon Explained

The FAT coupon that is included with new printheads is what we use to judge how well the printhead is printing. The sample coupon below is for information purposes only. It is a reference for the key parts of the coupon and what they convey. It would be to your advantage if you retrieved one of the coupons that came with a SG1024 printhead and used it while reading about the coupon as it is probably of better quality. A bit map image of the coupon is available from your technical support representative.

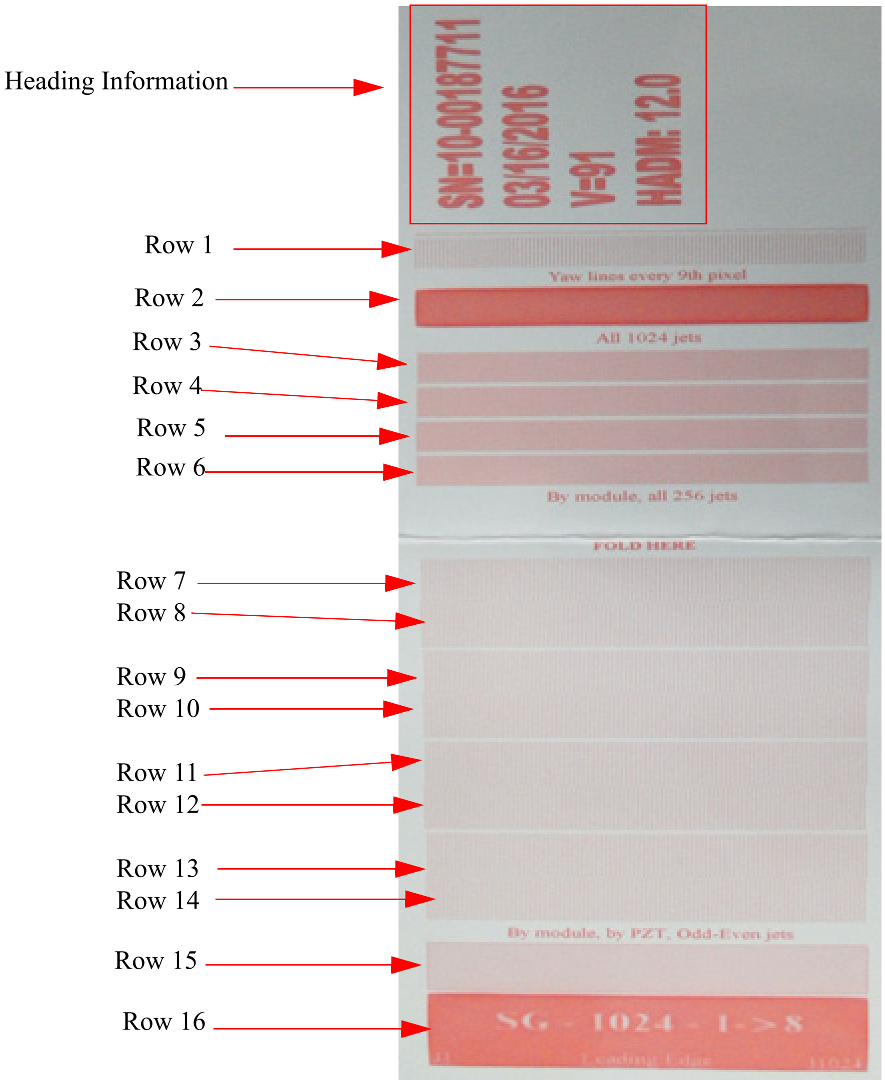


Figure 1 - 5 FAT coupon supplied with new printheads

5.1.1.1 Heading Information

SN – Printhead serial number. The first two digits show the nominal drop mass of the printhead when jetting XL-30 model fluid. The remaining digits represent the serialization.

Date – The date of manufacture of the printhead.

V – Voltage. This is the voltage used when testing the printhead.

HADM – Head Average Drop Mass. This is the measured drop mass of the printhead using either XL-30 (red) or Prova (purple) model fluid. Printheads measured with

Prova model fluid typically have a drop mass that is 10% less than nominal due to its reduced density relative to XL-30.

5.1.1.2 Explanation of Image Content and Use

Row 1 – Yaw lines every 9th jet: This image (114 lines) allows for alignment verification of the printhead within the testing station.

Row 2 – All 1024 jets: This pattern allows for the qualitative examination of uniformity across the printhead.

Rows 3 through 6 – By module, all 256 jets: These rows can be used for qualitatively evaluating the straightness of jets and can be used for measuring straightness and line width, highlighting differences between arrays. Weak and crooked jets can be most easily spotted in this dense line pattern.

Row 3 corresponds to Module 1

Row 4 corresponds to Module 2

Row 5 corresponds to Module 3

Row 6 corresponds to Module 4.

Rows 7 through 14 – By module, by PZT, Odd-Even jets: These rows are used primarily for measuring the straightness and line width of jets and for highlighting differences between PZTs within or among arrays (odd-even variation with a single PZT or PZT-to-PZT variation).

Row 7 corresponds to Module 1 Even jets

Row 8 corresponds to Module 1 Odd jets

Row 9 corresponds to Module 2 Even jets

Row 10 corresponds to Module 2 Odd jets

Row 11 corresponds to Module 3 Even jets

Row 12 corresponds to Module 3 Odd jets

Row 13 corresponds to Module 4 Even jets

Row 14 corresponds to Module 4 Odd jets

Row 15 – Stochastic pattern: This image is a random printing of jets that allows for the visual examination of individual drops and gives an indication as to the quality of the drop formation from the printhead.

Row 16 – Product Identification: This all-jets image identifies the leading edge of the coupon (and thereby the direction in which the image is printed), the jet #1 (J1) and jet #1024 (J1024) locations, and the product family (SG1024).

Dimatix determines the calibrated drive voltage by operating each printhead with XL-30 model fluid, at a prescribed pulse width, operating temperature, etc. Test voltage is iterated until the average drop mass, produced by all jets firing simultaneously, matches the target value drop mass.

When using the printhead, the way to achieve the best output is to start with the calibrated voltage, then apply any correction necessary for the specific application. This correction should take into account the ink used, the specific application's operating temperature and pulse width, and the target drop size particular to the application's resolution or substrate. The correction offset is typically determined during the development phase of the printing system, and held constant thereafter unless specifications change.

6.0 Interface Requirements

One of the primary benefits of the SG1024/A printhead is its easy interface. It has one electrical interface, two fluid connections (the two color version has four fluid connections), and three screws for its mounting. The printhead has a thermistor built into the body and heating at the printhead is designed to be through the mounting plate. It also supports an internal heater and thermistor.

The primary interfaces that you need to be familiar with to use the SG1024/A printhead are mechanical, thermal, fluid, and electrical.

Table 1 - 1 SG1024/A Printhead Interfaces

Interface	Description
Mechanical	Mounting to the printer, and alignment
Thermal	Thermal connections – thermistor, heater
Fluid	Jetting fluid connections and supply considerations
Electrical	Electrical connections to the printhead and HIB for fire pulse, data, and heater

Review the Interface Control Drawings found in Appendix A for specific information regarding the SG1024/A printhead interfaces.

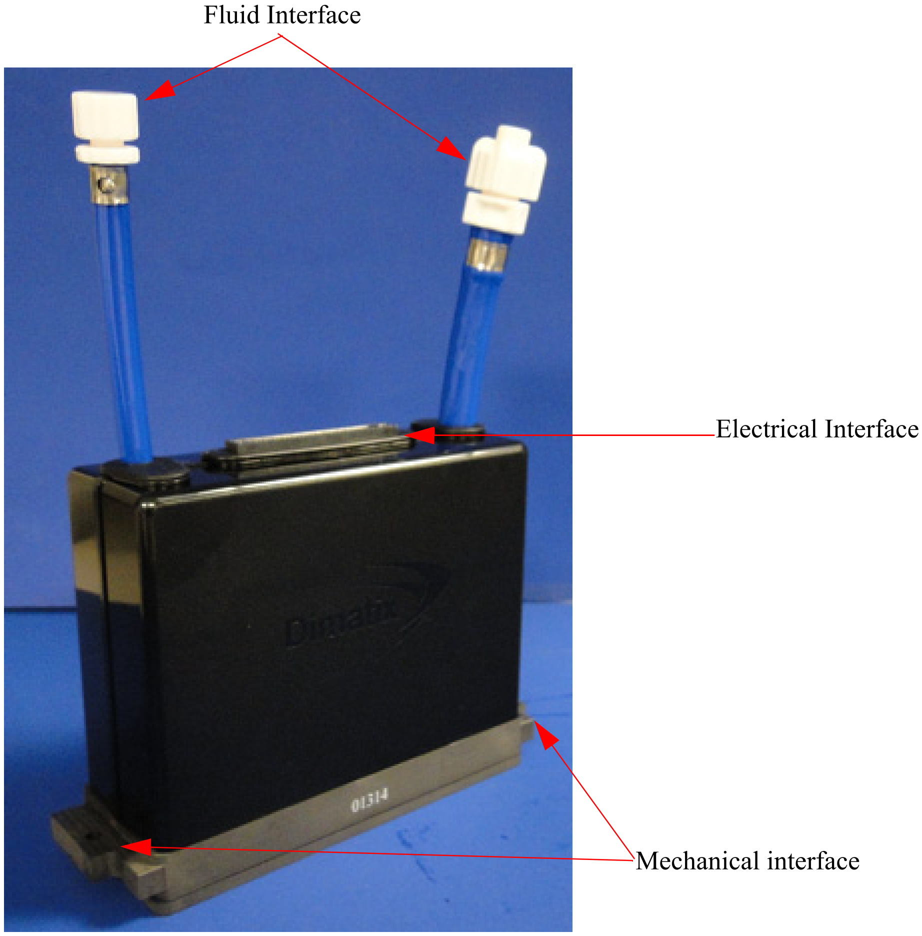


Figure 1 - 6 Interfaces for the SG1024/A printhead - one color

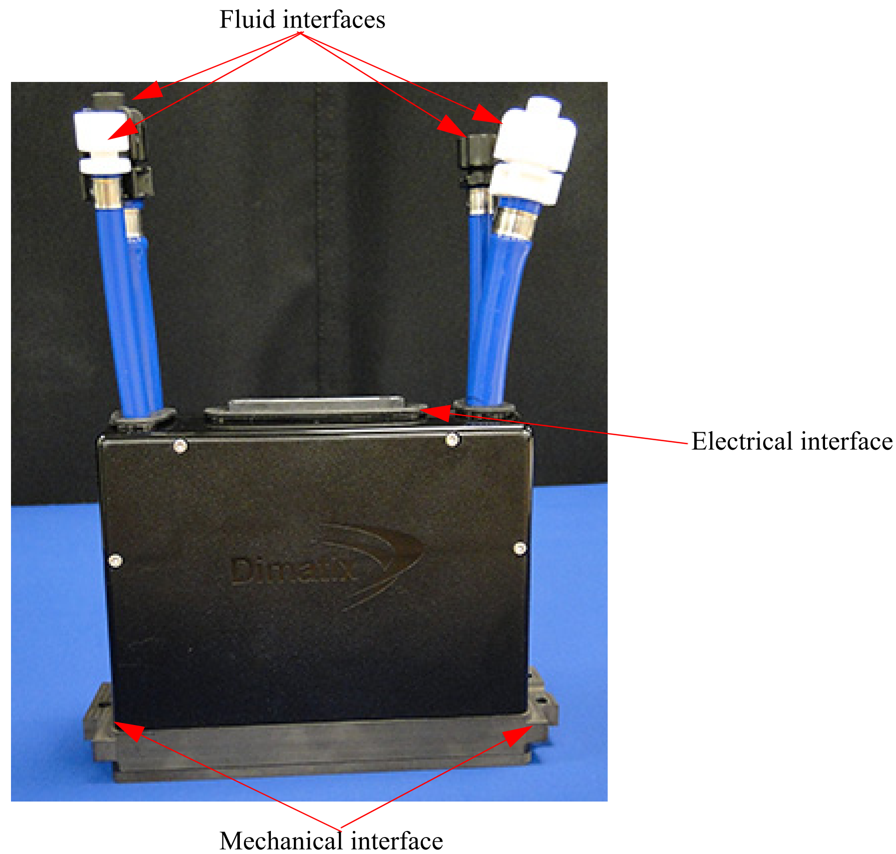


Figure 1 - 7 Interfaces for the SG1024/A printhead - two color

6.1 Handling and Installation

When handling an SG1024/A printhead we recommend that you keep in mind the following advisory and warnings.

6.1.1 ESD Advisory

Electro-Static Discharge (ESD) safe handling techniques must be employed by anyone servicing or handling this product. At a minimum, wrist straps and static-safe packaging must be used. Where possible, other workstation ESD reduction measures should be employed as well.

6.2 Warnings

WARNING

Before connecting or disconnecting the SG1024 printhead turn off the DC Logic power and allow it to bleed down to 0 V. This process will prevent damage to the printhead and possible loss of ability to read the EEPROM.

WARNING

The high drive voltage to the jets should be cut off by a safety interlock whenever an operator or service person is allowed access to the printhead.

Lock-out Tag-out procedures should be observed.

WARNING

The nozzle plate of the module is a fragile surface and should not be roughly handled or touched with sharp objects.

WARNING

Foreign materials should not be introduced into any ink fill port. This can result in damage to equipment or product loss.

Chapter 2 – Mechanical Interface & Mounting

1.0 Mechanical Interface

The SG1024/A printhead can be mounted to the printer from either the top or the bottom. There are three mounting holes: two on the ink fill end of the printhead and one on the recirculation return (outlet) end of the printhead.

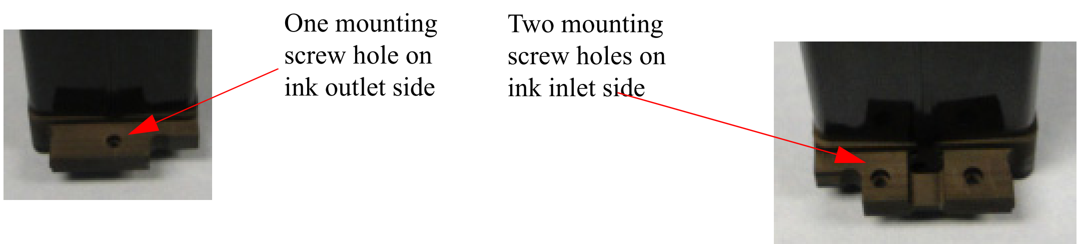


Figure 2-1 Mechanical Interface

The screws are the same whether you mount the printhead from the top or from the bottom. The screws are M3 x 0.5 mm captive screws with 2.5 mm internal Hex drives. The screws and springs are provided with the printhead.

When mounting from the top, the mounting screw should be bottomed in the receiving hole (4.5 mm deep). The receiving hole should be flat bottomed. The maximum torque value is 0.4 N-m. This sets the force applied by the spring holding the printhead in place.

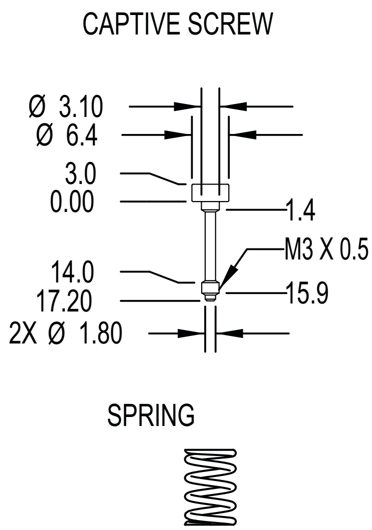


Figure 2-2 Mounting screw cross-section

For bottom mounting additional nuts (3) are required to hold the screws in place and to compress the springs.

1.1 Nozzle Pitch and Registration

The nozzle pitch (nozzle-to-nozzle distance) establishes the native dpi of the printhead. Nozzle pitch increases slightly with increased temperature. The printhead has a nozzle pitch of 0.0635 mm [0.0025 inches]. The printhead is not designed for using saber angle.

1.2 Thermal Expansion

The thermal expansion values in the following table were measured in the free state due to the number of variables when trying to measure thermal expansion when mounted. The free state values are provided.

Table 2-1 Typical Thermal Expansion Values

Part	Thermal Expansion
Nozzle Pitch, (X)	7.1 PPM/°C
Nozzle Pitch, (row to row,Y)	11 PPM/°C
Jet1 to X registration Surface	7.8 PPM/°C
Measured Unconstrained	

2.0 Stitch Error

Through extensive image quality work with the SG1024/A and a reference ink running at 400 X 400 dpi in small, medium and large drop formats, Dimatix has determined that the maximum stitch error should be about ± 25 µm. This maximum stitch error is offered as a reference.We found the value to be highly dependent on the image being printed, the drop size used, the media, and the jet overlap technique used (see Jet Overlap or Stitch Overlap Strategy section).

3.0 Printhead Mount

To achieve the required level of stitch error, a stable, reliable printhead mounting strategy is required. Dimatix has developed a reference, drop in mounting design which can be used in a top down or bottom up configuration. Through a balance of registration forces and controlled friction coefficients, the design reliably holds the printhead and mount plate registration features in contact. Spring rates are given which accommodate the total tolerance range for all of the parts and springs (see Precision Locating Features section). One of the key elements in this design is the electroless Ni / PTFE coating on the printhead mounting plate which lets the printhead slide during thermal expansion and contraction with sufficiently low force that the springs can keep the registration features in intimate contact. Only the surface that mates with the printhead collar should be coated. Please check http://www.balesmold.com/nicklon.htm for more information on this coating. This coating is essential for ensuring constant contact between the alignment surfaces of the printhead and mounting interface.

4.0 Printhead Mount Design

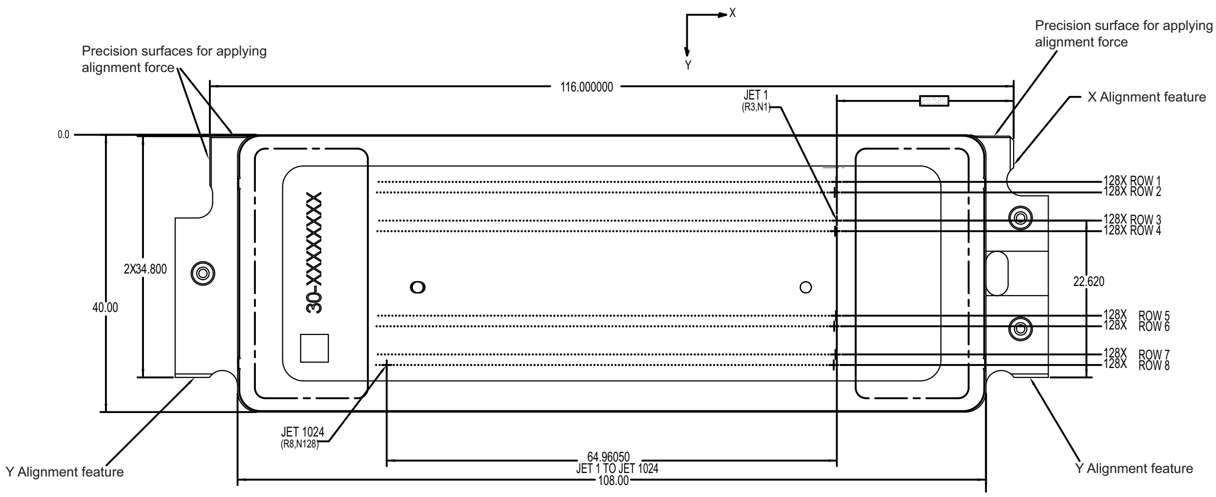


Figure 2-3 SG1024/A Mounting design intent

4.1 Precision Locating Features

The following diagram and table provide the values for the registration forces, the clamping forces, and the friction coefficients. These values are the same for top and bottom mounting.

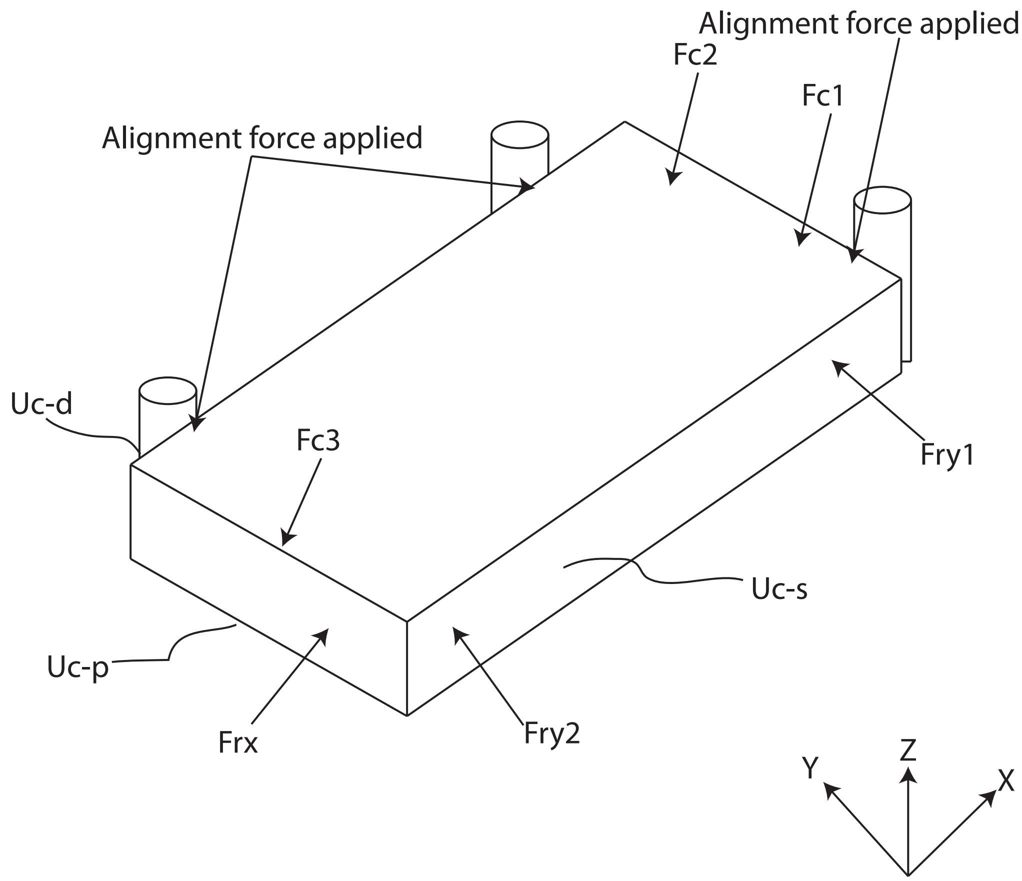


Figure 2-4 Mounting forces

Table 2-2 Mounting Forces

Force Type	Nominal	Tolerance	Low Limit	High Limit
Registration Forces				
Frx	64 N	10%	58 N	70 N
Fry1	32 N	10%	29 N	35 N
Fry2	32 N	10%	29 N	35 N
Clamping Force				
Fc1	12 N	10%	11 N	13 N
Fc2	12 N	10%	11 N	13 N
Fc3	12 N	10%	11 N	13 N
Friction Coefficients				
Uc-p	0.25	12%	0.22	0.28
Uc-d	0.25	12%	0.22	0.28
Uc-s	0.25	12%	0.22	0.28

The SG1024 printhead has three precision alignment surfaces (one X and two Y posts) which are machined on the finished assembly relative to the actual location (found optically) of the nozzles (please see product Interface Control Drawing (ICD) in Appendix A) where X is the cross process direction and Y is the process direction. The printhead also has three (3) precision surfaces for applying the holding force necessary to keep the printhead against the alignment pins. This holding force is supplied by the three (3) springs, shown in Figure 2-4.

The printhead surfaces mate with three (3) precision alignment surfaces on the mounting frame as shown in Figure 2-4. The mounting frame surfaces may be machined flats on pins or machined integrally to the frame. In either case the flats should be at least 1.5 mm wide and the surface finish should be an Ra of 0.8 μm or better to avoid damage to the printhead alignment surfaces. The friction coefficient of the frame surface is important. Machined stainless steel or aluminum coated with the Ni-PTFE coating would be good. Raw aluminum would not.

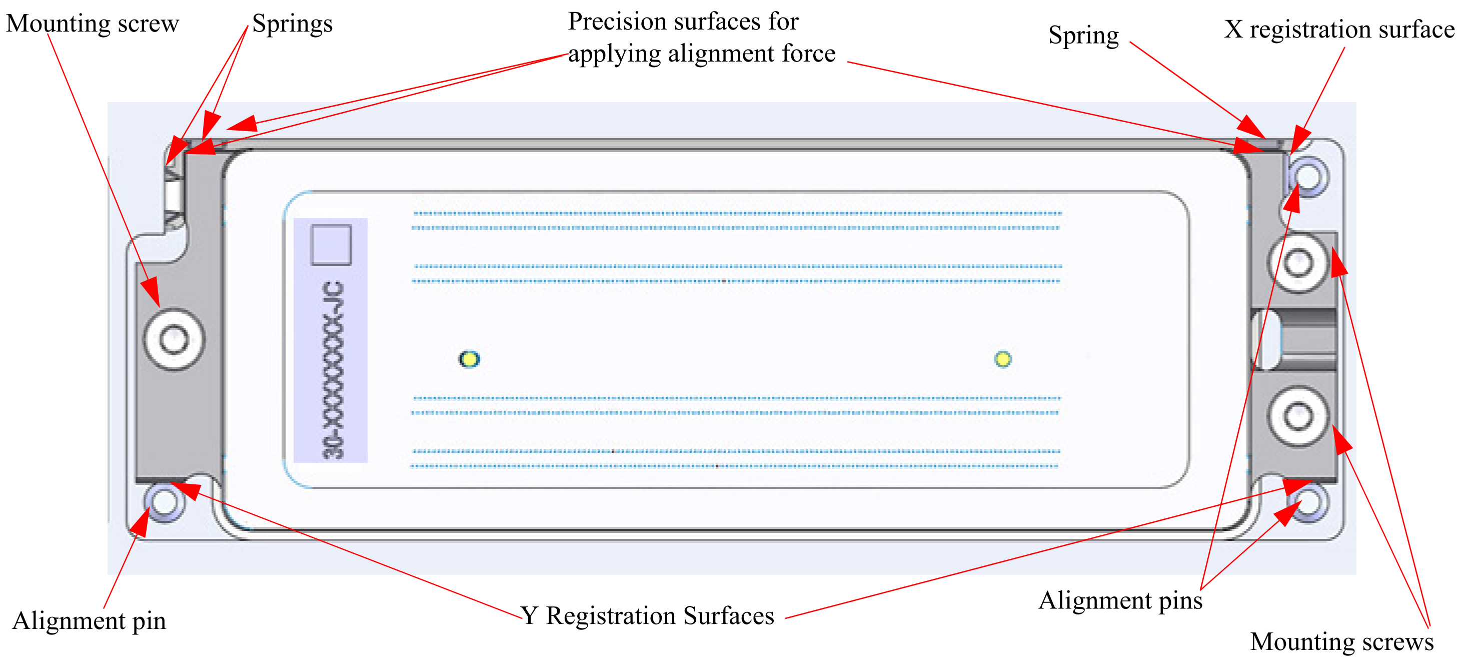


Figure 2-5 Bottom up mounting strategy – bottom view

4.2 Tolerance Budget

The design goal is to minimize the stitch error between overlapping nozzles from the end of one printhead with the beginning of the next printhead in line. The stitch error is determined by the stacking of all tolerances related to defining the location of these nozzles. This is described in the following table of cross process tolerances.

Table 2-3 Cross Process Tolerances

Precision surface to first nozzle of first printhead / ± um	**First nozzle to last nozzle of first printhead / ± um**	**Precision surface of first printhead to precision surface of second printhead / ± um**	**Precision surface of second printhead to first nozzle of second printhead / ± um**
7	12	10[1]	7
		RMS approximation of all 4 errors	~ 18.5 microns

Note: The value offered depends on the pin alignment accuracy of the machined interface plate. We offer an example of ± 10 microns as a reasonable value for the placement alignment surfaces (includes the plate machining, pins and placement).

4.3 Forces and Springs

When the printhead is mounted, it is first held against the head mounting surfaces (Z axis) with the captive screws and coil springs provided. The springs should be compressed 1.9 mm to achieve the target 12 N force on each screw. The printhead is then held against the two Y alignment features with a force of 32 N applied opposite each feature by a flat spring.

The coil spring compression (Z axis) is intended to be controlled by bottoming out the captive screw in the mounting plate (top down) or in the nut (bottom up).

The 32 N force in Y and 64 N force in X can be achieved with the same flat spring by doubling the deflection. It is important in the definition of the flat spring to ensure that the friction is limited.

4.4 Heat Transfer

Another function of the printhead mount is to provide heat to the printhead. The mounting frame is often the primary source of heat to the printhead. For this reason it is important that the frame be made of a conductive material and heated uniformly. The printhead mounting surfaces provide a large transfer area for heat into the printhead. See the *Thermal Interface* chapter for more detailed information on heating the printhead.

5.0 Top Down and Bottom Up

The following figures show how this mounting and alignment strategy is used to build the stitch overlap for multiple printheads with the added feature which enables heat transfer across the two ears of the printhead.

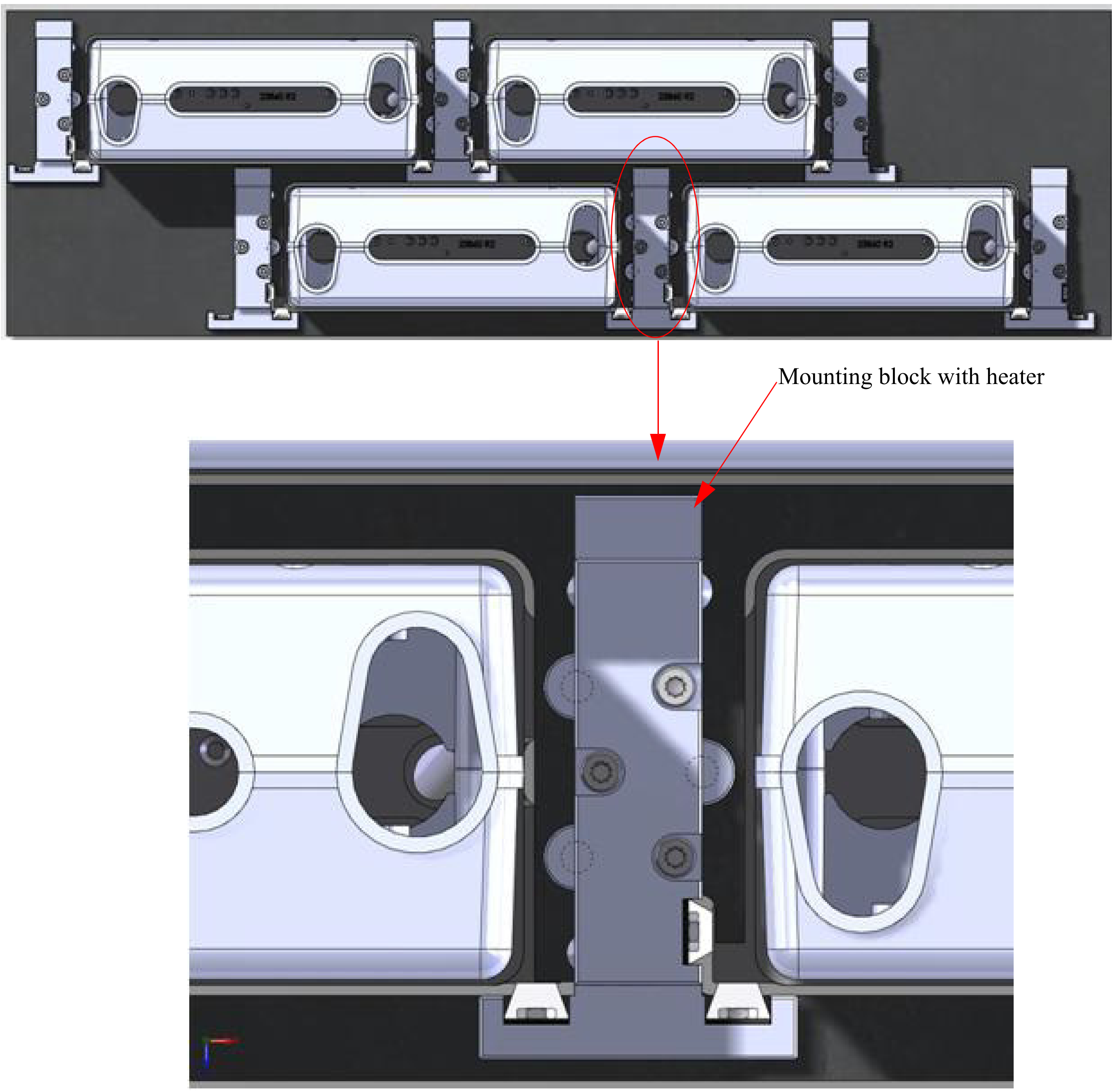


Figure 2-6 Bottom up mounting strategy, top view

The mounting blocks have heaters to assist in the transfer of heat across the printhead mounting surfaces.

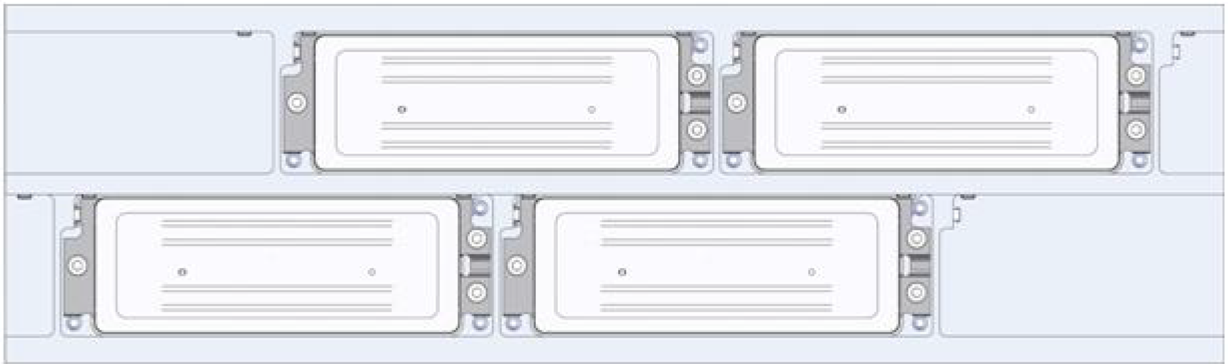


Figure 2-7 Bottom view, multiple printhead alignment

5.1 Jet Overlap or Stitch Overlap Strategy

The best method is to use a several jet overlap strategy between the end jets of one head and the starting jets of the next head.

Because of the mapping of adjacent nozzles to minimize the alignment error between one printhead and the next, we recommend that the following overlap strategy be used.

Small errors can be seen by eye, even when the target maximum stitch error is less than ± 25 microns. To overcome these effects, we recommend using either stochastic or checkerboard interlacing between these overlapping nozzles. The more overlapping jets between the end jets of one printhead and the starting jets of the next printhead the better. We present two examples, the first with just one jet overlapping from each printhead and the second with four jets overlapping from each printhead. For the latter example, we also present what the line spacing errors are at various yaw error positions for these overlapping nozzles.

The jet maps in the following tables show how to map nozzles at each end of the printhead by row. The following table show the jet mapping for both the one color printheads and the two color printheads. The jet numbers shown in the tables are fixed and are not dependent on the orientation of the printhead or the print direction. The pixel numbers are dependent on printhead orientation and print direction.

Table 2-4 Jet Mapping Data for 1 Color Printheads

Row	Jets	Connector Pins	Pixel Numbers (Column)
1	2, 10, 18, 26, ..., 1018	13, 14	1022, 1014, 1006, ..., 6
2	6, 14, 22, 30, ..., 1022	15, 16	1018, 1010, 1002, ..., 2
3	1, 9, 17, 25, ..., 1017	17, 18	1023, 1015, 1007, ..., 7
4	5, 13, 21, 29, ..., 1021	19, 20	1019, 1011, 1003, ..., 3
5	3, 11, 19, 27, ..., 1019	21, 22	1021, 1013, 1005, ..., 5
6	7, 15, 23, 31, ..., 1023	23, 24	1017, 1009, 1001, ..., 1
7	4, 12, 20, 28, ..., 1020	25, 26	1020, 1012, 1004, ..., 4
8	8, 16, 24, 32, ..., 1024	27, 28	1016, 1008, 1000, ..., 0

Table 2-5 Jet Mapping Data for 2 Color Printheads

Row	Color - Jets	Connector Pins	Pixel Numbers (Column)
1	C1-J1, C1-J5,...C1J509	13, 14	C1:511, 507, 503,... 3
2	C1-J3, C1-J7,... C1-J511	15, 16	C1:509, 505, 501,... 1
3	C1-J2, C1-J6,... C1-J510	17, 18	C1:510, 506, 502,... 2
4	C1-J4, C1-J8,...C1-J512	19, 20	C1:508, 504, 500,... 0
5	C2-J1, C2-J5,...C2J509	21, 22	C2:511, 507, 503,... 3
6	C2-J3, C2-J7,... C2-J511	23, 24	C2:509, 505, 501,... 1
7	C2-J2, C2-J6,... C2-J510	25, 26	C2:510, 506, 502,... 2
8	C2-J4, C2-J8,...C2-J512	27, 28	C2:508, 504, 500,... 0

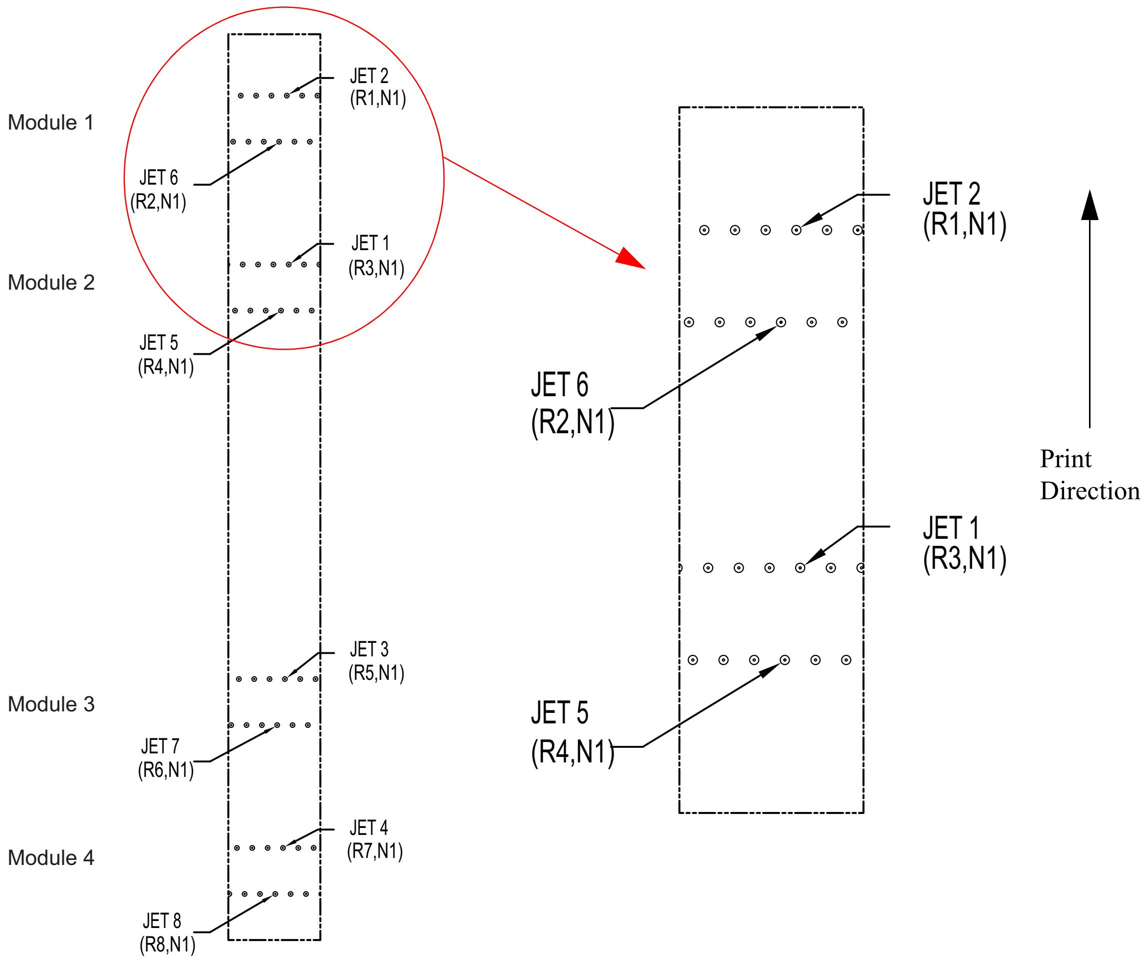


Figure 2-8 Nozzle plate showing nozzle layout by row number, with no yaw angle

5.1.1 Four Jet Overlap

Using the Jet Mapping Data table, the overlap is described by the following nozzle mapping.

Table 2-6 Nozzle Mapping

4 Jet Overlap	J1021-J1	J1022-J2	J1023-J3	J1024-J4
PH1-PH2	PH1 = R4,N128 PH2 = R3,N1	PH1 = R2,N128 PH2 = R1,N1	PH1 = R6.N128 PH2 = R5,N1	PH1 = R8,N128 PH2 = R7,N1
PH2-PH3	PH2 = R4,N128 PH3 = R3,N1	PH2 = R2,N128 PH3 = R1,N1	PH2 = R6.N128 PH3 = R5,N1	PH2 = R8,N128 PH3 = R7,N1

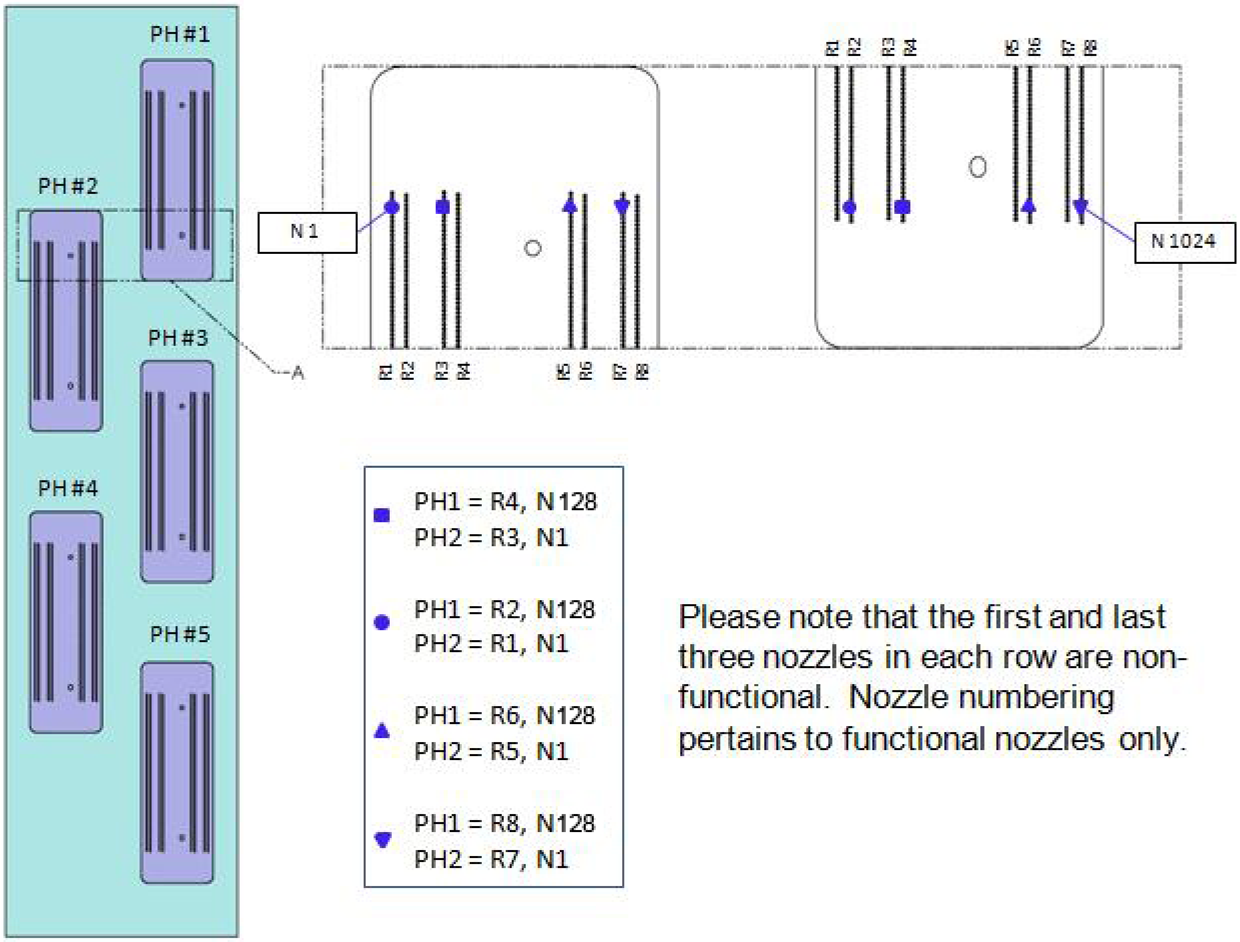


Figure 2-9 Four jet overlap strategy

The following table shows how the yaw angle affects the jet overlap and why this alignment is important. Using three different yaw error positions, ± 2, ± 1 and 0, the overlap error is calculated where a negative value indicates overlap and a positive number indicates a gap.

Table 2-7 Overlap Errors for 4 Jets Overlap at 3 Yaw Settings

4 Jets Overlap	**Delta (µm)**			
Yaw error position 0	**J1021 / J1**	**J1022 / J2**	**J1023 / J3**	**J1024 / J4**
PH1				
PH2	0.0	0.0	0.0	0.0
PH3	0.0	0.0	0.0	0.0
Yaw error ± 0.25 µm/mm	**J1021 / J1**	**J1022 / J2**	**J1023 / J3**	**J1024 / J4**
PH1				

Table 2-7 Overlap Errors for 4 Jets Overlap at 3 Yaw Settings

4 Jets Overlap	Delta (µm)			
PH2	-11.6	-11.6	-11.6	-11.6
PH3	12.4	12.4	12.4	12.4
Yaw error ± 0.5 µm/mm	**J1021 / J1**	**J1022 / J2**	**J1023 / J3**	**J1024 / J4**
PH1				
PH2	-23.2	-23.2	-23.2	-23.2
PH3	24.8	24.8	24.8	24.8

Using the target maximum overlap error of ± 25 microns, we can see that yaw error position ± 1 uses half of the tolerance alone, while yaw error position ± 2 uses all of the tolerance.

5.1.2 Single Jet Overlap Checkerboard Overlap Strategy

Finally, we show how to print with overlap by alternating between the overlapping nozzles from each overlapping printhead. In the following figure an image is created for 4 X SG1024/A printheads with a checkerboard strategy between the overlapped jets. This means that the printing of the overlapping lines of pixels is printed with a Printhead A – Printhead B – Printhead A – Printhead B …….. Pattern.

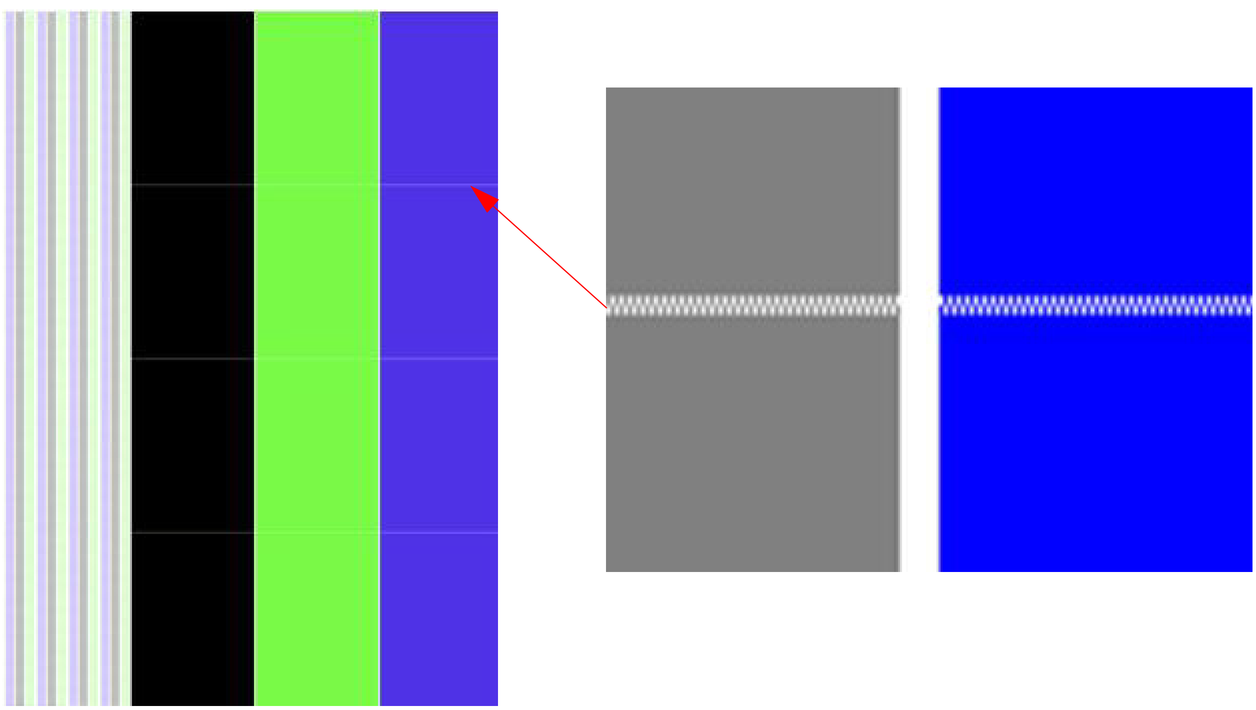


Figure 2-10 Stitch overlap test image with checkerboard

Black, Green and Cyan are used in this image to represent small, medium and large drop sizes which are useful in determining the sensitivity between stitch and drop size. This image is very sensitive to stitch errors because all the jets are running.

6.0 Top Mounting Strategy

The bottom up mounting strategy is not meant to indicate a limit on how these printheads can be mounted. It is also possible to use a very similar design for a top mounting strategy. The product ICD, in *Appendix A*, shows two sets of mounting surfaces: Recommended Mounting Surface and Alternate Mounting Surface. See the following figure for their locations.

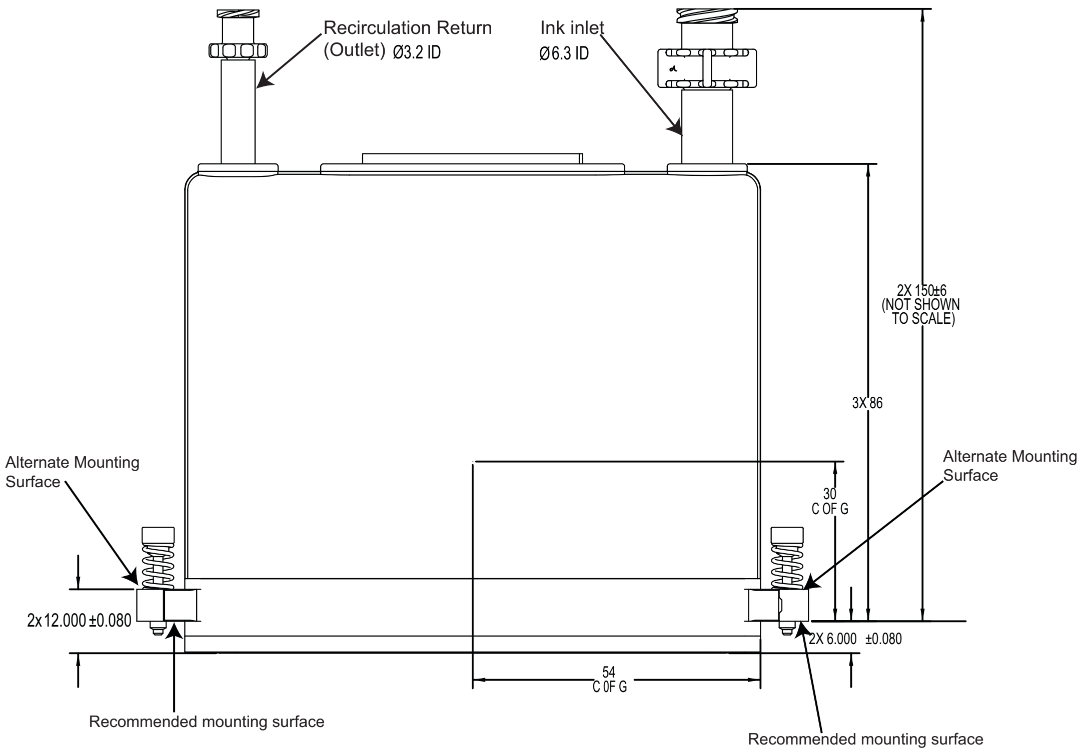


Figure 2-11 SG1024/A Side view with two sets of mounting surfaces

Instead of using the Alternate Mounting Surfaces (top surfaces) as in the bottom up mounting strategy, use the two Recommended Mounting Surfaces (bottom surfaces) for a top mounting strategy. The following shows how this design would look:

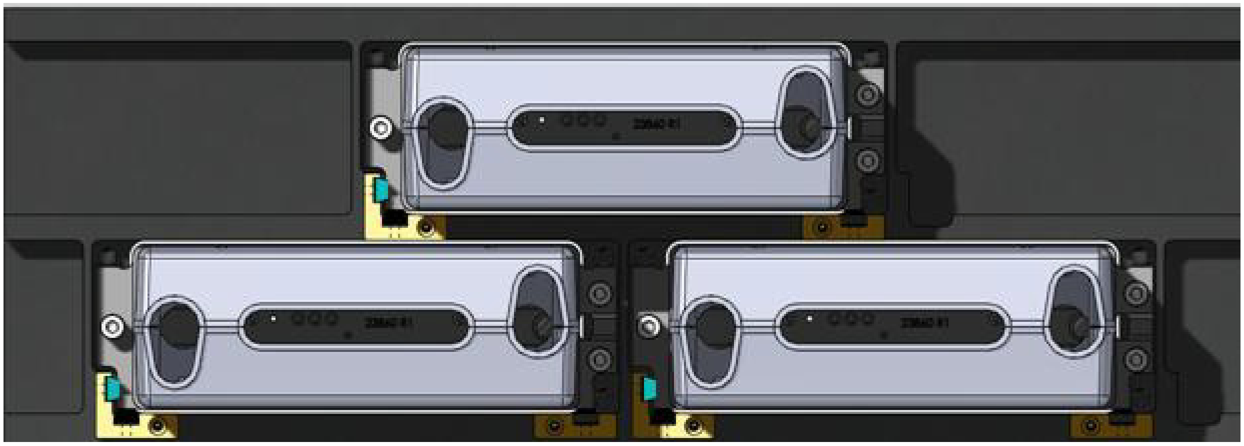


Figure 2-12 Top mounting, multiple head view

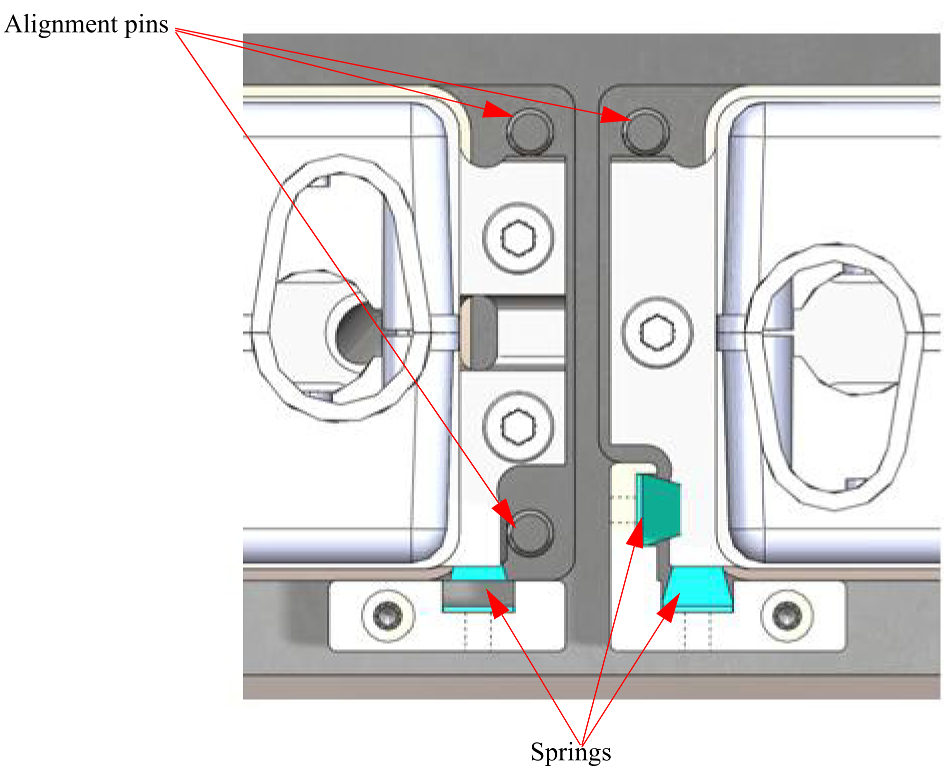


Figure 2-13 Top mounting, close up

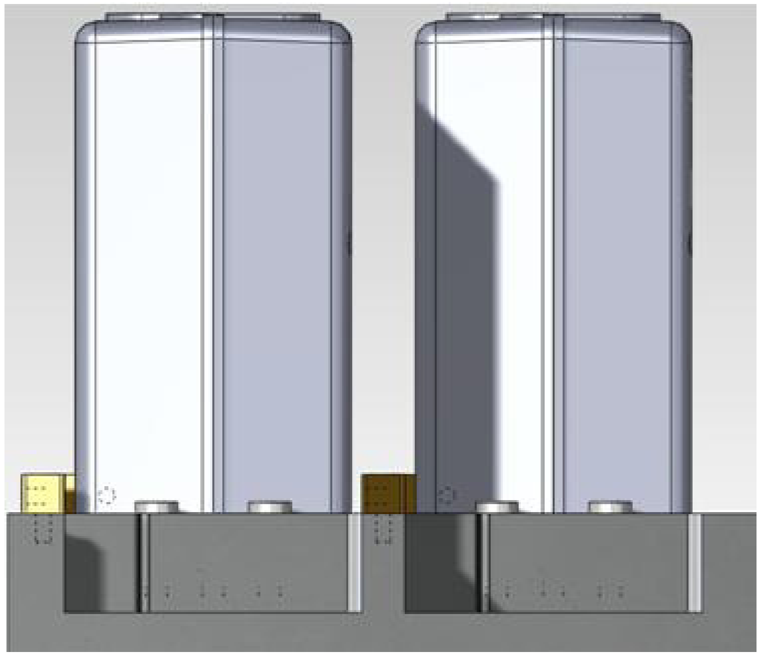


Figure 2-14 Top mounting, side view

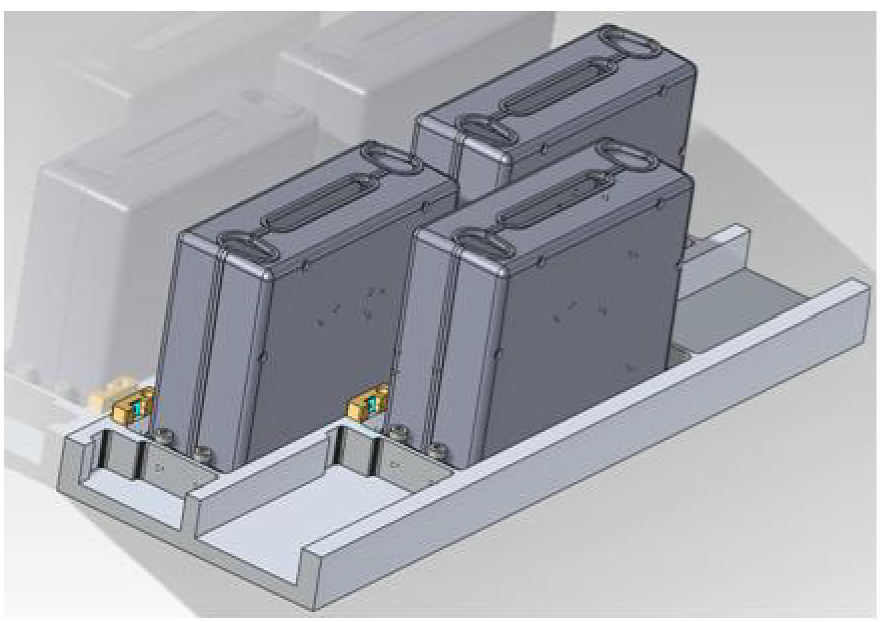


Figure 2-15 Top mounting

7.0 Yaw Evaluation

The SG1024 printhead is a 400 dpi, 1024 nozzle printhead, with 8 rows of 128 nozzles, with each row having 50 dpi spacing. The printhead produces the 400 dpi images using adjacent jets from different rows. Adjacent jets are those in the jet-1, jet-2, jet-3, ... jet sequence, and are spaced at 400 per inch in the cross-process direction. To ensure that the dot spacing is evenly spaced for all adjacent jets, the printhead must be aligned with precision relative to the motion of the printhead or the media transport. The following figure shows the head with no yaw error relative to the print direction.

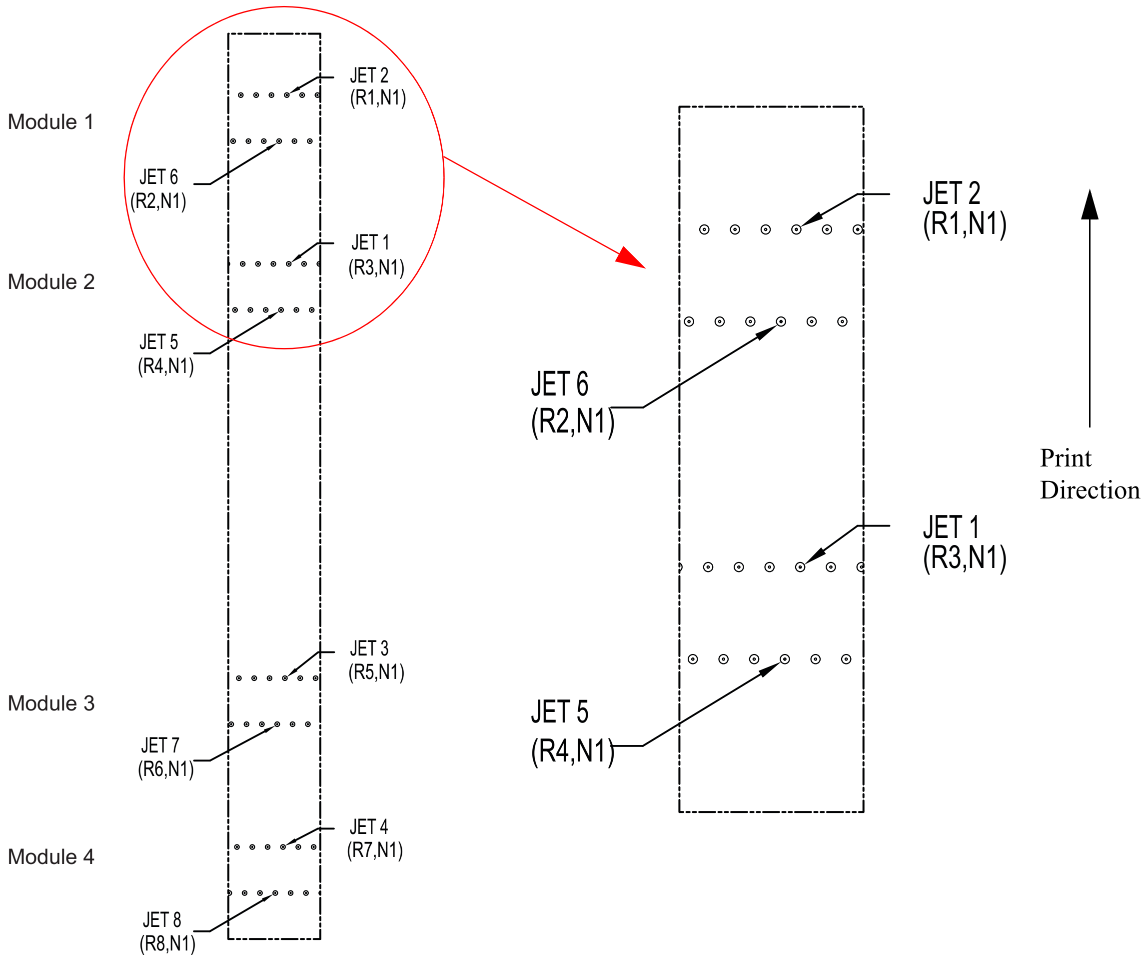


Figure 2-16 Nozzle plate showing nozzle layout by row number, with no yaw angle

When yaw is misaligned as shown in the following figure, we see an adjacent nozzle spacing error.

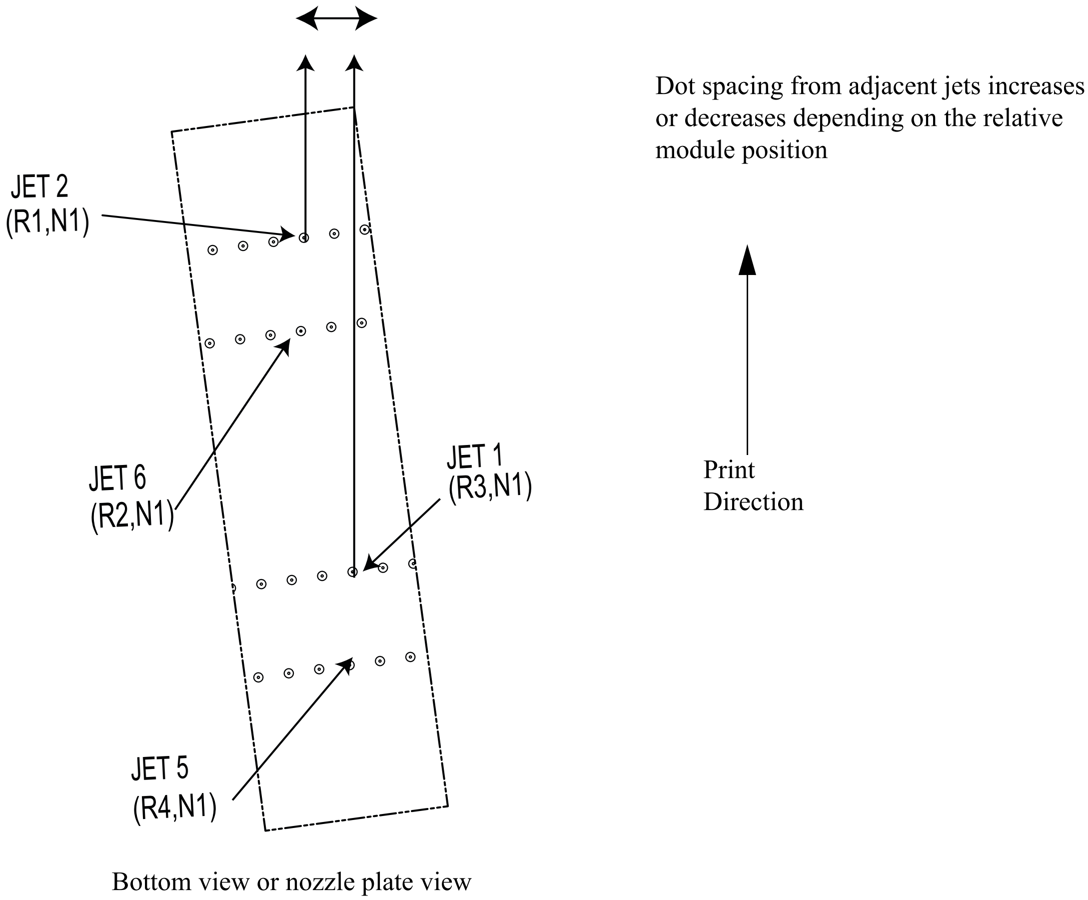


Figure 2-17 Nozzle plate showing nozzle layout by row number, with clockwise yaw angle relative to top view

It is important to understand the nozzle mapping in relation to row and module. The following figure shows the nozzle mapping and the adjacent nozzle locations by row and module.

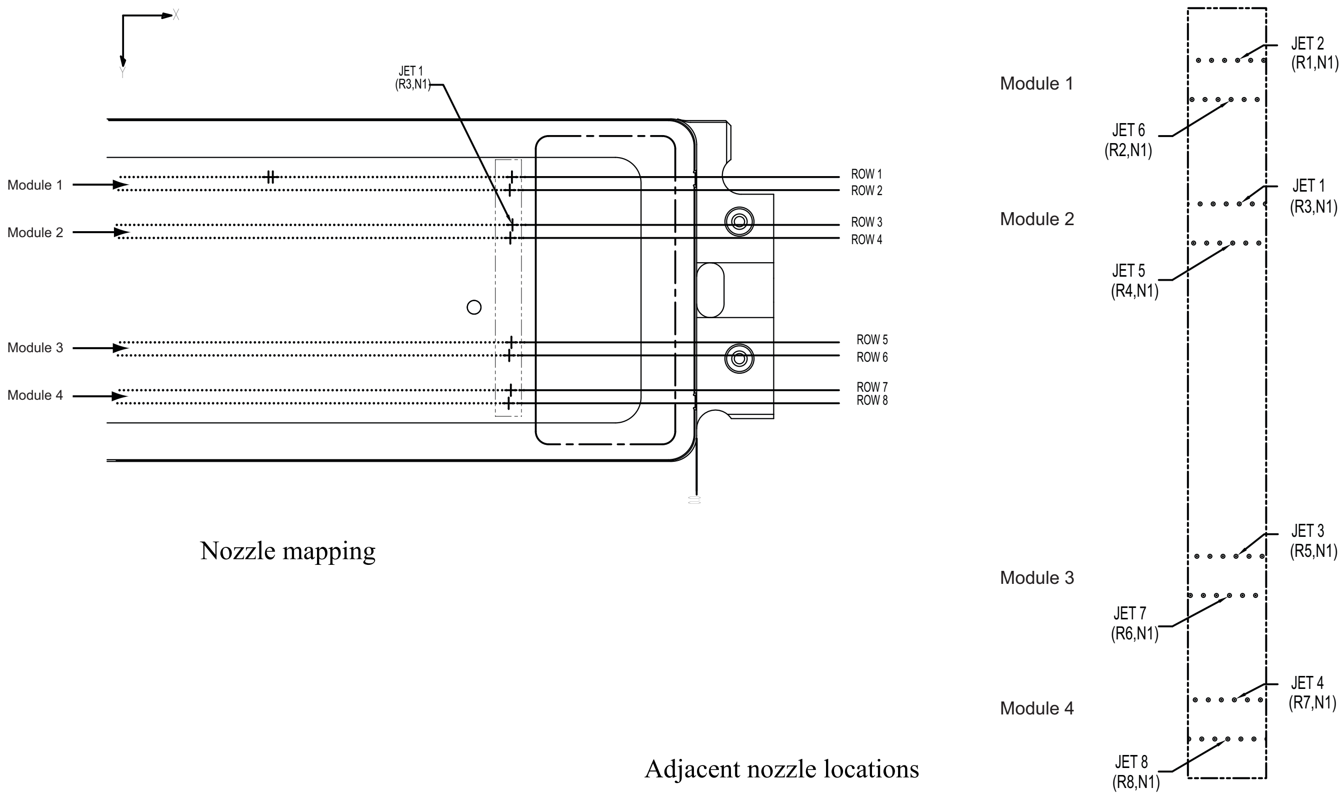


Figure 2-18 Nozzle mapping and adjacent nozzle locations by row and module

7.1 Yaw Test Image

Dimatix can supply a yaw test image that prints yaw lines. This image, shown in Figure 2-19, does not use adjacent jets (such as R3, N1 and R1, N1) which would produce solid indistinguishable lines, but uses the next jet in the same row as the adjacent jet or a spacing of 9 pixel counts (R3, N1 and R1, N2).

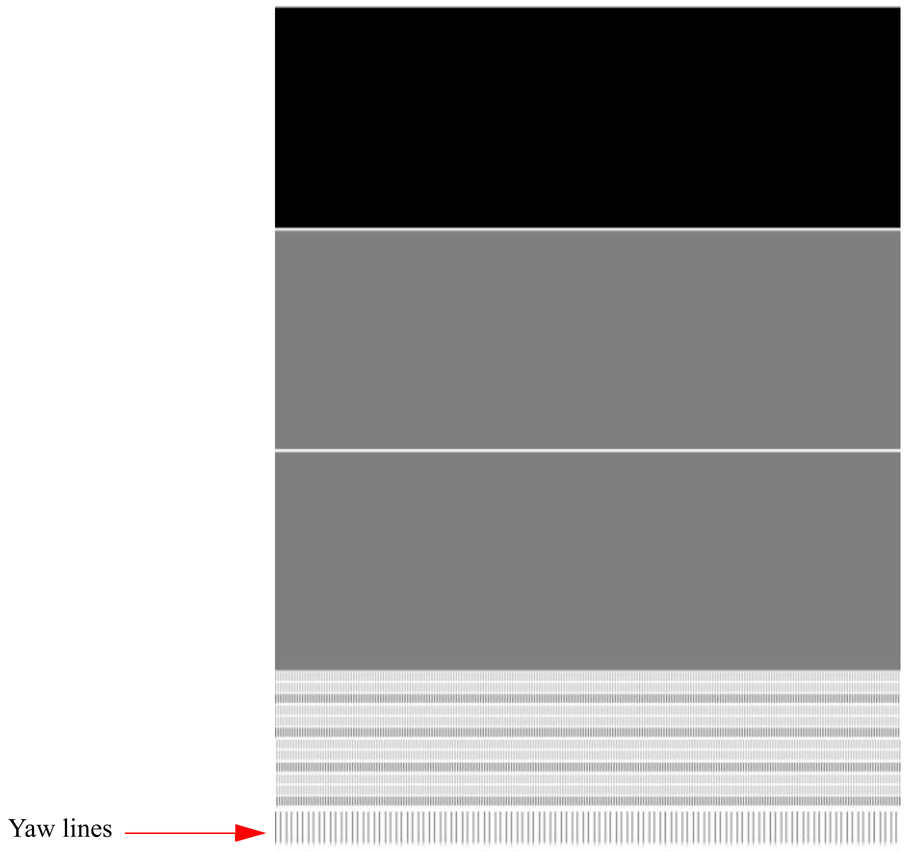
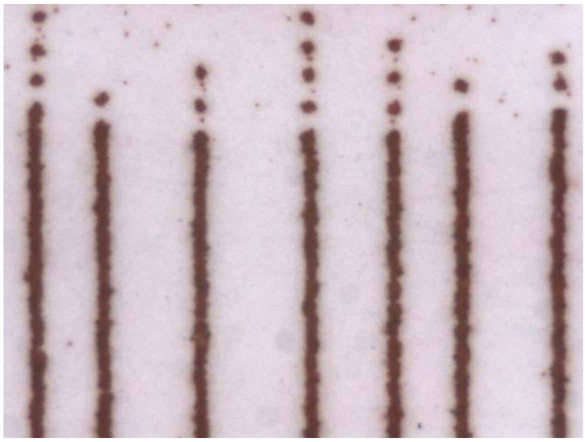
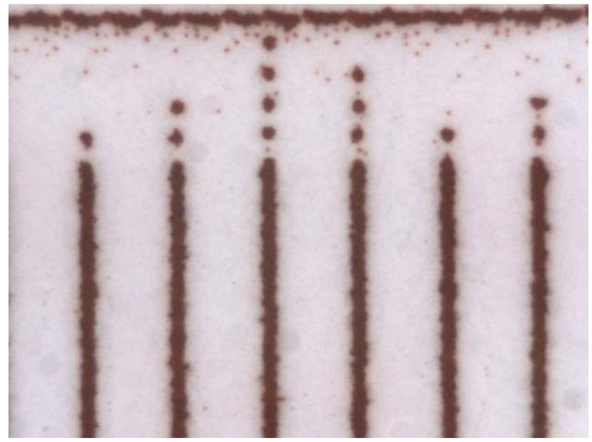


Figure 2-19 Yaw test image

The goal when the printhead is aligned is to have evenly spaced yaw lines as shown in the good yaw example in Figure 2-20. The spacing between these yaw lines should be 571.5µm (or 9 pixel counts or 9 / 400 dpi). When the yaw is incorrect, the view looks like the poor yaw example in Figure 2-20. The number of dots at the end of each line indicates which module jetted the line.



Poor yaw, lines with uneven spacing



Good yaw, lines with even spacing

Figure 2-20 Examples of Poor and Good yaw Lines

The following table describes how to use the yaw adjustment image designed by Dimatix and available through our Tech Support Web access. The table shows the relationship between the yaw lines in SG1024 test image and the nozzles that are actually jetting.

Table 2-8 Nozzle, module and row map

Jet Number	Row #	Nozzle #	Yaw Line	Module #
1	3	1	1	2
2	1	1		1
3	5	1		3
4	7	1		4
5	4	1		2
6	2	1		1
7	6	1		3
8	8	1		4
9	3	2		2
10	1	2	2	1
11	5	2		3
12	7	2		4
13	4	2		2
14	2	2		1

Table 2-8 Nozzle, module and row map

Jet Number	Row #	Nozzle #	Yaw Line	Module #
15	6	2		3
16	8	2		4
17	3	3		2
18	1	3		1
19	5	3	3	3
20	7	3		4
21	4	3		2
22	2	3		1
23	6	3		3
24	8	3		4
25	3	4		2
26	1	4		1
27	5	4		3
28	7	4	4	4
29	4	4		2
30	2	4		1
31	6	4		3
32	8	4		4
33	3	5		2
34	1	5		1
35	5	5		3
36	7	5		4
37	4	5	5	2
-	-	-	-	-
1017	3	128		2
1018	1	128	114	1
1019	5	128		3
1020	7	128		4
1021	4	128		2

Table 2-8 Nozzle, module and row map

Jet Number	Row #	Nozzle #	Yaw Line	Module #
1022	2	128		1
1023	6	128		3
1024	8	128		4

The Dimatix yaw test image, SG1024 test image.tif, has yaw lines which can be identified by the module which prints them (see the number of dots at the end of each line in Figure 2-20). Table 2-8 below shows the relationship between the yaw lines and yaw adjustment. CW and CCW adjustments refer to the rotation of a SG1024 printhead looking from above down into the printhead.

Table 2-9 Relationship between printhead modules separation and direction of yaw error

Interlaced lines	Clockwise	Counter clockwise
M2 → M1	Increases	Decreases
M1 → M3	Decreases	Increases
M3 → M4	Decreases	Increases
M4 → M2	Increases	Decreases

Therefore the poor yaw picture in Figure 2-20 indicates that a clockwise rotation of the printhead has occurred and needs a counterclockwise adjustment.

To ensure that this procedure works, first check that the correct rows and modules are mapped correctly by commanding each one to print separately. Table 2-9 describes how these yaw lines are printed by module and row number. There are 8 rows of nozzles so the yaw lines need to follow the module sequence 2, 1,3, 4, 2, 1, 3, 4,……..

The following table shows spacing errors between yaw lines and other various yaw errors. From imaging experiments, we know what level of yaw is important for acceptable image quality. We recommend that you set the yaw alignment at least between - 0.5 µm/mm and + 0.5 µm/mm, preferably between - 0.25 µm/mm and + 0.25 µm/mm. The second column of the table uses yaw error positions in terms of an error in µm/mm. If the distance between the pivot point of the printhead and the adjustment device is known, then these values can be converted to the amount of adjustment needed.

Table 2-10 Yaw Error Positions Based on 571.5 µm Nominal Spacing

Yaw Error Positions	Yaw Error (µm/mm)	Row 1 (M2-M1)	Row 3 (M4-M2)	Row 5 (M1-M3)	Row 7 (M3-M4)	Yaw Rotation	Adjustment rotation
-4	-2.14	-12.5	-40.5	42	12	CCW	CW
-3	-1.04	-6.5	-19.5	21	5.5	CCW	CW
-2	-0.51	-3.5	-9.5	3	3.5	CCW	CW
-1	-0.28	-2	-4.5	10.5	1.5	CCW	CW
0	0	0	-0	0	0	0	0
1	0.23	1	5	-4	-0.5	CW	CCW
2	0.52	1	12	-8.5	-4	CW	CCW
3	1.1	5.5	22	-20.5	-6.5	CW	CCW
4	2.13	12	41.5	-41	-12	CW	CCW

Since some of the spacings are small, we recommend counting between as many as possible or simply sticking to measuring M2-M4 and M3-M1. A 50 X objective with 20 micron divisions is probably good enough to get to about ± 1 yaw error position or within 0.25 µm/mm.

For example, if we determine that there is a yaw error of 2.13 µm/mm and there is a 40 pitch screw used in the printhead yaw adjustment with the distance between the screw and the pivot point is 300 mm, then the screw must be turned 300 X 2.13 or 639 microns. One turn of the screw is 635 microns (1/40 inch), so one complete turn in a counter clockwise direction looking down at the printhead is needed.

The following graph is useful in representing the relationship between module line spacing and optimum yaw alignment.

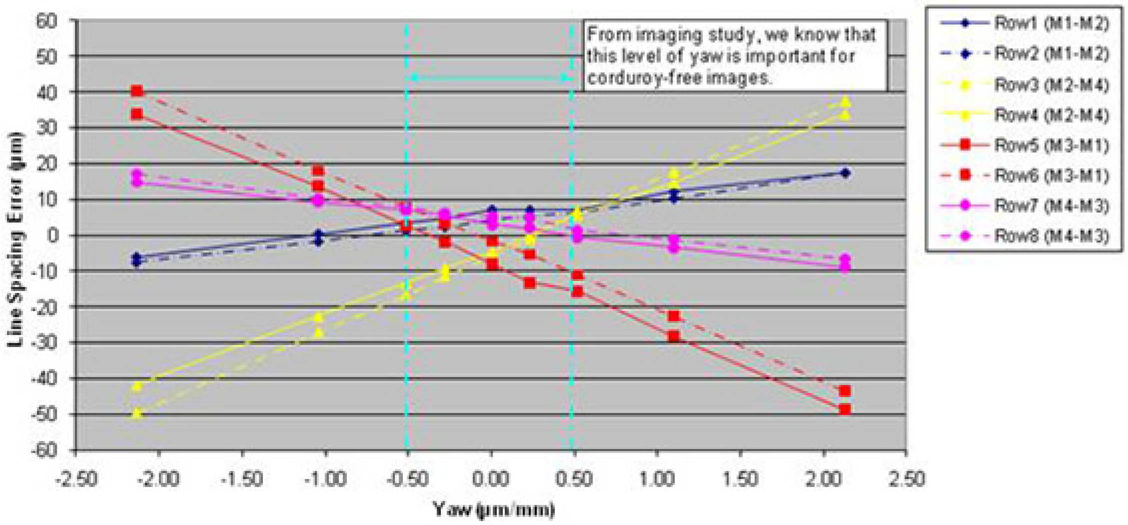


Figure 2-21 Graphical representation between yaw errors and module line spacing

8.0 Image Quality Problems Associated with Yaw

When there is a yaw misalignment, printed images display corduroy or ridgy line artifacts.

The corduroy effect shows up as non uniform spacing of adjacent pixels which changes the appearance of solid filled. It is most noticeable in the small drop images. The corduroy problem can be seen in the following figure using the yaw values from Table 2-9, where small, medium and large drop sizes are used (25, 55 and 80 pl approximately). There is enough coverage at the large drop to cover most of the errors in all 3 yaw positions, but the yaw errors are noticeable in small and medium drop mode.

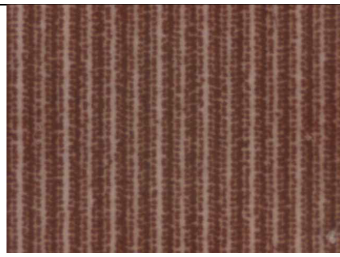
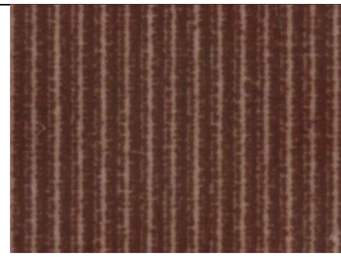
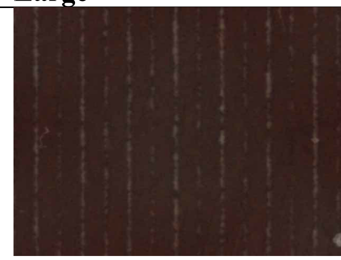
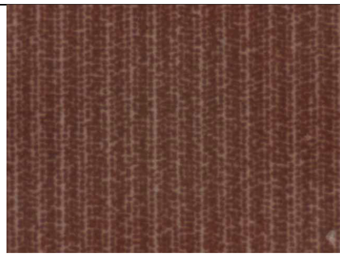
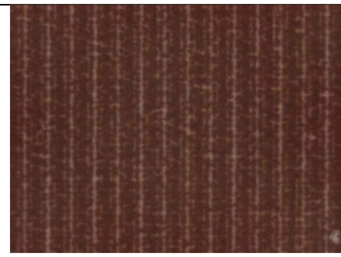
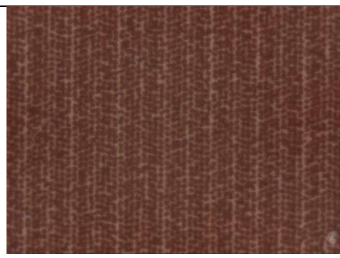
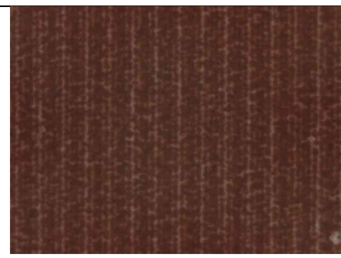
	Small	Medium	Large
Yaw #±4			
Yaw #±3			
Yaw #±2			

Figure 2-22 Small, medium and large drop sizes using 3 different yaw values

9.0 Yaw Recommendation

There is a good correlation between image yaw and perception as it is seen by uneven line spacing or what we call the corduroy artifact. Higher yaw images have significant non-uniformity in line spacing that is even visible in large drops. An image yaw error described by yaw ± .5 µm/mm or lower results in acceptable image quality and uniform image density. This is the target.

It is critical that a means to accurately and repeatedly adjust the printhead yaw be made available when initially setting up the printer. A means to accurately measure the spacing between 10 sets of modules lines is also recommended. This yaw adjustment must be lock down capable to ensure permanent yaw is maintained.

10.0 Quick Yaw Alignment Guide

The following steps outline the proper alignment procedure for setting the best yaw for the SG1024 printhead.

1. Mount SG1024 printhead over the printing station.

2. Ensure that there is minimum web weave on the media transport that is used to print the yaw images. An ideal value for web weave on the media transport would be on the same order as required yaw error of the printhead or 0.5 µm/mm or better.

3. Make sure that there is a reliable means to adjust the yaw of the printhead and, once set, a way to lock it in position.

4. Contact FujiFilm Dimatix to get a copy of the yaw test image.

5. Make sure that the image processing does not change the yaw test image in any way.

6. Make sure that the correct modules are running by turning on one at a time.

7. Print the yaw test image at 400 dpi in the media advance directions at a speed of 0.5 m/s (20 inch/seconds).

8. Using a microscope with a calibrated stage or an eye-loop with a minimum 50X objective and 20 micron gradations, measure the distance between M4 and M2 and M1 and M3 only. These have the largest error position values and will be the easiest too measure.

9. Determine the difference between these values and the nominal of 571.5 microns, ensuring that the sign of the value is carefully noted. A negative value shows that the measured distance from M2 -M4 was found to be shorter than 571.5 microns.

10. Repeat this measurement at least five times in different positions across the yaw image.

11. Using Table 2-10, decide which yaw position best represents the errors measured.

    For example, if the average distance from M4 to M2 is found to be shorter than nominal or -45 microns and from M3-M1 to be longer than nominal or +37 microns, then the yaw position error is at -4 or -2.14 µm/mm and looking from the top of the printhead down, the head is in a CCW rotation. To move it into position requires a CW rotation.

    If the same screw and 300 mm pivot point distance is used, then an adjustment of 300 X 2.14 or 642 microns or approximately one turn of the screw moving in a clockwise direction is required.

12. This procedure may have to be repeated a few times until the desired yaw alignment is reached. It is likely that zero values will never be reached as the web weave of the media will have some contribution to what appears to be yaw error.

Chapter 3 – Thermal Interface

The thermal interface is through the 60 pin connector at the top of the Dual HIB to the controller.

60 pin connector

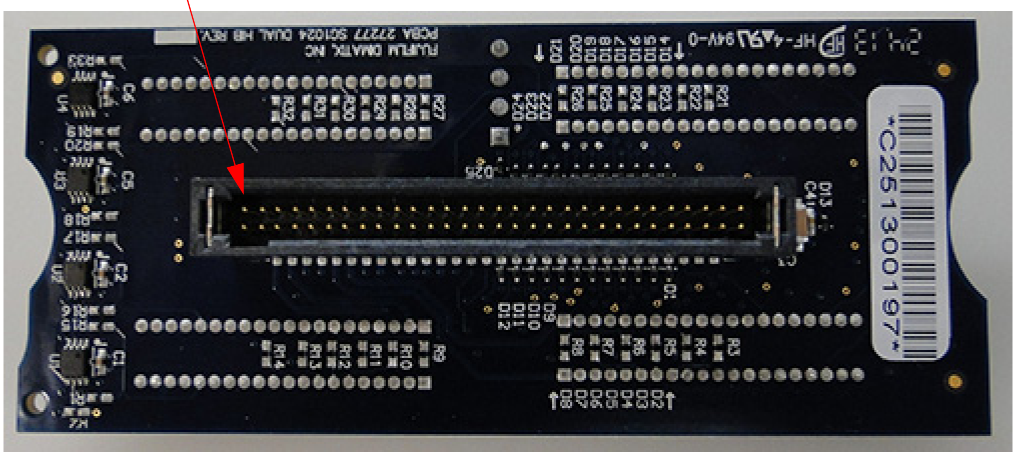
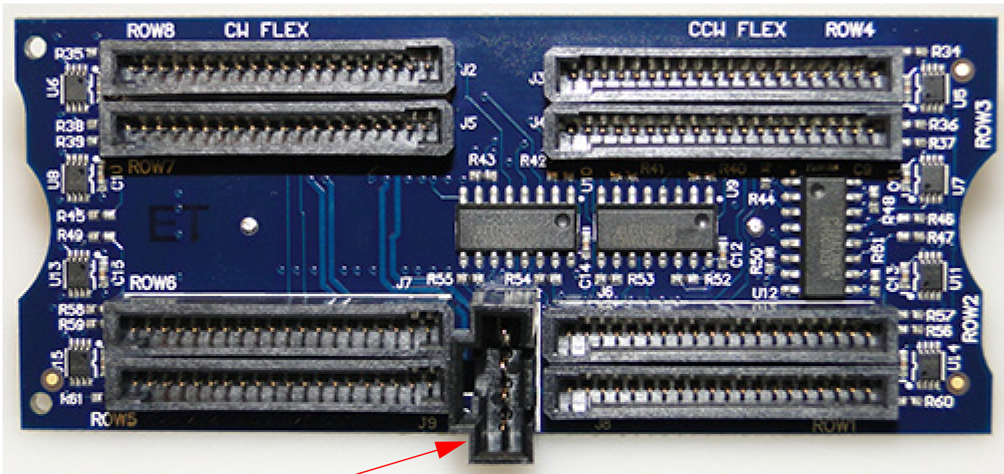


Figure 3-1 Top view of Dual HIB

It receives the signal from the thermistor and heater through the four pin connector on the underside of the Dual Head Interface Board (HIB).



4 pin connector for heater/thermistor

Figure 3-2 Connector for heater/thermistor on underside of the Dual HIB

The following table shows the pinouts for the heater and thermistor for the 60 pin connector on the Dual HIB.

Table 3-1 Heater/Thermistor pinouts for 60 pin connector

Pin Number	Connection	Description
35	THB	Printhead Thermistor
36	THA	Pull Up for Printhead Thermistor
37	HTRB	Ground for Printhead heater
38	HTRA	Control for Printhead Heater
41	HTRB	Ground for Printhead heater
42	HTRA	Control for Printhead Heater

1.0 Temperature

The viscosity of the ink in the nozzles is a critical parameter affecting jetting performance, and the temperature of the ink is a critical factor affecting the viscosity. Therefore, it is important to understand the viscosity/temperature characteristics of the ink and to maintain its required temperature in the printhead.

For optimal image quality it is important that the viscosity of the ink remain constant, and within a range of 10 to 16 cP. The printhead is heated from the mounting plate through the collar assembly. Additionally, each printhead has a thermistor for monitoring purposes.

2.0 Operating Temperature Range

The lower end of the operating temperature range is essentially a cold normal room temperature. There is no reason why the printhead cannot function at a colder temperature, assuming that condensation is avoided. Most users jet at temperatures slightly above normal room temperature because it allows easy control of temperature and thus viscosity, benefiting output uniformity. The upper temperature operating limit is determined by the potential weakening of internal bond integrity, both from time at temperature and from thermal cycling. Thermal cycling outside the specified temperature range can also cause a gradual decrease in jet performance due to a pyroelectric effect on PZT poling coefficients.

3.0 Heating the Printhead

3.1 External Heating

The SG1024/A printhead is designed to be heated through the mounting plate. At each end of the printhead the flange provides 1.5 cm^2 of surface area for heat transfer. If the printhead is top mounted, then the area is at the bottom of the flange. If the printhead is bottom mounted, then the transfer area is at the top of the flange.

There is a thermistor built into the printhead for temperature monitoring through the 60 pin connector.

3.2 Internal Thermal Interface

The SG1024/A printheads have a heater mounted in the printhead which can be used for heating the printhead. The heater is 30 W, 24 V DC or AC. It is powered by the Dual HIB 60 pin connector. Pins 37, 38, 41, and 42 should all be used to supply sufficient power through the cable and connector. (See Chapter 5 of this manual for more information about the pinouts.) The SG1024 printhead has a thermal zone comprised of 1 thermistor and 1 heater, which are attached to the 4-pin C-Grid connector located on the bottom of the Dual HIB. The following table describes the connections.

Table 3-2 Heater Connector J10 Description

Pin Number	Connection	Description
1	THA	Pull up for printhead thermistor
2	THB	Printhead thermistor
3	HTRB	Ground for printhead heater
4	HTRA	Control for printhead heater

The accompanying thermistor is located above the mounting surface on the ink inlet end of the printhead. The thermistor hole is 1.99 mm x 56 mm deep.

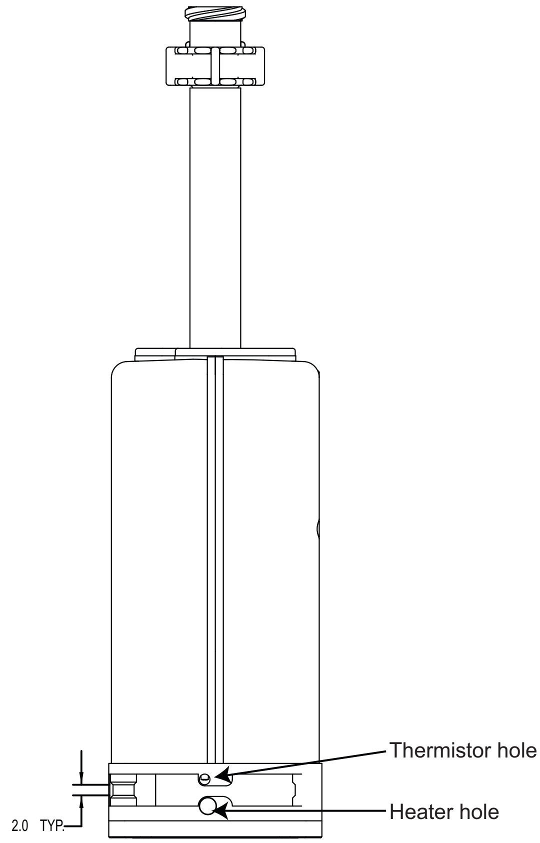


Figure 3-3 Internal heater location

Chapter 4 – Fluid Interface

1.0 The Fluid Interface

The StarFire SG1024/A fluid interface is simple. It has one ink inlet connection for connecting to the ink supply and it has one ink outlet connection for recirculating the ink.

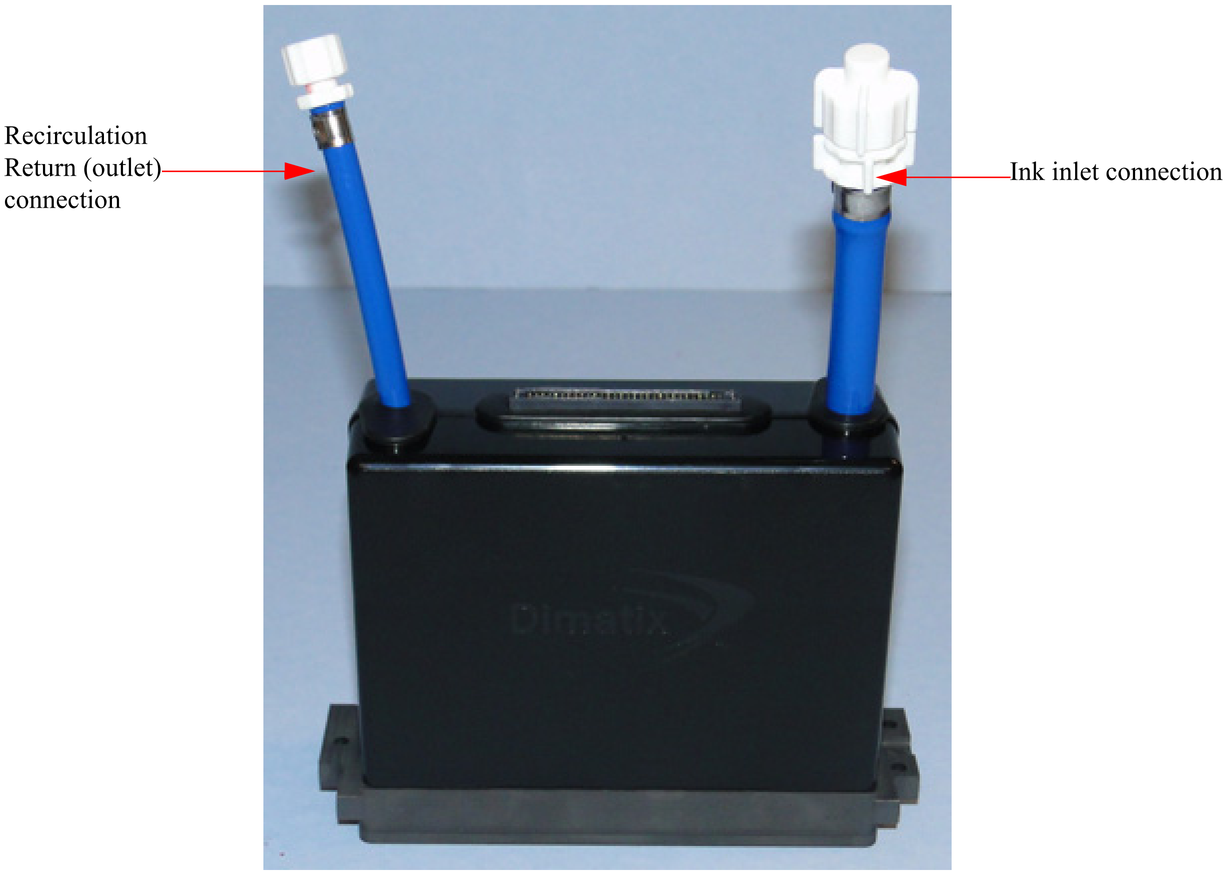


Figure 4-1 SG1024/A showing location of ink connections

The fluid connections are located above the printhead and the above the electrical interface connection. Care should be taken when connecting or disconnecting the fluid and recirculation lines that no significant quantity of fluid flows over the electrical connection.

WARNING

Make sure that when connecting/disconnecting the ink inlet connection or the recirculation connection that no significant amount of fluid is allowed to flow over the electrical interface connection.

WARNING

Jetting fluids and flushes that are highly conductive and/or have a low flash point may pose a danger to the printhead and the operator as hazardous voltages and temperatures are required for printhead performance. Customers contemplating using such jetting fluids and flushes should consult with their fluid supplier to ensure safe operation.

Ink Inlet Connection – The ink inlet connection connects to the ink supply via a luer fitting. It extends beyond the printhead cover for easy access. The tubing is Tygon 2375 and a mated luer fitting is included with the printhead.

Recirculation Return (Outlet) Connection – The recirculation return (outlet) connection connects to the Recirculation system. It extends beyond the printhead cover for easy access. The tubing is Tygon 2375 and a mated luer fitting is included with the printhead.

The above holds true for the 2 color version as well. It is just doubled. However, note that the ink inlet for color one and the recirculation line for color 2 are on the same side of the printhead. This is true for the other side i.e. ink inlet for color 2 and the recirculation line for color 1 are on the same end of the printhead. The ink flow is across the printhead rather than straight down.

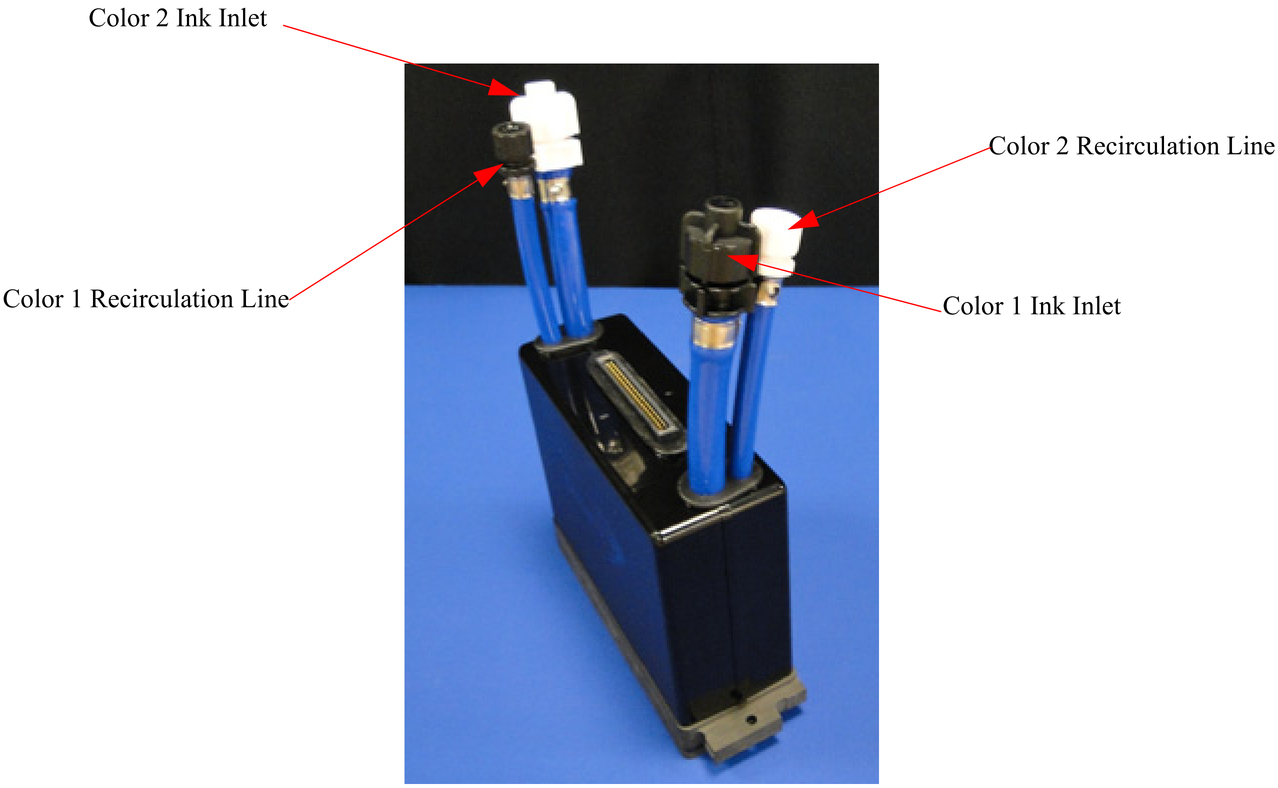


Figure 4-2 SG1024/A-2C printhead – ink connections

1.1 Fluid Fittings – One Color

The fluid fittings provided with the printhead are white and are made of nylon.

For the ink outlet (recirculation) line:

- 1 – Male Luer plug
- 1 – Male tubing adapter 3.2 ID
- 1 – Female Luer cap

For the ink inlet line:

- 1 – Male large taper plug (installed)
- 1 – Male large taper adapter 6.4 ID
- 1 – Female large taper cap

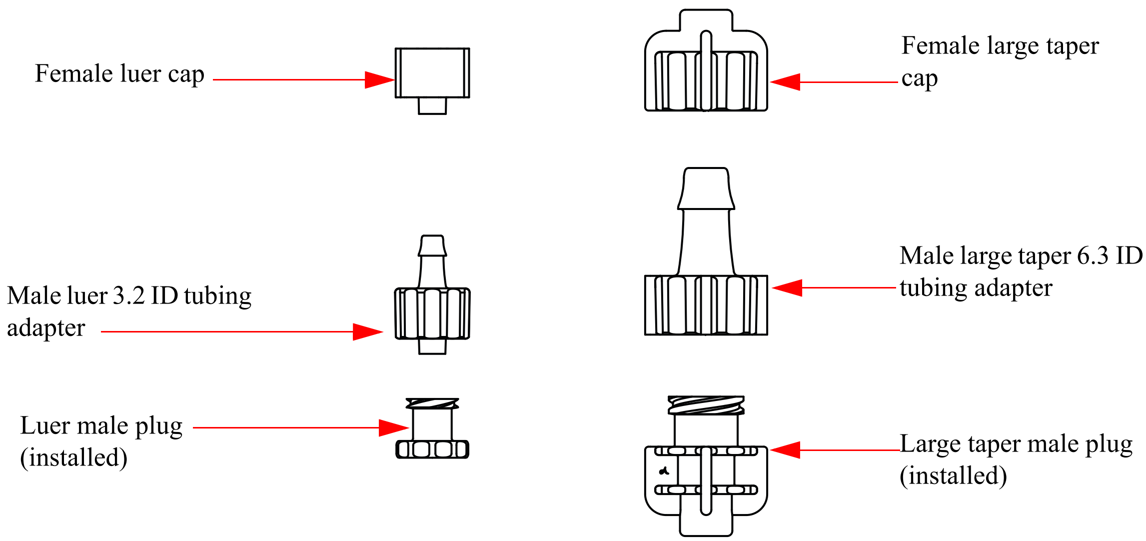


Figure 4-3 Fluid fittings for the SG1024/A

1.2 Fluid Fittings – Two Color

The fluid fittings for the two color printhead have a white set and a black set. They are made of nylon.

For the ink outlet (recirculation) lines a white set and a black set:

- 1 – Male Luer plug
- 1 – Male tubing adapter 3.2 ID
- 1 – Female Luer cap

For the ink inlet lines a white set and a black set:

- 1 – Male large bore taper plug (installed)
- 1 – Male large taper bore adapter 4.8 ID
- 1 – Female large bore taper cap

Note: Take notice that the inside diameter for the ink inlet on the 2 color is smaller than that of the one color.

2.0 Materials Compatibility

Full materials compatibility between the materials used in the printhead and the jetting fluid is absolutely critical for ensuring good performance and long life of the product.

WARNING

It is the Customer's responsibility to ensure that all jetting fluids and flushes are compatible with the materials used in the SG1024 printhead. Compatibility testing should be performed using the intended jetting fluid and flush and the materials in the SG1024 prior to incorporating the printhead into the printer.

The Interface Control Drawing provides a list of materials in contact with the jetting fluid. Samples of these materials can be provided to support ink qualification tests.

Refer to Interface Control Drawings in *Appendix A* for information regarding the fluid interface connections. The following parts of the printhead are in the fluid path.

Table 4-1 Materials in Fluid Path

Material	Component
Resin filled carbon	Actuator body, manifold, and collar
Polyimide (Upilex)	Flink, rock trap
17-7 Stainless Steel	Actuator and collar laminates
303 Stainless Steel	Collar barbs
Coated Nickel	Nozzle Plate
Parylene	Actuator Assembly
Tygon 2375	Ink tubing (blue)
EPDM	O-ring (purple)
Spectra epoxy	Actuator and collar assemblies
Barb Epoxy	Collar assembly
Nylon	Fluid connectors

We have Materials Compatibility Kits (MCK) available for testing the materials in the fluid path with your jetting fluid. See document IN000046, ***PQ, QE, QS AAA and SG1024 Printhead Materials Compatibility Kit (MCK) Instructions*** for information on testing for materials compatibility. Contact your Customer Service representative for more information.

The cover may come into occasional contact with jetting fluids. The following table lists the materials that may have occasional contact with the jetting fluid.

Table 4-2 Cover Materials – Occasional Contact with Jetting Fluid

Material	Part or Assembly
Acetal	Cover
Fluoro Silicone	Cover seals
Liquid Crystal Polymer	Connector housing

3.0 Recirculation

Recirculation provides three main benefits to your print system. It allows for quicker priming times, helps maintain inks that are prone to sedimentation, and it keeps the printhead wetted when handling quick drying inks.

3.1 General Guidelines

When designing a recirculation system it is important to keep a few basic tenets in mind: maintain an outlet pressure of 20 inches H_2O, and a meniscus vacuum of 1 inch H_2O at the nozzle plate with a ±.25 inch H_2O tolerance. Now with that being said, you can actually have outlet pressure from 10 inches H_2O to 50 inches H_2O depending on the jetting fluid, application, and system. The key word is maintain. Whatever pressure is right for your application, it is important that you design your recirculation system to maintain that amount. The same is true for the meniscus vacuum. Regardless of the meniscus vacuum that works for your application it should be maintained within the ±.25 inch H_2O tolerance window.

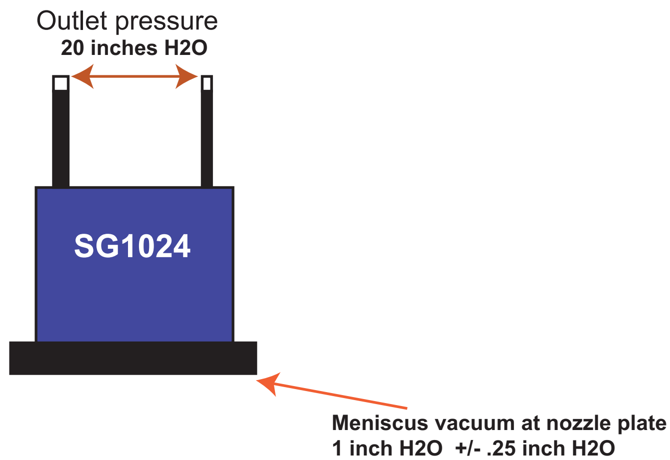


Figure 4-4 Maintained pressures at printhead

IMPORTANT	Certain design considerations should be met for any recirculation system. The outlet pressure should be 20 inches of water, meniscus vacuum fluctuations should be kept low, changes in pressure between reservoir and printhead should be kept low, and the emphasis should be on constant pressure not constant flow.

3.2 Two Reservoir System

The following figure is an example of a two reservoir recirculation system. We call this our mechanical solution. It is the easiest to implement but you may experience some ink bubbling especially with difficult inks. The ink properties of the fluid to be jetted may impact the requirements for your recirculation system.

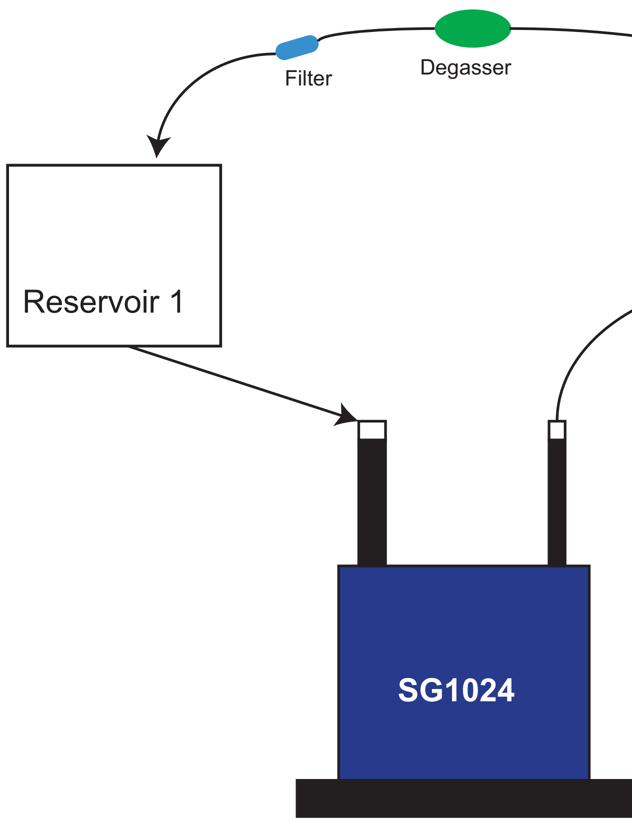


Figure 4-5 Two reservoir recirculation system

The two reservoir system works in the following manner:

1. Ink inlet line carries ink from supply to Reservoir 2.
2. Ink pump draws ink from Reservoir 2. The ink passes through the degassing device to get the air out.
3. It then passes through the filter to remove any impurities.
4. The degassed and filtered ink fills Reservoir 1.
5. Reservoir 1 fills the printhead.
6. The printhead prints then recirculates additional ink to Reservoir 2.
7. As the supply reservoir empties it signals the controller which causes it to refill from the recirculation reservoir and the system regains it equanimity.

For the purposes of our testing we have set the meniscus at head height plus one inch. The recirculation line was set to 50 mb (20 inches of H_2O).

3.3 One Reservoir System

If we call the first example a mechanical solution then this is the electronic solution. This system may be more difficult to implement but once it is set, it is easier to maintain than the two reservoir system. In this example we have only one reservoir, one pump, and two stainless steel pressure transducers that regulate the pressure to make the pump run to maintain the pressures at their intended settings.

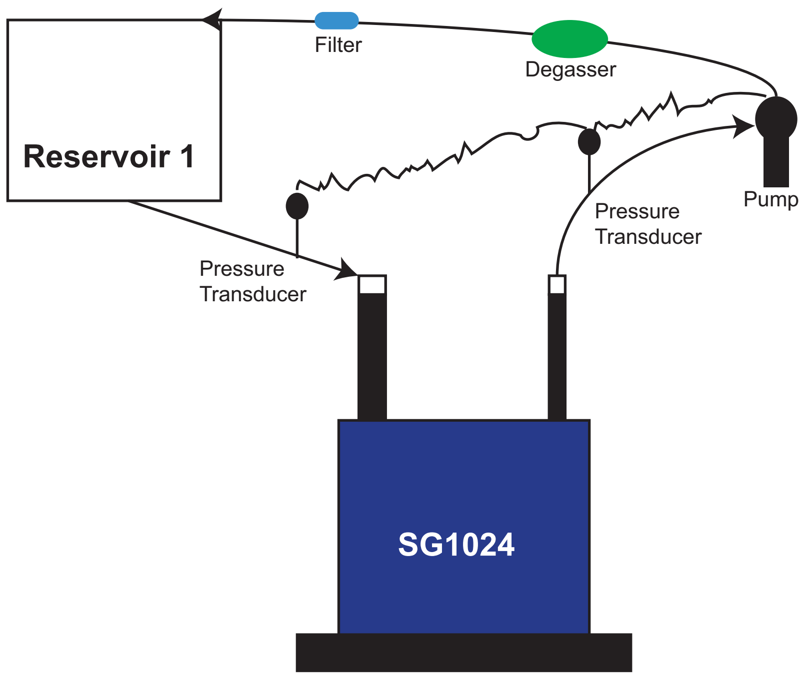


Figure 4-6 Single reservoir with 2 pressure transducers recirculation system

The one reservoir system works in the following manner:

1. Ink inlet line carries ink from supply to Reservoir.
2. Reservoir supplies ink to the printhead.
3. The printhead prints then recirculates additional ink via the pump.
4. The pump draws excess ink from the printhead. The ink passes through the degassing device to get the air out.
5. It then passes through the filter to remove any impurities.
6. The degassed and filtered ink fills the Reservoir.

7. The two stainless steel pressure transducers read the pressure in the two ink lines and report to the micro controller on the control board which in turn signals the pump to maintain the selected pressure. In this case 20 inches H_2O.

Note: We recommend the use of stainless steel transducers as it is compatible with all types of ink.

8. The Reservoir fills the printhead.

The relative costs of the two systems should be about equal.

3.4 Flow Rate

The following chart shows the recirculation flow rate versus the recirculation vacuum. The measurements were taken at 33° C at between 7 and 50 inches of H_2O. The printhead was not jetting during measurement.

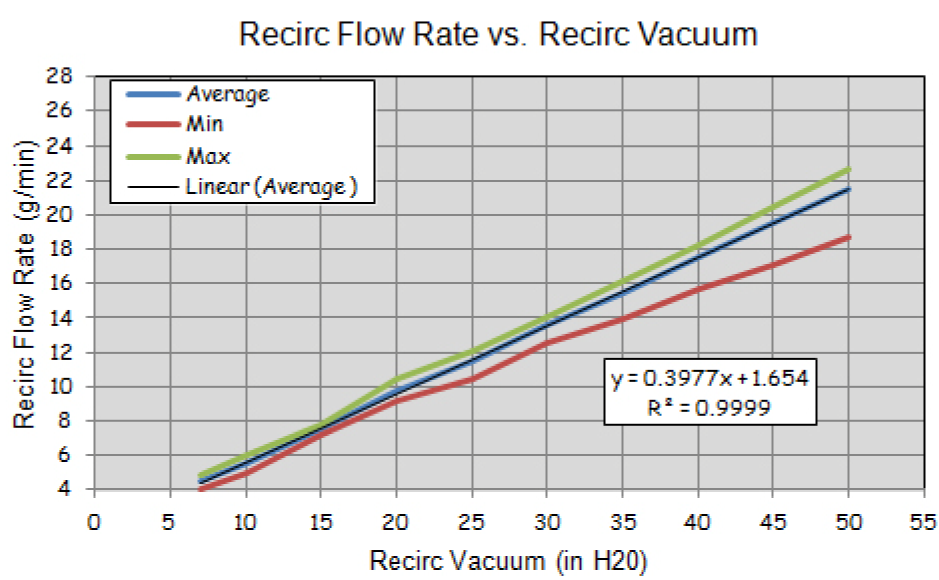


Figure 4-7 Recirculation Flow Rate vs. Recirculation Vacuum

4.0 Fluid Supply

Typical jetted materials for this product are expected to be UV and aqueous inks. The inks can contain both pigments and dyes, and may be slightly conductive. Inks need to contain particles no larger than 2 microns in diameter and be filtered to a 5 micron level upstream of the printhead.

Establishing an efficient and functional fluid supply is crucial for good printhead performance. Long term compatibility with various jetting materials helps applications attain reliable results. The fluid delivery system should be flushed prior to introducing any fluid to the printhead. If this is overlooked it can cause unnecessary problems. Refer to Application Note: *Flushing An Ink Delivery System*, document number AN000053, for an established procedure for flushing the ink delivery system.

4.1 Filtration

Although inks and jetting fluids must be well filtered during the manufacturing and packaging process, Dimatix strongly recommends that jetting fluids also be filtered just upstream of the printhead to the print system. Filtering at this location helps to trap any particles that may have been introduced when tubing was connected or when the printhead was installed. Such additional filtering is necessary because the quality of the jetting fluid is critical to product life and because there is no appreciable filter capacity within the printhead itself.

4.2 Deaeration

High frequency jetting sustainability and initial startup performance require using inks that are not saturated with dissolved air or other gases. Inks can be desaturated in a vacuum chamber and stored in airtight containers, or they can be actively degassed at the time of use in the printhead.

4.3 Degassing Devices

Membrane degassing devices have proven to be highly effective in removing dissolved gases and are easily implemented even within existing ink delivery systems. See Application Note: *Using Membrana Superphobic® Membrane Contactors* (AN000026) for information about degassing devices and their implementation. Check to ensure that jetting fluid is compatible with the degassing device prior to use. We do not recommend the use of a contactor with UV ink.

4.4 Meniscus Vacuum Regulation and Flow Rate

A small, negative pressure (referred to as the meniscus vacuum or meniscus pressure) should be applied at the local ink reservoir in order to establish the proper meniscus shape of the fluid in the nozzles and to prevent weeping of ink from the nozzles. The vacuum at each nozzle should be in the range of 2.5 to 10 mb [1 to 4 inches H_2O]. The elevation difference between the reservoir free surface and the nozzles, multiplied by the ink's specific gravity, should be added to this in order to compensate for the weight of the fluid column.

Variations in the meniscus vacuum can result in image defects, particularly if the frequency of the fluctuation produces a spatial frequency within the range to which the human eye is most sensitive. A change in meniscus vacuum of 2.5 mb [1 inches H_2O] can produce a measurable change in jet output. At 5-12 mb [2-5 inches H_2O] excess vacuum, it is possible to cause jets to ingest air and stop firing. The ink circulation vacuum is less sensitive, with a recommended variation in the ink circulation vacuum of ± 127 mm of H_2O (± 5 inches of H_2O). Therefore, the flow design of the ink supply into the printhead should accommodate the worst case maximum jetting rate (drop mass x number of jets x print frequency x duty cycle), with a pressure drop less than ± 0.5 inches H_2O between the printhead and the free surface of the local ink reservoir.

5.0 Priming the Printhead

The StarFire SG1024/A printhead does not require flushing prior to initial use if used with a jetting fluid compatible with the XL-30 model fluid shipped in the printhead. Please see the section on XL-30 Model Fluid in Appendix C for more information.

5.1 Priming the SG1024

Prior to printing the printhead needs to be primed. The following procedure steps you through the priming procedure. This priming procedure may need to be altered based on your experience with the fluid you are jetting.

Use a Membrana G638 2 inch x 6 inch contactor for degassing the ink prior to it entering the printhead.

The priming procedure:

1. Introduce the ink to the printhead with the recirculation flow disabled to fill the internal plumbing in the printhead and to wet the nozzles.

2. Once the ink is purging freely through the nozzles without any indication of air in the ink, enable recirculation.

3. Run recirculation at -50 mb (-20 inches of H_2O).

4. With recirculation enabled, continue priming with an iterative cycle consisting of:
   a. A low pressure purge (< 300 mb [4.0 psi], approximately 5 seconds).
   b. Followed by wiping the nozzle plate with a clean Texwipe.
   c. Assessment of jets in by firing the printhead onto a test coupon.
   d. A rest period of approximately 5 minutes.
5. After approximately 15 minutes of this routine, perform a final purge-wipe-print cycle.

Prior to initial use of the SG1024/A printhead, use the following steps to prime the printhead.

1. Load with ink.
2. Recirculation off. (Recommended)
3. Perform 2 purges of 2 to 3 second duration at 300 mb [4.0 psi] to ensure surfaces are wetted and air is out.
4. Recirculation running at -50 mb (-20 inches of H_2O).
5. Perform 2 purges of 2 to 3 second duration at 300 mb [4.0 psi].
6. Wipe.
7. Print.

6.0 Jetting Fluid Properties

A complete specification of ink properties is outside the scope of this document. The following list briefly touches on some of the more important characteristics:

WARNING

Jetting fluids and flushes that are highly conductive and/or have a low flash point may pose a danger to the printhead and the operator as hazardous voltages and temperatures are required for printhead performance. Customers contemplating using such jetting fluids and flushes should consult with the fluid supplier to ensure safe operation.

Viscosity – In general terms, less viscous fluids are under-damped, prone to swallowing air during drop ejection at high frequencies, and are likely to produce satellites. More viscous fluids require higher fire pulse amplitudes to eject drops; the higher energy can introduce vibrations that contribute to crosstalk. Also note that the measured bulk viscosity may differ from what the print engine experiences due to shear rate dependencies.

Surface Tension – Adequate surface tension is essential in order to produce well formed drops with minimal satellites and minimal pooling on the nozzle plate.

Open Time – For volatile or self-drying jetting fluids, the open time is a measure of how long the nozzles remain operable if inactive. Inks with an open time of less than one minute can be successfully jetted, provided there are means in place to prevent nozzle drying. For high image quality applications, the relevant open time is defined as how long the jet can remain inactive, yet still produce drops within specification when required. The recirculation function of the SG1024/A printhead has shown to significantly improve open time. You should test this condition when designing your printer.

Methods to control nozzle drying (also known as “decap”) may include:

- spitting each jet into a gutter during scans
- randomly firing jets in white space to exercise each jet
- low frequency jetting while idling
- subpulsing, i.e. driving the jets at all times with pulses of smaller width or amplitude that are too small to produce drops
- using a capping mechanism

Particle Size – The maximum recommended pigment particle size is 2 microns.

Vapor Pressure – Dimatix printheads utilize active refill into the pumping chamber to enable high frequency jetting of relatively high viscosity fluids. The excitation of a channel in the PZT produces a negative pressure pulse to draw the ink into the chamber. High vapor pressure fluids can cavitate during the negative pressure pulse and defeat the pumping mechanism. As an example of the acceptable range, fluids like water and acetates have been successfully jetted, whereas isopropyl alcohol and acetone do not jet properly.

Chapter 5 – Electrical Interface

The electrical interface is accomplished through a single 60 pin connector. All of the external electrical connections to the printhead are made through this connection. The connector is located on the top side of the Head Interface Board and extends through the cover for ease of connectivity. There is a rubber seal around the connector that minimizes the chance of fluid entering the cover.

Figure 5-1 The SG1024/A printhead Dual HIB

The fluid connections are located above the printhead and the above the electrical interface connection. Care should be taken when connecting or disconnecting the fluid and recirculation lines that no significant quantity of fluid flows over the electrical connection.

WARNING

Make sure that when connecting/disconnecting the ink inlet connection or the recirculation connection that no significant amount of fluid is allowed to flow over the electrical interface connection.

The following sections include the electrical connections and their pin-outs as well as information about the Dual Head Interface Board (Dual HIB).

WARNING

Do not connect or disconnect the SG1024 printhead when the 5 V DC logic power is high. This can lead to permanent damage of the printhead and the loss of ability to access the EEPROM. Before connecting or disconnecting the printhead turn off the DC Logic power and allow it to bleed down to 0 V.

1.0 SG1024/A Dual Head Interface Board

The Dual Head Interface Board (Dual HIB) is the main electrical interface for the printhead. It is located inside the printhead cover and under the 60 pin connector. The 60 pin interface located on the top side of the Dual HIB contains all required power, ground, data, and control signal connections, as well as those for the fire pulse.

60 pin connector

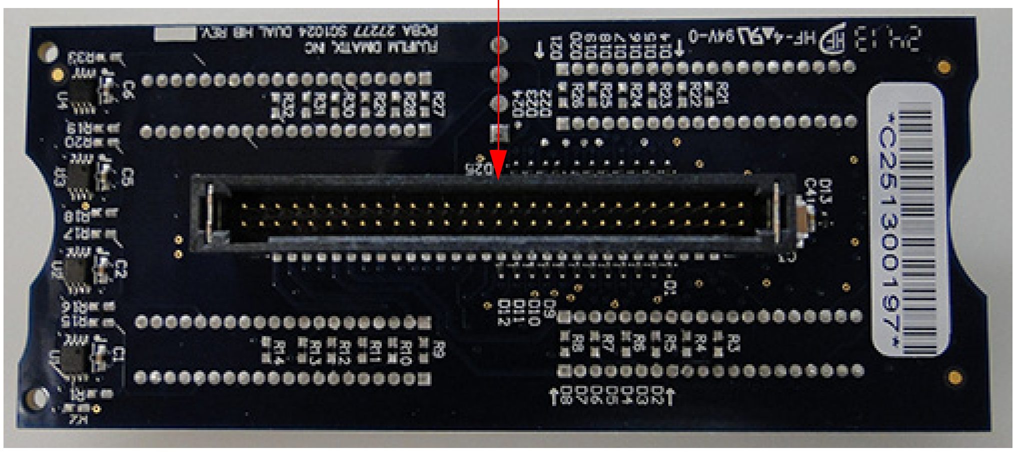
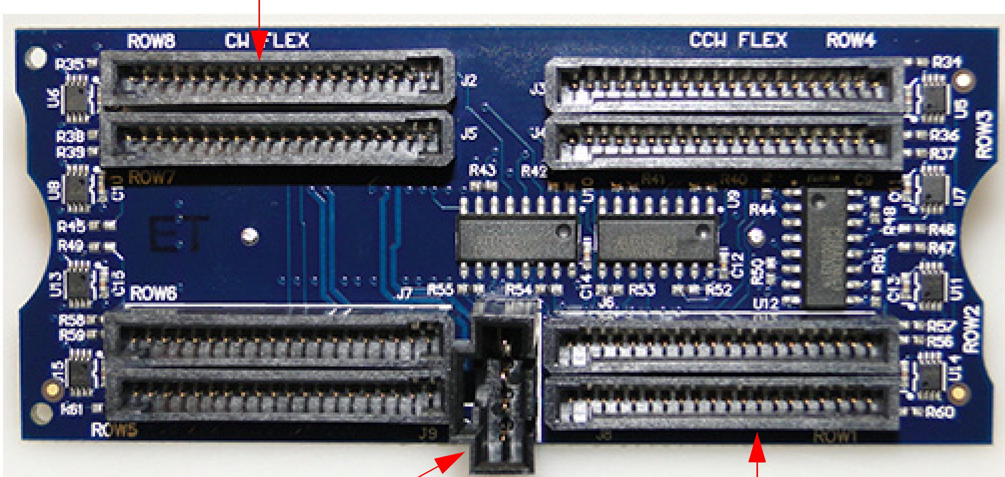


Figure 5-2 Top of Dual HIB

The eight 20 pin connectors on the underside of the Dual HIB are for the eight flexes of the actuator assemblies. It also has a four pin connector for the heater and thermistor. All connections are made at Dimatix prior to shipment.

20 pin connectors for CW flexes (4)



4 pin connector for heater/thermistor

20 pin connectors for CCW flexes (4)

Figure 5-3 Bottom of Dual HIB

1.1 Dual HIB Components

The top side of the board has the main input connector as well as the LVDS receivers and the ESD diodes. The bottom side of the board has 8 connectors for flex connections as well as a 4 pin connector for a thermistor and heater. The bottom side also has a collection of pull up and pull down resistors for address selection on the I^2C interface to each flex. For more information about LVDS, please visit the following National Semiconductor web site: http://www.national.com/assets/en/appnotes/National_LVDS_Owners_Manual_4th_Edition_2008.pdf. For information about the LVDS receiver got to http//www.ti.com/lit/ds/symlink/ds90c032b.pdf and for information about the mating LVDS driver go to http//www.ti.com/lit/ds/symlink/ds90c031b.pdf.

For more detailed information regarding I^2C go to: www.nxp.com/documents/user_manual/UM10204.pdf. For information about the SG1024 flex's EEPROM data format and interface go to Appendix B to review the SG1024 Flex EEPROM Data Format and Interface specification.

2.0 Input Connector (J1)

The Dual HIB assembly has one 60 pin interface connector with 0.050 inch spacing. The connector is keyed with a recess that matches a protrusion on the cable connector to prevent mis-connecting the cable to the Dual HIB.

All of the external electrical connections to the SG1024/A Dual HIB are made through the J1 connector. It accepts the inputs for driving the SG1024/A.

Rubber collar around connector

60 pin input connector - J1

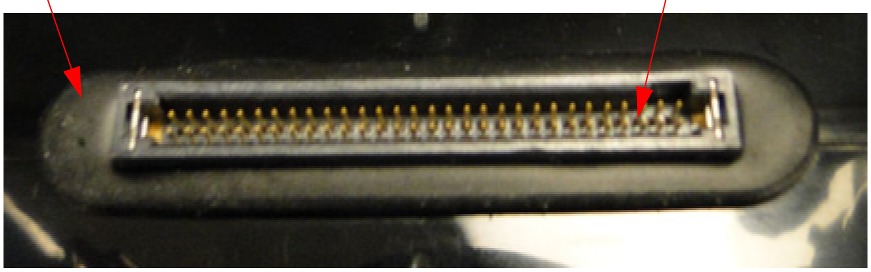


Figure 5-4 J1 connector

The pinouts for the connector are listed in the following table.

Table 5-1 Connector Pin Assignments – Samtec ASP-166916-01

Pin Number	Connection	Description
1	GND	Head Common
2	VCC	5.0 VDC Logic power for driver chips
3	GND	Head Common
4	VCC	5.0V DC Logic power for driver chips
5	CONFIG	Configuration – Low/GND: 1 - color mode – High/VCC: 2 - color mode

Table 5-1 Connector Pin Assignments – Samtec ASP-166916-01

Pin Number	Connection	Description
6	GND	Head Common
7	C1_CLK_N	Negative LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
8	C1_CLK_P	Positive LVDS Data Clock Signal for Color1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
9	C2_CLK_N	Negative LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
10	C2_CLK_P	Positive LVDS Data Clock Signal for Color2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
11	C1_LAT_N	Negative LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
12	C1_LAT_P	Positive LVDS Data Latch Signal for Color 1(Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
13	D0_N	Negative LVDS Data signal serial input for Row 1
14	D0_P	Positive LVDS Data signal serial input for Row 1
15	D1_N	Negative LVDS Data signal serial input for Row 2
16	D1_P	Positive LVDS Data signal serial input for Row 2
17	D2_N	Negative LVDS Data signal serial input for Row 3
18	D2_P	Positive LVDS Data signal serial input for Row 3
19	D3_N	Negative LVDS Data signal serial input for Row 4
20	D3_P	Positive LVDS Data signal serial input for Row 4
21	D4_N	Negative LVDS Data signal serial input for Row 5
22	D4_P	Positive LVDS Data signal serial input for Row 5
23	D5_N	Negative LVDS Data signal serial input for Row 6
24	D5_P	Positive LVDS Data signal serial input for Row 6
25	D6_N	Negative LVDS Data signal serial input for Row 7
26	D6_P	Positive LVDS Data signal serial input for Row 7
27	D7_N	Negative LVDS Data signal serial input for Row 8
28	D7_P	Positive LVDS Data signal serial input for Row 8
29	C2_LAT_N	Negative LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
30	C2_LAT_P	Positive LVDS Data Latch Signal for Color 2 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode) (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
31	GND	Head Common
32	SCL	I^2C Clock signal for Serial Interface
33	GND	Head Common
34	SDA	I^2C Data signal for Serial Interface
35	THB	Printhead Thermistor
36	THA	Pull Up for Printhead Thermistor

Table 5-1 Connector Pin Assignments – Samtec ASP-166916-01

Pin Number	Connection	Description
37	HTRB	Ground for Printhead heater
38	HTRA	Control for Printhead Heater
39	GND	Head Common
40	GND	Head Common
41	HTRB	Ground for Printhead heater
42	HTRA	Control for Printhead Heater
43	GND	Head Common
44	GND	Head Common
45	GND	Head Common
46	FP0	Fire Pule Tied to Row 1
47	GND	Head Common
48	FP1	Fire Pulse tied to Row 2
49	GND	Head Common
50	FP2	Fire Pulse tied to Row 3
51	GND	Head Common
52	FP3	Fire Pulse tied to Row 4
53	GND	Head Common
54	FP4	Fire Pulse tied to Row 5
55	GND	Head Common
56	FP5	Fire Pulse Tied to Row 6
57	GND	Head Common
58	FP6	Fire Pulse Tied to Row 7
59	GND	Head Common
60	FP7	Fire Pulse Tied to Row 8

GND – the common grounds for both logic power and fire pulse.

VCC – the 5 V logic level power connections to the Dual HIB and flexprint assemblies.

CONFIG – this input signal selects the mode of operation. When CONFIG is low, the SG1024 is set to one color mode where all flexprint assemblies are driven by C1_CLK and C1_LAT. When this input is pulled high or left floating, the SG1024 is set to two color mode where the second half of the SG1024 (the clockwise jetting arrays) are driven by C2_CLK and C2_LAT.

C1_CLK, C2_CLK(_N/P) – are LVDS differential signals for clocking the serial data bits into the flexprint driver chips. The Clock signals are converted to single ended and distributed through buffers to the flexprint assemblies. The maximum clock rate allowed is 14 MHz.

C1_LAT, C2_LAT(_N/P) – are LVDS differential signals which controls the transfer (latching) of the data bit values in the flexprint driver chips from the input registers to the driver outputs. The Latch signals are converted to single ended and distributed through buffers to the flexprint assemblies. The data latch occurs on the logic low-to-high edge transition. When a logic **1** is transferred to a driver output, it will connect its respective ink jet cell circuit to the flexprint ground plane and enable that piezo cell to fire when the high voltage fire pulse waveform is applied.

D0-7_N/P – are differential signals which are converted to single ended and sent to one of the flexprint assemblies.

SCL – is a logic level signal which provides the clock to an I^2C interface. This interface is for an on board PIC on each flexprint assembly.

SDA – is a logic level signal which provides the data to an I^2C interface. This interface is for an on board PIC on each flexprint assembly.

THB – is the ground side of the thermistor which is central to the carbon body of the printhead.

THA – is the pull up side of the thermistor which is central to the carbon body of the printhead.

HTRB – is the ground side of a heating element which is central to the carbon body of the printhead. There are two pins for this connection which are used to split the current handling should a 25 W+ heater be used.

HTRA – is the control side of a heating element which is central to the carbon body of the printhead. There are two pins for this connection which are used to split the current handling should a 25 W+ heater be used.

FP1-7 – are the eight high voltage fire pulse signals. Each one is distributed to a flexprint assembly.

2.1 Output Connectors J2-9

The connections to the flexprint assemblies are through a 20 pin connector located on the bottom side of the Dual HIB. The following table describes the connections.

Table 5-2 Connector J2-9 Description

Pin Number	Connection	Description
1	FIREPULSE	Array return for PZT
2	FIREPULSE	Array Return for PZT
3	NC	
4	NC	
5	Ground	Ground/driver chip common
6	SA02	I^2C Serial Address 2
7	SA01	I^2C Serial Address 1
8	SA00	I^2C Serial Address 0
9	SCL	I^2C Serial Clock
10	SDA	I^2C Serial Data
11	Ground	Ground/driver chip common
12	Ground	Ground/driver chip common
13	DATA_IN	Data signal input for all 128 HV outputs
14	DATA_OUT	Data signal input for all 128 HV outputs
15	Ground	Ground/driver chip common
16	LATCHn	Data Latch Signal for driver chips – this control signal is shared by all 4 driver chips
17	Ground	Ground/driver chip common
18	CLOCK	Data Clock Signal for driver chips – this clock signal is shared by all 4 driver chips
19	Ground	Ground/driver chip common
20	VCHIP	5.0 V DC Logic power for driver chips

2.2 Heater Connector J10

The SG1024 printhead has a thermal zone comprised of 1 thermistor and 1 heater, which are attached to the 4-pin C-Grid connector located on the bottom of the Dual HIB. The following table describes the connections.

Table 5-3 Heater Connector J10 Description

Pin Number	Connection	Description
1	THA	Pull up for printhead thermistor
2	THB	Printhead thermistor
3	HTRB	Ground for printhead heater
4	HTRA	Control for printhead heater

2.3 Bundling the Cable

When connecting the cable to the SG1024 printhead connector, the wires for the cable should be bundled such that the eight fire pulses and their grounds are separate from the rest of the lines. The energy from the return path on the fire pulse couples into the digital grounds and distorts them. Separation prevents this from occurring.

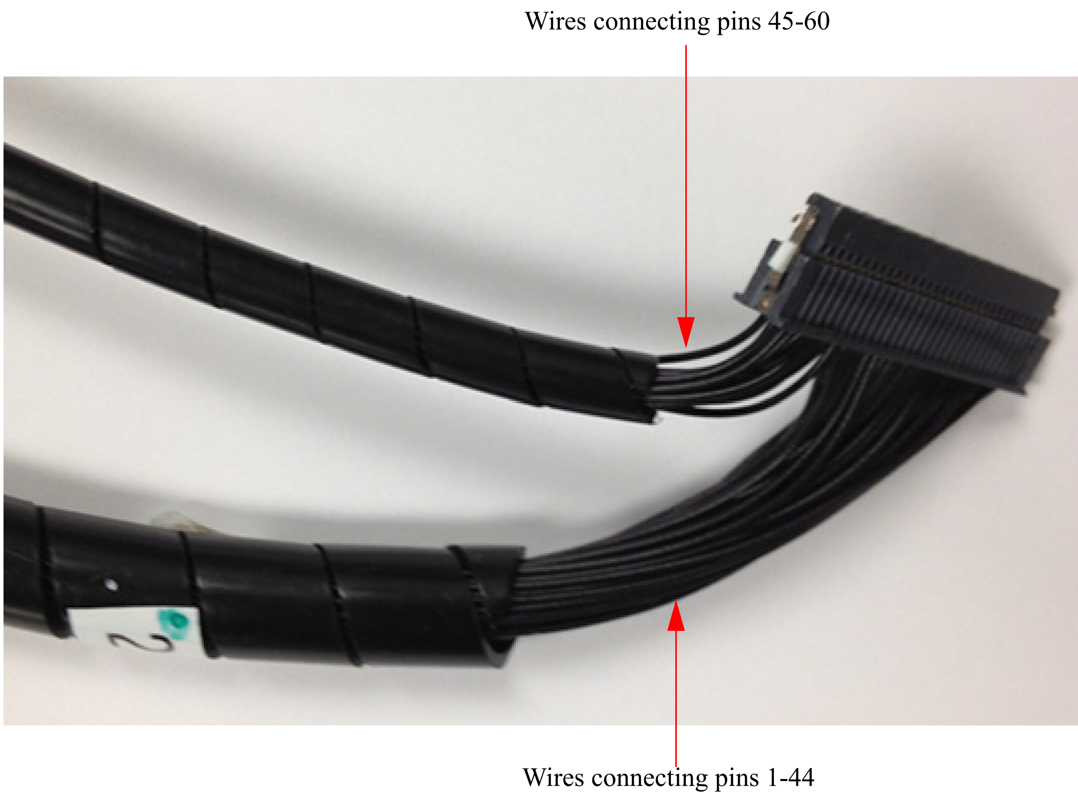


Figure 5-5 Proper bundling of cabling for SG1024 printhead J1 connection

2.4 Ordering the Cable and Mating Connector

To order the Samtec mating connector and cable to complete the electrical interface go to the Samtec web site at www.samtec.com. The part number of the connector we use on our HIB is **ASP-166916-04**. If you want to order the mating connector and either a 12 inch or 24 inch cable, use the following numbers:

REF-175679-01 – mating connector and 12 inch cable.

REF-177149-01 – mating connector and 24 inch cable.

Samtec has worldwide distribution of their products. The listed part number is available through these varied locations throughout the world. To find the nearest Samtec supplier go to their website and at the Home Page scroll down to where it says CONTACT US.

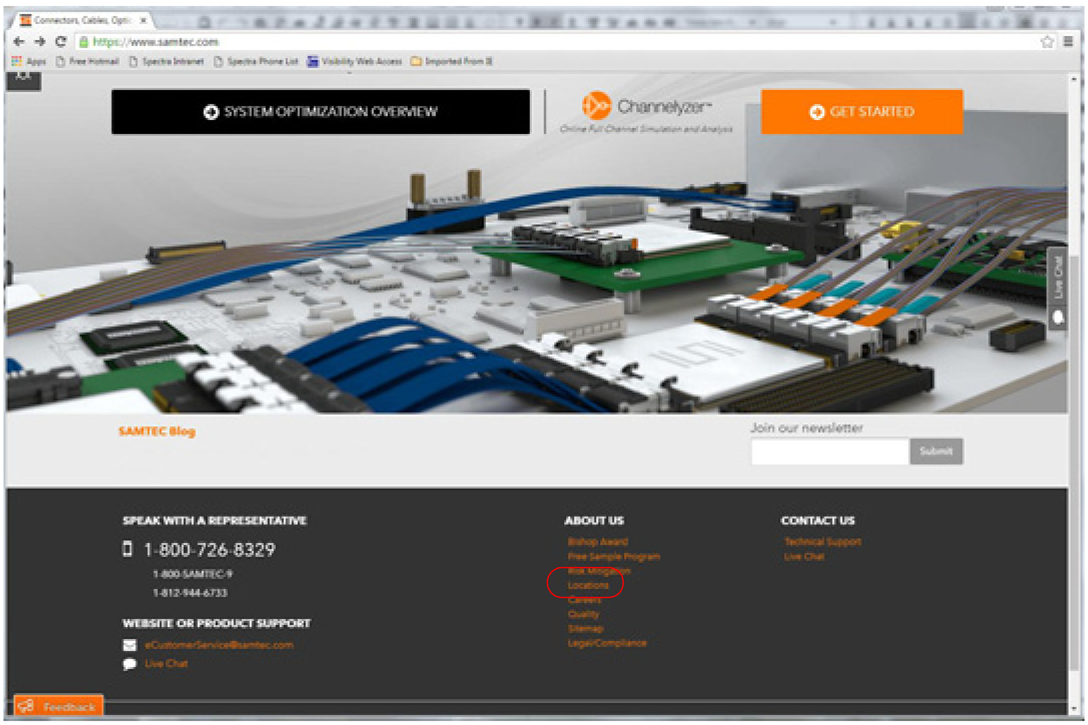


Figure 5-6 Samtec Home page

Under the heading CONTACT US, select location. This takes you to the Samtec Location screen where you can select the region you are interested in.

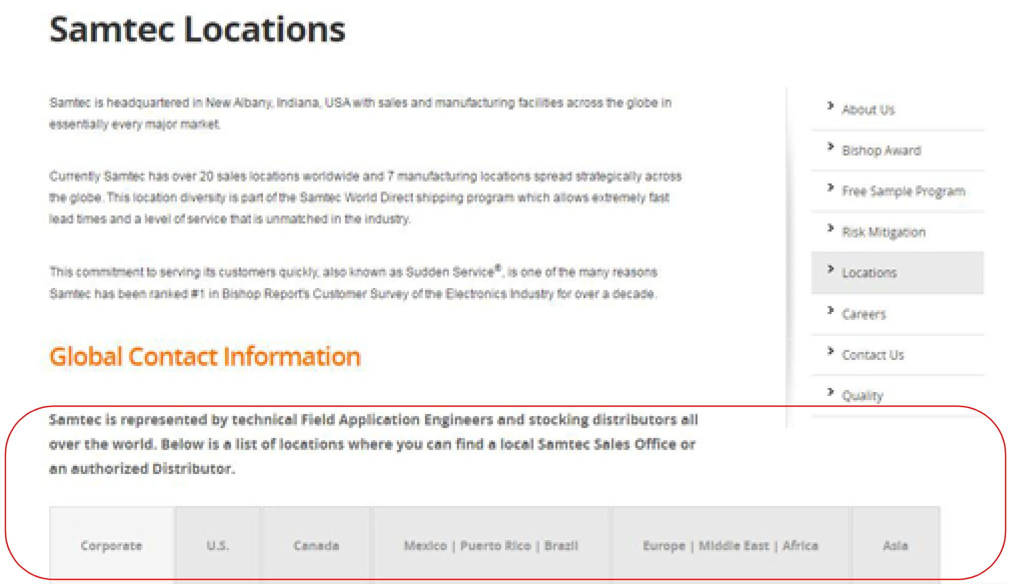


Figure 5-7 Samtec location screen

Click on your region and a scrollable list is generated for the selected region.

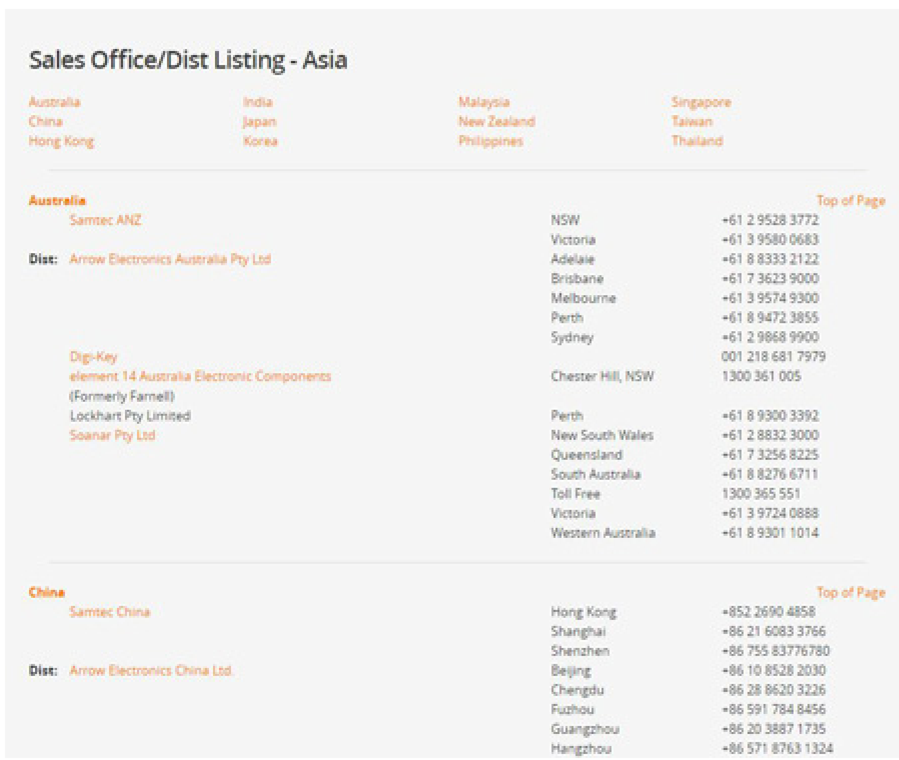


Figure 5-8 Partial listing Samtec representatives in Asia

3.0 General Considerations

3.1 Grounding

WARNING

For the safety of the equipment operators and of the equipment, and for compliance with IEC safety standards, any printhead must be earth grounded at all times during operation of the equipment. Any OEM product cover should include recognized safety labeling for electrical shock hazard. The cover should be electrically resistive and prevent operator contact with any electrical hazard on the printhead.

The printhead is grounded through its contact with the carriage. Please refer to the ICD in Appendix A for more information.

3.1.1 ESD Drain

The ESD drain is accomplished through its contact with the carriage.

3.2 Fire Pulse Considerations

3.2.1 Fire Pulse Amplitude

Refer to the calibrated voltage value on the coupons (included with the printhead) for determining the nominal FPA with model fluid for each module. The amplitude may need to be adjusted to accommodate for ink properties and printhead to printhead variations.

3.2.2 Fire Pulse Width

The printhead can operate over a broad range of pulse widths.

3.2.3 Fire Pulse Rise Time

The performance of the printhead is relatively insensitive to this parameter, with variations ranging from the minimum to the maximum recommended values having minimal impact. The specified typical value represents the operating point where Dimatix has the most experience for this product.

Note: A value of 35-40 V/µs is recommended for the rise time. We have not found any performance differences by making this faster.

3.2.4 Fire Pulse Fall Time

As with the fire pulse rise time, the upper limit of the fire pulse fall time is determined by the current limit of the driver chip. Variation of this parameter can affect drop formation. However, most applications are able to more easily control drop formation through other changes in the operating conditions, including fire pulse amplitude and width, temperature, and jetting fluid physical properties. The specified typical value represents the operating point where Dimatix has the most experience for this product.

Note: A value of 35-40 V/µs is recommended for the rise time.

4.0 Operating Modes and Timing Requirements

The printhead can operate at a wide range of data and jetting frequencies, and supports four (4) modes of operation.

WARNING

Under no circumstances should the driver chip outputs be made to change state while a fire pulse is active or damage to the Dual HIB or PZT array may occur.

4.1 Serial Data Timing

Each PZT flex assembly has 1 serial data input line. To completely load all (128) driver chip outputs with new image data, a series of one hundred and twenty eight (128) clock pulses must be used in coordination with appropriate data bit values on this data line (4 x 32 bits = 128 output bit values). One serial data line is daisy chained through all four driver chips on the flex.

Refer to the following diagram and table for data sequencing.

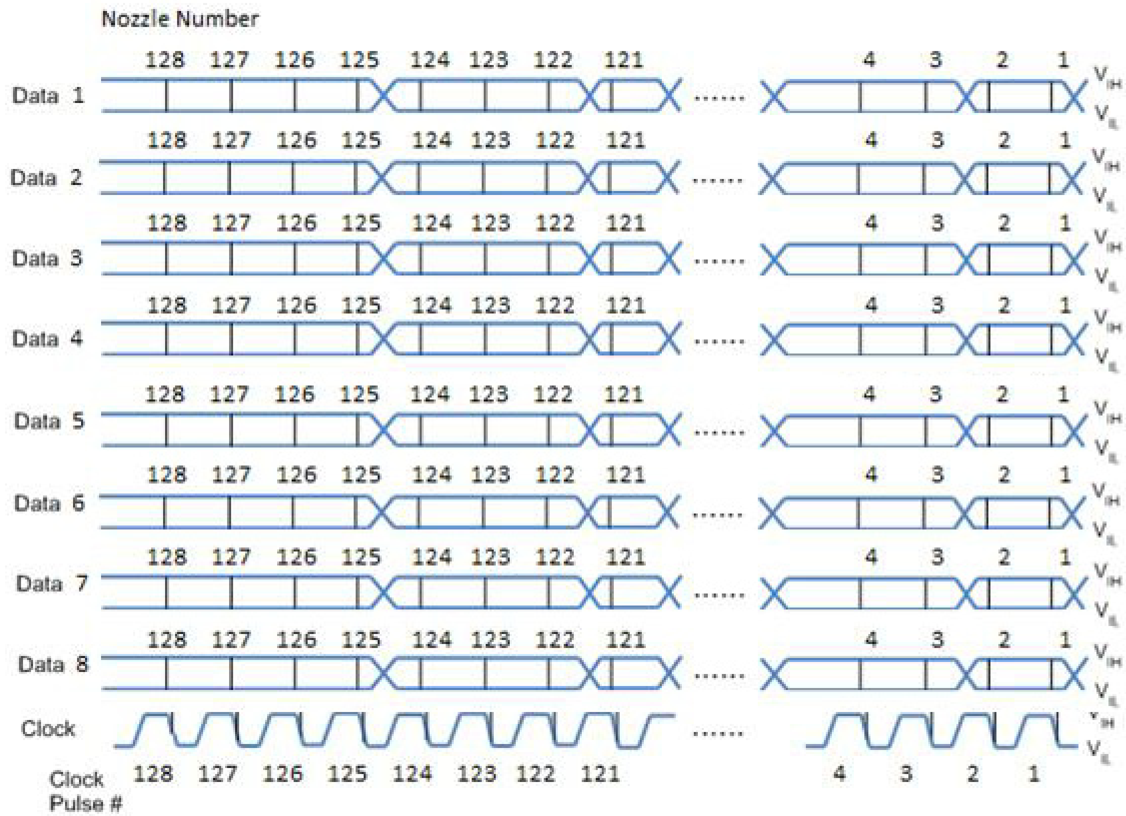


Figure 5-9 Data sequencing diagram

This sequence loads data into all 32 driver chips. Data transfer to the driver chip outputs follows one of two modes: Transparent Latch Mode or Latched Data Mode. To use Transparent Latch Mode, hold the Data Latch input at V_{IH} level (1) while clocking in serial data. During data clocking the output states of the driver chips change after each new data bit shifts in. To use Latched Data Mode, hold the Data Latch input at V_{IL} level ("0"), clock in all data, then raise the Data Latch signal. Driver chip outputs remain in their previous state until Data Latch is raised, permitting data transmission during periods of high fire pulses. These operating modes and their respective timing diagrams are described in further detail in the following sections.

WARNING

Changing the output state of the driver chips during an active fire pulse can destroy the driver chips and/or associated circuitry on the jetting assembly.

To avoid possible timing violations which could damage data or jetting controller circuitry, maintain a 1 µs (microsecond) gap between the start or end of a fire pulse and the changing of the output data of the jetting assembly. This 1 µs gap is shown in Figure 5-10 as timing interval **T2**.

The Dual HIB Driver Output Timing figure shows a simplified single pulse fire pulse waveform and the timing windows (green) during which it is safe for the driver outputs to change state. The time interval needed to load the driver chips with data (**T1**) is 32 data bits/16 MHz = 2 µs. The maximum fire pulse rate is **T1** + 2 x **T2** + **T3** = **T4**. The timing can be relaxed if the print rate allows (i.e. clock can be less than 16 MHz).

The following are examples of clock/print rates.

Parameters:
Print Rate: 50 kHz
Grey levels: 4
Bits to Encode Grey Level: 2

Number of nozzles	Fire Pulse Frequency (kHz)	Fire Pulse Period (µs)	Fire pulse Period Minus T2 Safety Margin	Required Minimum Clock Frequency (MHz)	Comments
128	100	10	8	16	This is the MAX clock rate for the printhead but is not suitable for printing.

Parameters:
Print Rate: 16 kHz
Grey levels: 4
Bits to Encode Grey Level: 2

Number of nozzles	Fire Pulse Frequency (kHz)	Fire Pulse Period (µs)	Fire pulse Period Minus T2 Safety Margin	Required Minimum Clock Frequency (MHz)	Comments
128	32	31.25	29.25	4.376	This is the MAX print rate for grey scale printing.

Parameters:
Print Rate: 30 kHz
Grey levels: 2
Bits to Encode Grey Level: 1

Number of nozzles	Fire Pulse Frequency (kHz)	Fire Pulse Period (µs)	Fire pulse Period Minus T2 Safety Margin	Required Minimum Clock Frequency (MHz)	Comments
128	**30**	**33.333**	**31.333**	**4.085**	**This is the MAX print rate for binary printing.**

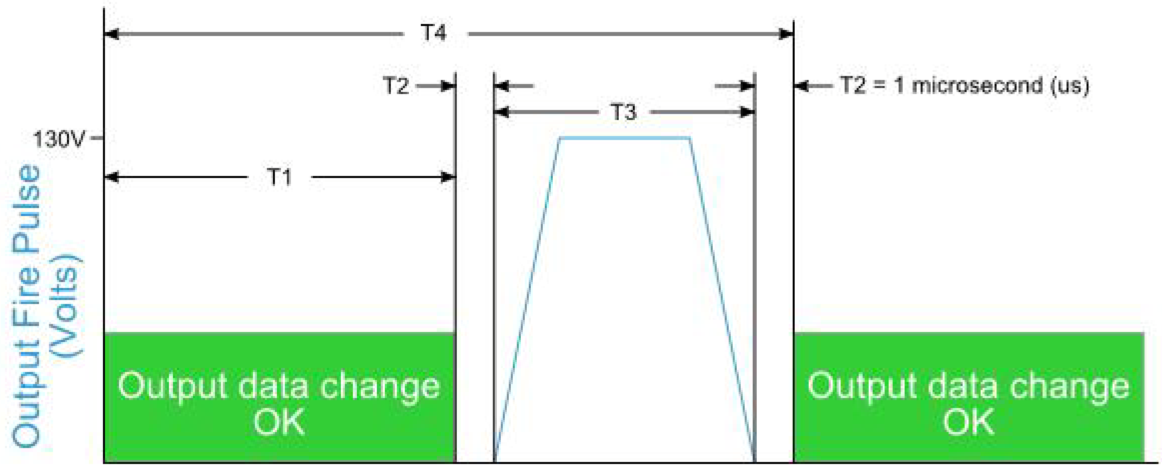


Figure 5-10 Dual HIB Driver Output Timing

Supported Dual HIB operation modes and their timing requirements are described in the following sections.

4.2 Jet Mapping

The following table show the jet mapping for both the one color printheads and the two color printheads. The jet numbers shown in the tables are fixed and are not dependent on the orientation of the printhead or the print direction. The pixel numbers are dependent on printhead orientation and print direction.

Table 5-4 Jet Mapping Data for SG1024 1-Color

Row	Jets	Connector Pin	Pixel Numbers (Column)
1	2, 10, 18, 26, ..., 1018	13, 14	1022, 1014, 1006, ..., 6
2	6, 14, 22, 30, ..., 1022	15, 16	1018, 1010, 1002, ..., 2
3	1, 9, 17, 25, ..., 1017	17, 18	1023, 1015, 1007, ..., 7
4	5, 13, 21, 29, ..., 1021	19, 20	1019, 1011, 1003, ..., 3
5	3, 11, 19, 27, ..., 1019	21, 22	1021, 1013, 1005, ..., 5
6	7, 15, 23, 31, ..., 1023	23, 24	1017, 1009, 1001, ..., 1
7	4, 12, 20, 28, ..., 1020	25, 26	1020, 1012, 1004, ..., 4
8	8, 16, 24, 32, ..., 1024	27, 28	1016, 1008, 1000, ..., 0

Table 5-5 Jet Mapping Data for SG1024 2-Color

Row	Jets	Connector Pin	Pixel Numbers (Column)
1	C1-J1,C1-J5,...C1-509	13, 14	C1: 511,507,503,...3
2	C1-J3,C1-J7,...C1-511	15, 16	C1: 509, 505, 501,...1
3	C1-J2,C1-J7,...C1-J510	17, 18	C1: 510, 506, 502,...2
4	C1-J4,C1-J8,...C1-J512	19, 20	C1: 508, 504, 500,...0
5	C2-J1,C2-J5,...C2-509	21, 22	C2: 511,507,503,...3
6	C2-J3,C2-J7,...C2-511	23, 24	C2: 509, 505, 501,...1
7	C2-J2,C2-J6,...C2-J510	25, 26	C2: 510, 506, 502,...2
8	C2-J4,C2-J8,...C2-J512	27, 28	C2: 508, 504, 500,...0

4.3 Transparent Latch Mode

This is the simplest normal operational mode of the SG1024/A because the Data Latch input is held at a constant logic level 1 (> 4.0VDC). In this mode, data bits are transferred directly from the 32-bit input shift registers of each driver chip to the outputs during serial data loading. While this has the advantage of simplicity, it has the disadvantage of driver outputs changing state during the clocking of the serial data.

As a safety margin, users should provide a one microsecond (1 µs) time window starting immediately before and extending until one microsecond (1 µs) after a fire pulse waveform during which the Data Latch must not transition from logic ‘0’ to logic “1”. Clocking of serial data into the SG1024/A may occur at any time that does not conflict with this time window.

Transparent Latch Mode may present undesirable limitations depending upon the jetting frequency demands of the system. In this situation, the Latched Data Mode of operation can be used. On this assembly polarity and blank are not brought out to the connector but they are pulled to a logic level HIGH using pull up resistors. If Latch is left high this mode is enabled. If latch is driven low, the device is in transparent latch mode.

Table 5-6 Transparent Latch Mode Function

Datax	Clock	Data Latch	Blank	Polarity	Driver Output
0	↓	1	1	1	0
1	↓	1	1	1	1

X = Don't Care (not applicable)

1 = Logic Level "1" (Vin > 4.0V)

0 = Logix Level "0" (Vin < 1.0V)

↓ = Falling Edge signal

Timing diagrams of the Transparent Latch Mode of operation follow.

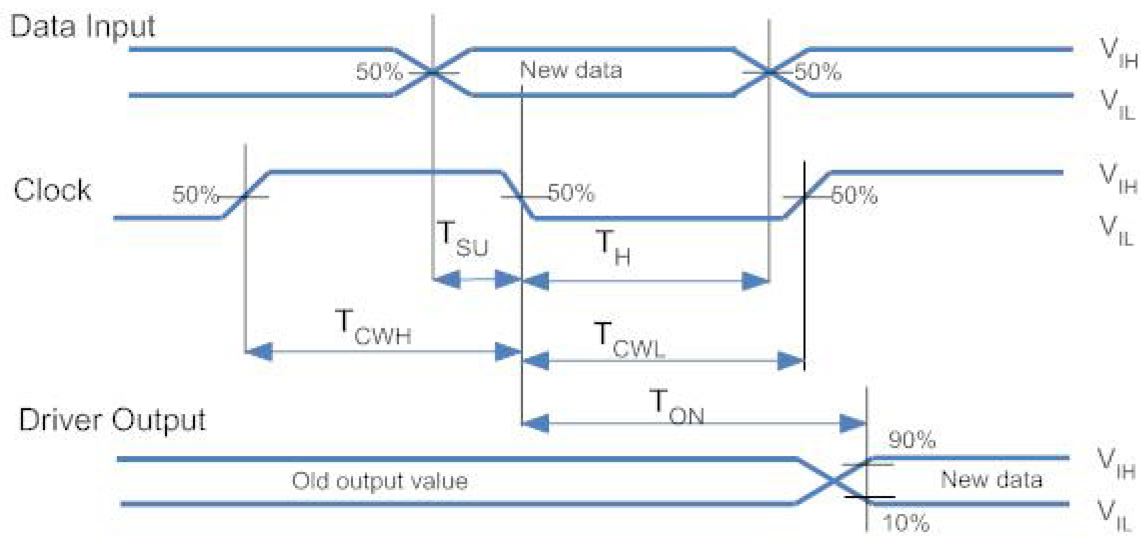


Figure 5-11 Transparent Latch Mode Timing Diagram

Table 5-7 Transparent Latch Mode Timing(VCHIP = 5.0V, T_{AMB} = 25C)

Symbol	Parameter	Min	Typ	Max	Units
T_{CWH}	Clock High pulse width	-	31.25	-	ns
T_{CWL}	Clock Low pulse width	-	31.25	-	ns
T_H	Data Hold Time after ↓clock edge	10	-	-	ns
T_{SU}	Data Setup Time before ↓clock edge	25	-	-	ns
T_{ON}	Turn on time for driver output	-	-	400	ns
F_{CLK}	Clock Frequency	-	-	16	MHz
C_{INDatx}	Data Input pin capacitance	-	-	30	pF
C_{INCL}	Control/Clock Input pin capacitance	-	-	200	pF

4.4 Latched Data Mode

On this assembly polarity and blank are not brought out to the connector but they are pulled to a logic level HIGH using pull up resistors. Latched Data Mode provides maximum timing flexibility because serial data may be clocked into the SG1024/A during the fire pulse. Driver chip outputs do not change state until the Data Latch input transitions from logic “0” to logic “1”.

Data bits may be safely clocked into the driver chips at any time provided Data Latch remains LOW; the driver outputs are isolated from the input shift register by the internal latches. This provides the flexibility of clocking the data into the SG1024/A at almost any time, as long as the Data Latch signal is held at logic level “0” and only allowed to transition to logic level “1” during a “safe” window of time in which no fire pulse waveform is active on the SG1024/A.

As a safety margin, users should provide a one microsecond (1 usec) time window starting immediately before and extending until one microsecond (1 usec) after a fire pulse waveform during which the Data Latch must not transition from logic 0 to logic 1. Latching of serial data into the SG1024/A may occur at any time that does not conflict with this time window.

Latched Data Mode can provide greater total throughput than Transparent Latch Mode.

Table 5-8 Latched Data Mode Function

Datax	Clock	Data Latch	Blank	Polarity	Driver Output
0	1 or 0	↑	1	1	0
1	1 or 0	↑	1	1	1

X = Don't Care (not applicable)

1 = Logic Level "1" (Vin > 4.0V)

0 = Logix Level "0" (Vin < 1.0V)

↑ = Rising Edge signal

Timing diagrams of the Latched Data Mode of operation are shown here.

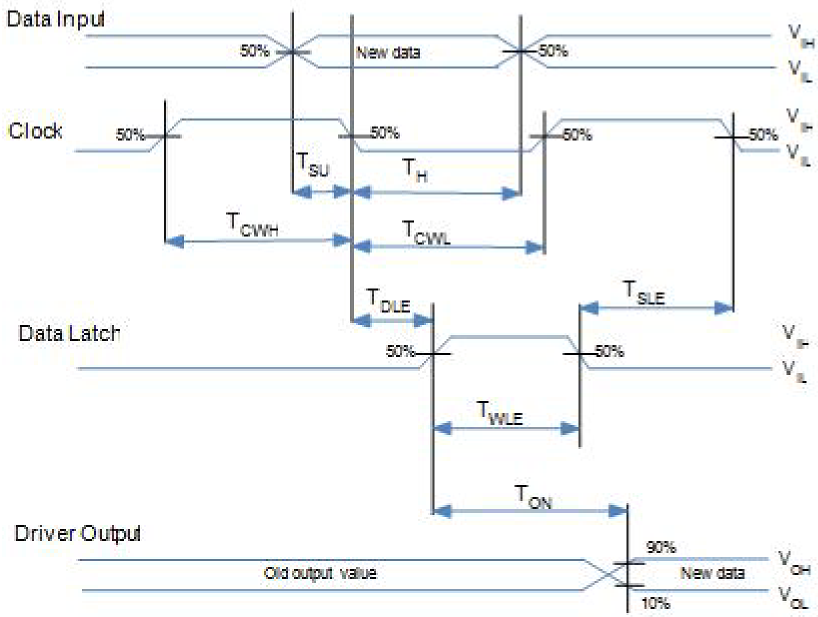


Figure 5-12 Latched mode timing diagram

Table 5-9 Latched Data Mode Timing (VCHIP = 5.0V, T_{AMB} = 25° C)

Symbol	Parameter	Min	Typ	Max	Units
T_{CWH}	Clock High pulse width	-	31.25	-	ns
T_{CWL}	Clock Low pulse width	-	31.25	-	ns
T_H	Data Hold Time after ↓clock edge	10	-	-	ns
T_{SU}	Data Setup Time before ↓clock edge	25	-	-	ns
T_{DLE}	Delay Time from ↓clock edge to ↑Data Latch edge	20	-	-	ns
T_{WLE}	Width of Data Latch pulse	20	-	-	ns
T_{SLE}	Data Latch Setup Time before ↓clock edge	20	-	-	ns
T_{ON}	Turn on/off time for driver output	-	-	400	ns
F_{CLK}	Clock Frequency	-	-	16	MHz
C_{INDatx}	Data Input pin capacitance	-	-	30	pF
C_{INCL}	Control/Clock Input pin capacitance	-	-	200	pF

5.0 Technical Specifications of the Dual HIB

This section provides environmental and recommended operating parameters for the Dual HIB. For proper operation of the Dual HIB, it is recommended that storage and operation only occur under the following conditions.

5.1 Operating Voltages and Conditions

The Dual HIB is designed to be operated with the following recommended voltage levels and frequency limits.

Table 5-10 Operating Voltages and Conditions

Symbol	Parameter	Min	Typ	Max	Units
V cc	Logic Supply Voltage	4.75	5.0	5.5	V
V_{IL}	Data/Control Input Low Level Voltage	0	-	0.2*Vcc	V
V_{IH}	Data/Control Input High Level Voltage	0.8*Vcc	-	V cc	V
Fire Pulse	Fire Pulse Voltage	-0.5	-	130	V
Slew Rate	Fire Pulse Voltage slew rate	-	-	80	V/µs
Clock Frequency	Serial Data Clock frequency	-	-	14	MHz

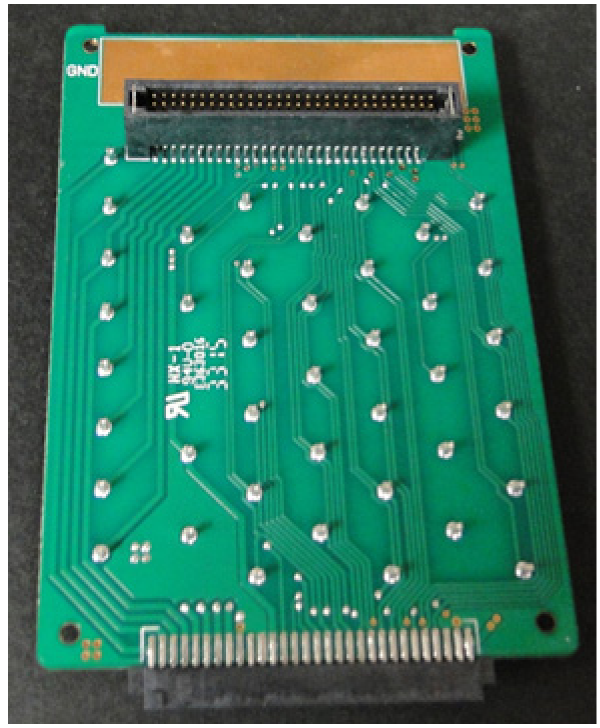
Chapter 6 – Maintenance

1.0 Break Out Board

The SG1024 break out board is a test board designed to connect in-line between a bundled cable and the SG1024 HIB. Its purpose is to "break out" each conductor to a test point that can be interfaced with an oscilloscope for signal analysis. All the signals that are transmitted and received by the printhead may be analyzed. These signals include:

- VCC
- clock
- data
- latch
- Fire pulse
- Heater
- Thermistor
- Config

Front view



Back view

Figure 6-1 SG1024 Breakout board

The breakout board is encased in plastic for its protection when handling and from ink. The J1 connection to the HIB is located at the bottom of the board and the J2 connection for the bundled cable is on the back of the board.

Break out Board in case – front view

J2 Connection to bundled cable

J1 Connection to HIB

Break out Board in case – back view

Figure 6-2 Break out boards in cases

Once the board is connected to the HIB and the bundled cable then the oscilloscope can be connected to the appropriate signal pin for testing. The signal pins are on the front of the board and are clearly marked for making the connections for testing.

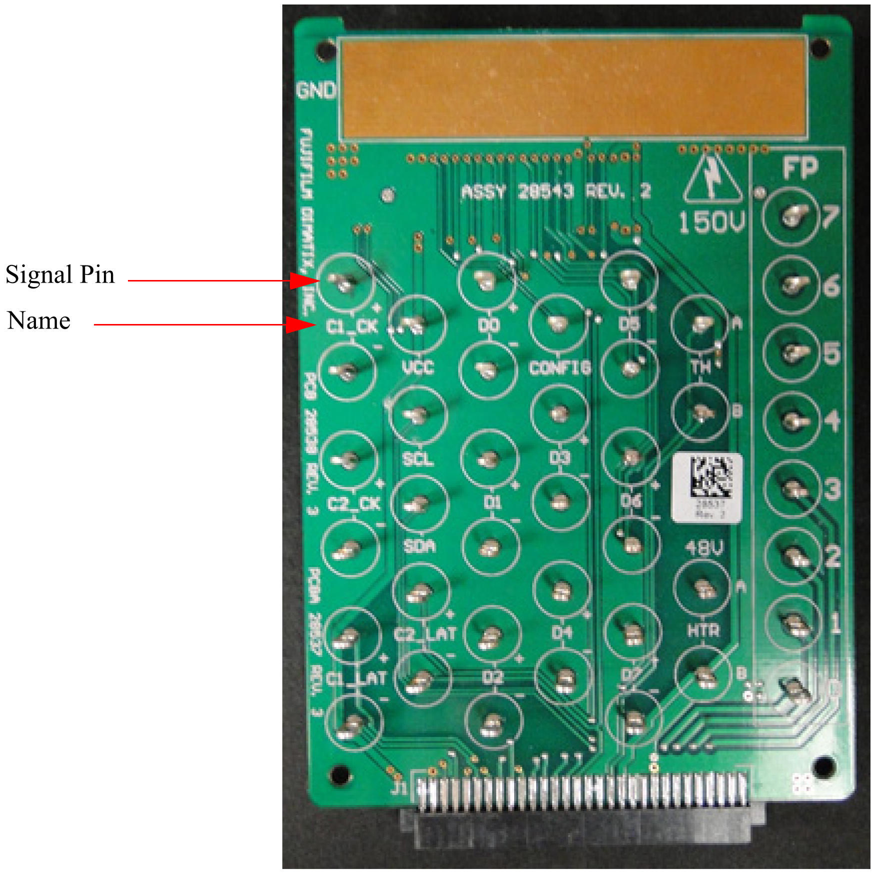


Figure 6-3 Signal pin locations and names

2.0 Purging

2.1 Air Pressure Purge

Air Pressure purges are commonly used because they are simple to implement. Typically a regulated pressure is applied for a fixed amount of time at the air interface to the ink reservoir attached to the printhead. The amount of pressure and the length of time are dependent on the intended purpose of the purge.

2.1.1 Long Purge

A long purge is used to push air bubbles out of the nozzles, transfuse deaerated ink into the printhead (in implementations where a lung is employed), and to clear clogs. A long purge is typically part of the startup procedure. When a lung is used, the ideal volume displacement is a function of lung capacity and downstream internal ink volume. The purge pressure and duration (psi-seconds) can be established once the printhead flow resistance has been determined.

2.1.2 Short Purge

A short purge is used to flush debris from the nozzles and re equilibrate meniscus (especially after wiping). In a short purge, very little fluid is expelled compared to a long purge.

For either type of purge, the applied pressure must be greater than the rock trap bubble pressure of 65 mb [1.0 psi]. Empirically, Dimatix has had good results with a purge pressure as low as 100 mb [1.5 psi], although a higher pressure up to 300 mb [4.0 psi] is recommended for initial priming and wetting of internal surfaces.

2.1.3 Vacuum Purge

An alternative to a pressure purge is the vacuum purge. In a vacuum purge, an airtight seal is formed around the nozzles and a vacuum is applied. The same strategies as described for the pressure purges apply. Because of the difficulty in providing a good face seal, vacuum purges are typically not implemented except in systems where capping is also required.

3.0 Wiping

Wiping is a common maintenance procedure to clear debris and reestablish uniform wetting around the nozzles.

3.1 Manual Wiping

For manual wiping, use a clean, cleanroom wipe. Wiping materials must be compatible with printhead materials and jetting and maintenance fluids. Manual wiping may be performed on a routine preventative basis or only after a jetting anomaly is detected. Manual wiping requires good operator training and discipline to prevent unnecessary damage to the printhead.

3.1.1 Manual Wiping Technique

When wiping the nozzle plate the clean room wipe may become frayed. To minimize the chance of fraying the wipe and dragging debris into the nozzles, we highly recommend the following wiping technique.

1. Place wipe in middle of the nozzle plate.

2. Wipe in one direction.
3. Remove wipe from nozzle plate and fold the wipe to expose a clean surface.
4. Place wipe in middle of nozzle plate and wipe in the opposite direction.

4.0 Capping

Volatile or self-drying inks may require capping when not in use to prevent build-up around nozzles. Periodic jetting of ink while not printing can extend the time before capping must take place. Elastomeric material selection must take into consideration long-term materials compatibility. If capping is required, the addition of a vacuum purge capability to the cap can be useful and easily implemented. See the ICD in Appendix A for specific capping instructions.

5.0 Flushing

The flushing process displaces the application ink and clears all ink passages within the printhead and nozzle plate. This is done for several reasons: clearing clogged jets, ink changeover, short or long term storage.

5.1 Flushing Guidelines

The flushing procedure is dependent on a number of variables that determine the temperature to flush at, the type of flush needed, the volume of flushing fluid required, the time required to flush the printhead, whether you use vacuum to pull the fluid or pressure to push the fluid. The following guidelines provide a base line to build your own method based on your requirements.

- **Soaking** – It may be necessary to soak the printhead in ink prior to flushing, if the printhead has been sitting for a while. This is dependent upon the type of ink.
- **Temperature** – The flushing fluid and printhead should be heated to at least the same temperature as your jetting temperature. This is ink dependent. Check with your ink supplier to make sure that the flushing fluid can be heated and to what temperature.
- **Flushing Fluid** – This is dependent on the ink that has been jetted. Contact your ink supplier for the appropriate flushing fluid.
- **Volume** – The amount of flushing fluid needed is dependent upon the type of ink and the condition of the printhead. You should have approximately 400-600 ml of flushing fluid for aqueous inks and 600-800 ml for ceramic applications per printhead.

- **Time** – There is no way to say how long it will take. Time is dependent on the condition of the printhead, the ink properties, and whether you use pressure or vacuum.
- **Pressure or Vacuum** – You can either use pressure to push the fluid or vacuum to pull the fluid. Which you choose depends on whether you have a peristaltic pump (pressure) or a pneumatic pump (vacuum). Pressure should be in the range of 3-5 psi and vacuum should be set to 20 inches of water. In our test labs we have found the Pressure method to be more effective.
- **Flush Direction** – Flushing should be done in one direction. The flushing fluid should be introduced through the ink inlet line and drawn out the recirculation line or pushed out the nozzles. Do not back flush.

5.2 Flushing Procedure

The following flush procedure is a generic method for flushing an SG1024 printhead. It may need to be modified in order to meet your specific requirements. Nevertheless it will give you a place to start.

1. Mount the printhead in the flushing station.
2. Clamp off the recirculation line and fill printhead with flushing fluid.
3. Allow printhead to soak for an extended period of time. Length of time is dependent on how badly the printhead is caked with ink.
4. Gently shake the printhead occasionally to agitate the chamber and help loosen any debris.

5.2.1 Pressure Method

5. Unclamp the recirculation line and apply 3 to 5 psi of pressure.
6. Let fluid flow from the ink inlet through the refill chamber and out the recirculation line into a catch bottle for 3 to 5 minutes.
7. Clamp off recirculation line and push the fluid out through the nozzles for 3 to 5 minutes.
8. Wipe nozzle plate.
9. Repeat steps 5 through 8 three to five times. or until fluid flows clear.
10. Once fluid is flowing clear purge the printhead dry.

5.2.2 Vacuum Method

11. Unclamp the recirculation line and apply vacuum at 20 inches of water.

12. Let fluid flow from the ink inlet through the refill chamber and out the recirculation line into a catch bottle for 3 to 5 minutes.

13. Clamp off recirculation line and raise the flushing fluid supply to allow gravity to push the fluid through the nozzles for 3 to 5 minutes.

14. Wipe nozzle plate.

15. Repeat steps 10 through 13 three to five times or until fluid flows clear.

16. Once fluid is flowing clear purge the printhead dry.

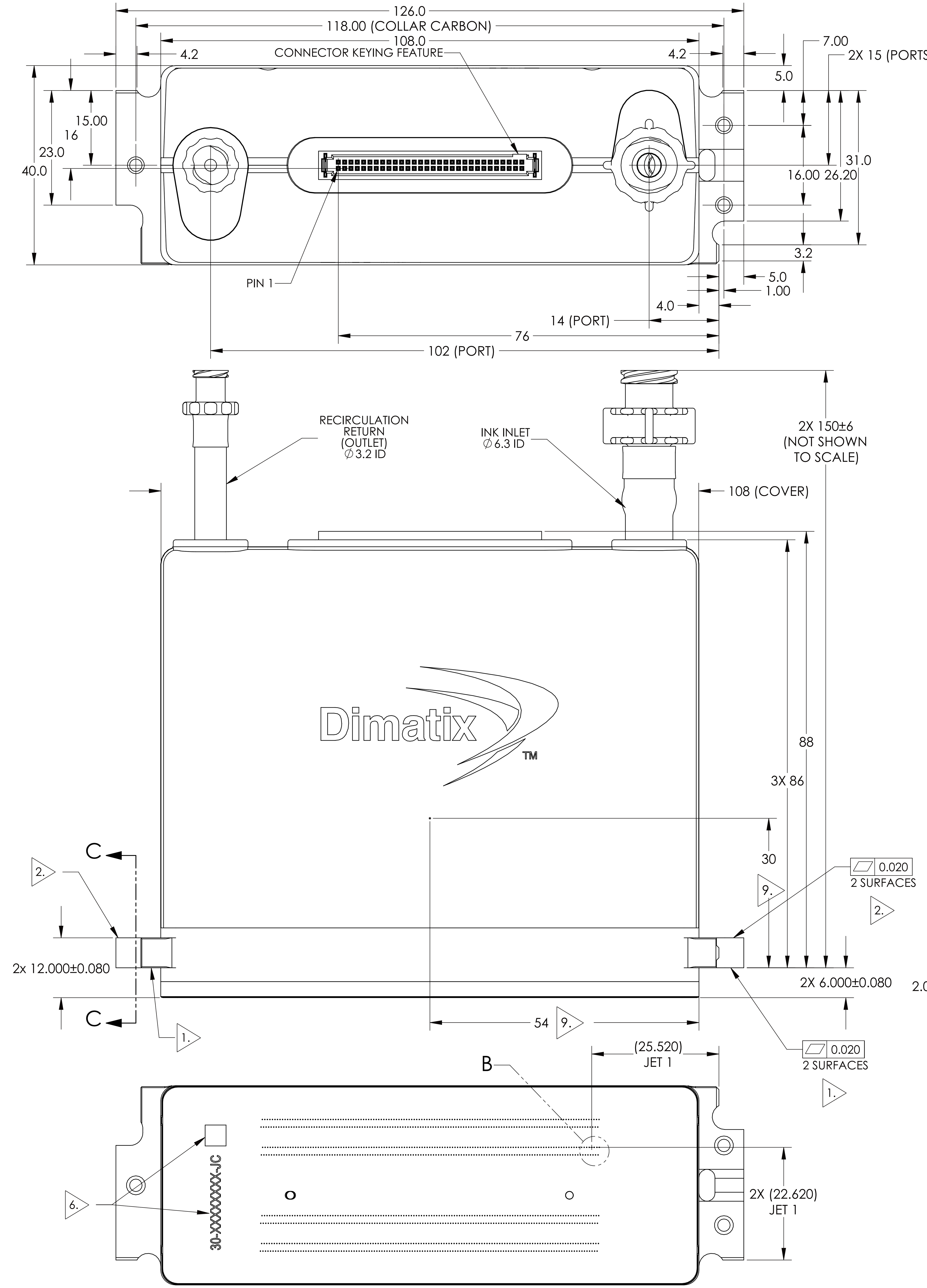
Interface Control Drawings

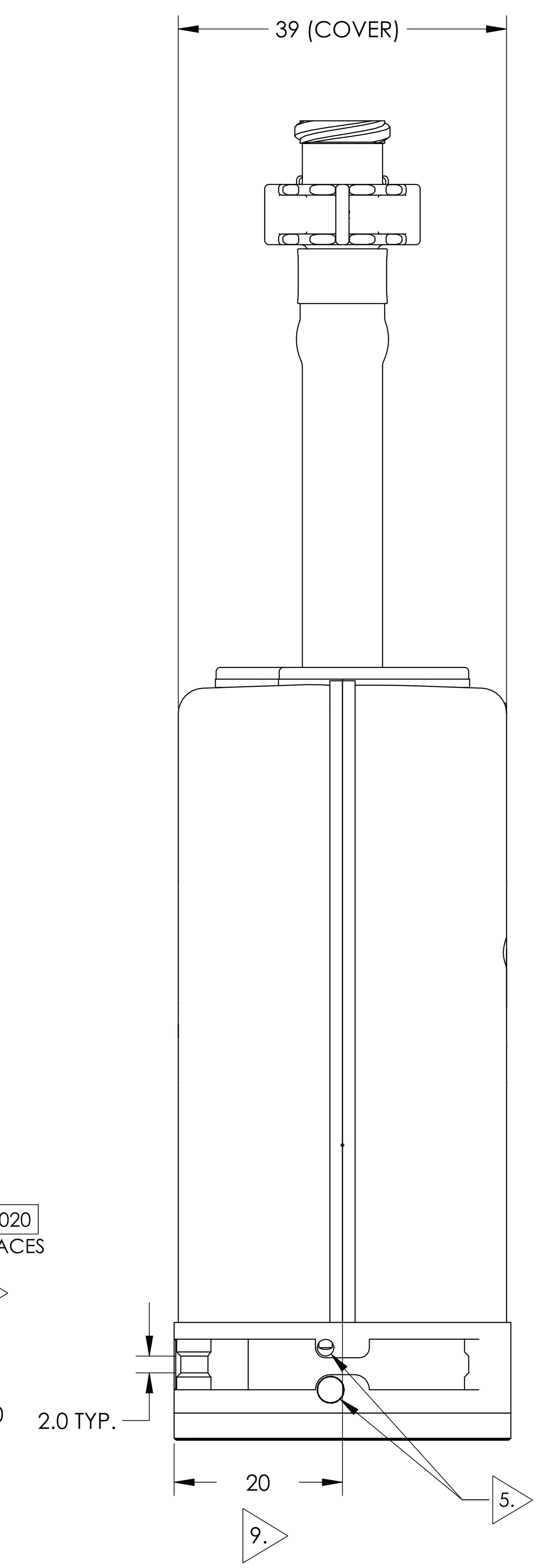
1.0 SG1024/A Single Color Printhead – ICD# 27472

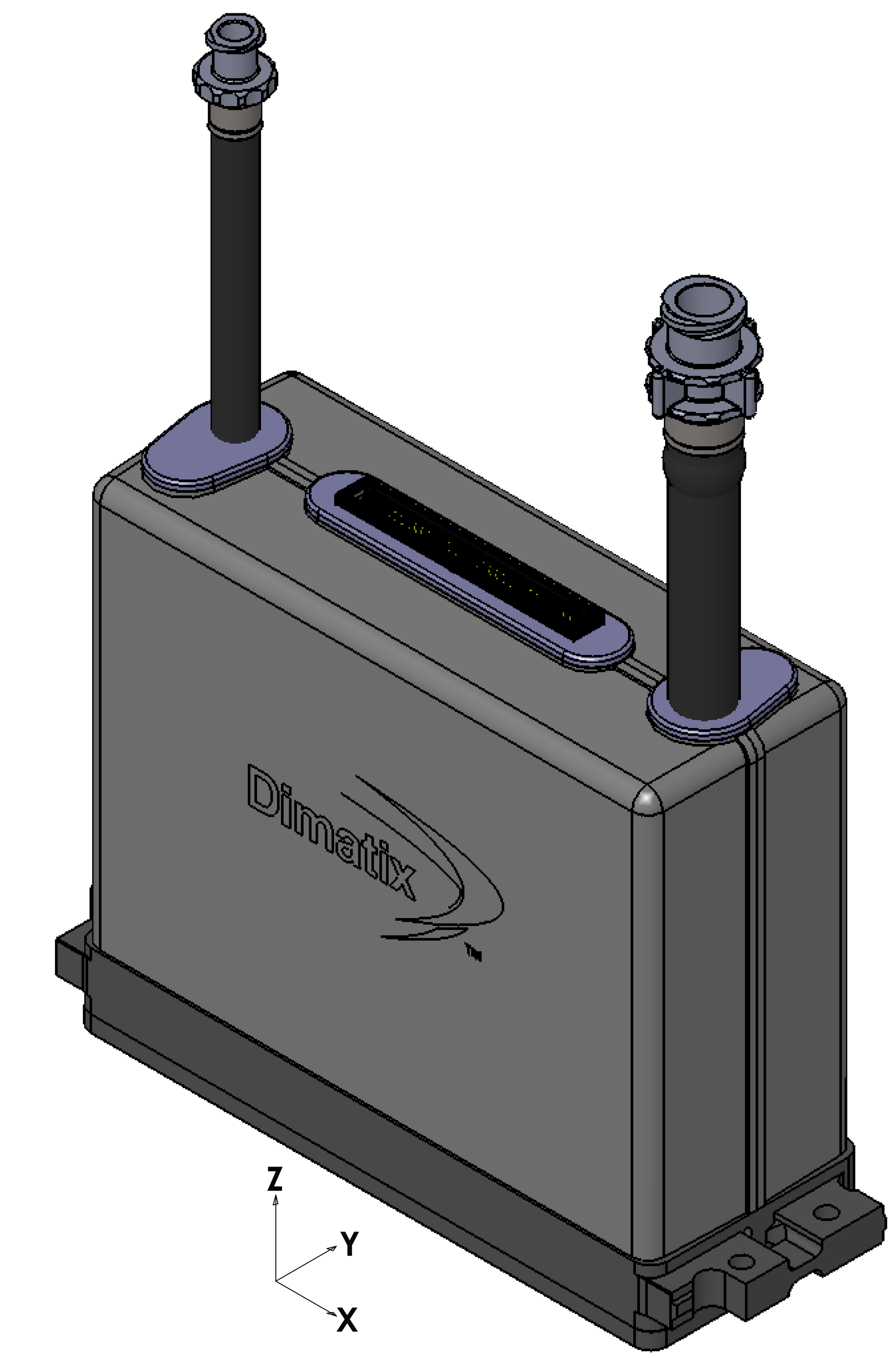
REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	DERIVED FROM 23865 REV 5	10/9/12	B WELLS	D BRADY
1	INITIAL DRAWING RELEASE PER ECO #7034	8/20/13	B WELLS	D BRADY
2	CHANGED PER ECO #7275	11/10/2013	B WELLS	D BRADY
3	CHANGED PER ECO #7889	4/22/2014	B WELLS	D BRADY

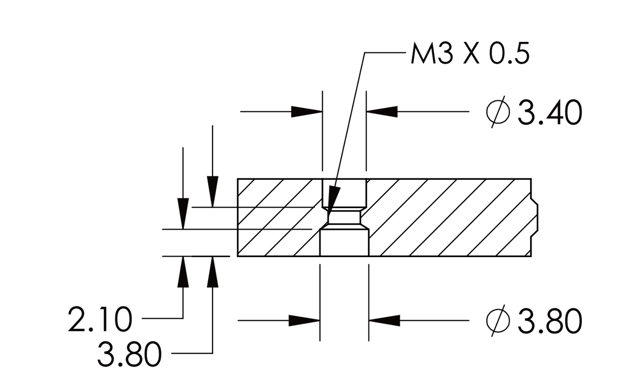
NOTES:

1. RECOMMENDED MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
2. ALTERNATE MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
3. ALL DIMENSIONS APPLY AT 20 DEG C
4. M3 X 0.5 CAPTIVE HEAD MOUNTING SCREW(3 SUPPLIED), 2.5 INTERNAL HEX DRIVE. SCREW MAY BE USED IN TOP DOWN OR BOTTOM UP MOUNTS. IN TOP DOWN MOUNTS, RECEIVING HOLE SHOULD BE 4.5 DEEP, FLAT BOTTOMED AND THREADED 3.5 DEEP TO ACHIEVE 12N CLAMPING FORCE WITH SUPPLIED SPRING. SEE PRODUCT MANUAL FOR DETAILS ON RECOMMENDED MOUNTING. MAX TORQUE = 0.4 N·m
5. FEATURES FOR EXTERNAL HEATER AND THERMISTOR,
   - THERMISTOR: ∅1.990±0.050, 56 DEEP
   - HEATER: ∅3.230±0.050, 84 DEEP. HEATER OPTION UTILIZES HOLE.
6. HUMAN AND MACHINE READABLE (2D CODE DATAMATRIX) SERIAL NUMBER.
7. PRECISION ALIGNMENT FEATURES
8. PRECISION SURFACE FOR APPLYING ALIGNMENT FORCE
9. LOCATION OF CENTER OF GRAVITY (C OF G)
10. DEFINITION OF JET NUMBER (JET 1) AND ROW AND NOZZLE (R3,N1)
11. THERE ARE 3 NON-FUNCTIONAL, BLANKED OFF, HOLES IN THE NOZZLE PLATE IN EACH ROW, BEFORE THE FIRST AND AFTER THE LAST FUNCTIONAL JET .
12. HIGH LOCALIZED PRESSURE, SUCH AS THE PRESSURE REQUIRED TO COMPRESS AN O-RING, SHOULD NOT BE APPLIED IN THIS AREA. SEE PRODUCT MANUAL FOR RECOMMENDATIONS.
13. FLUID FITTINGS PROVIDED WITH PRINTHEAD: 2 MALE PLUGS, LUER AND LARGE TAPER, INSTALLED. 2 MALE TUBING ADAPTERS, MALE LUER-3.2 ID TUBE AND MALE LARGE TAPER-6.4 ID TUBE, SEPERATE. 2 FEMALE CAPS, LUER AND LARGE TAPER, SEPERATE.
14. SPRING (3 SUPPLIED):
    MATERIAL: STAINLESS STEEL. FREE LENGTH = 8.64
    OD = 5.9 ID = 4.4 SPRING RATE = 6.1 N/MM
15. ALL NOZZLES FALL WITHIN 0.012 (RADIUS) OF THEIR NOMINAL (NOM.) LOCATION.
16. DIMENSIONS WITH NO TOLERANCES EXPRESSED (E.G. X±0.0X) OR IMPLIED (BY THE TITLE BLOCK) ARE FOR REFERENCE ONLY.



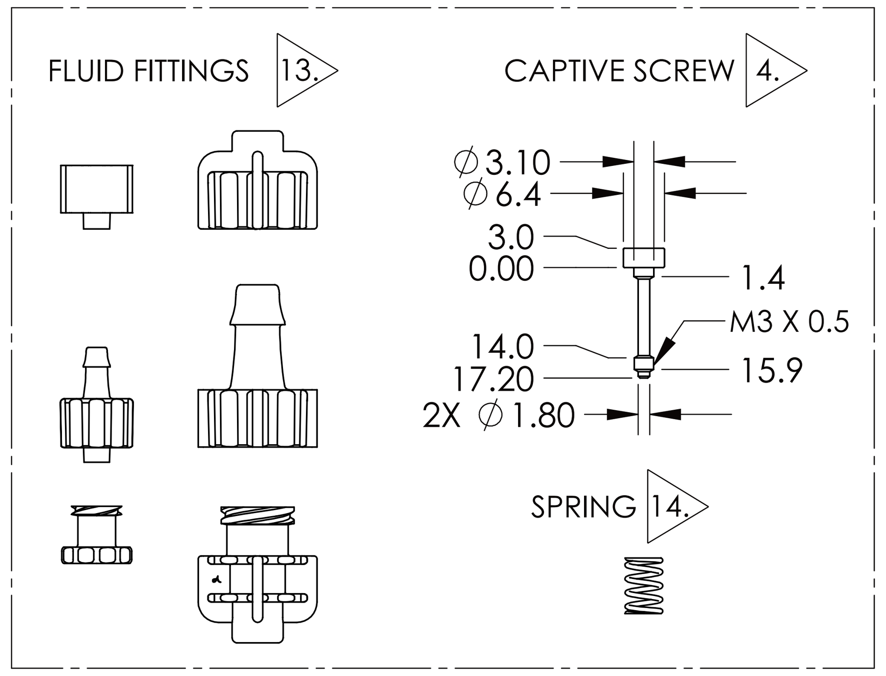


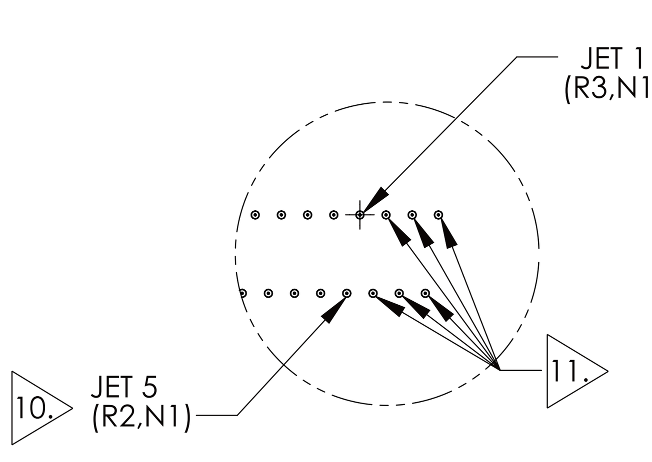




SECTION C-C

ACCESSORIES SUPPLIED





DETAIL B
SCALE 8 : 1

DO NOT SCALE FROM PRINT!	DWG INTERPRETATION: ASME Y14.5M-1994	DRAWN: B WELLS	DATE: 6/3/2013	FUJIFILM Dimatix	109 ETNA ROAD LEBANON, NH 03766 USA
INSPECTION	UNLESS OTHERWISE SPECIFIED: DIMENSIONS IN: METRIC/MM; TOTAL RUNOUT: 0.15/25MM; PERPENDICULARITY: 0.15/25MM; EDGE BREAKS: 0.10-0.40; FILLET RADII: 0.10 MAX; ANGLES: ±0°30'; SURFACE ROUGHNESS: Ra 3.2	CHECKED: D BRADY	DATE: 6/5/2013		
PART STATUS: NA	TOLERANCES: XX.X ± 0.25; XX.XX ± 0.13; XX.XXX ± 0.020	MATERIAL: SEE NOTES		TITLE: ICD,SG1024, 1 COLOR	
LEGEND: ** CRITICAL DIMENSION; * MAJOR DIMENSION; (NO *) MINOR DIMENSION	THIRD ANGLE PROJECTION	FINISH: NA		SIZE: D; DRAWING NUMBER: 27472	REV: 3
THIS DRAWING IS PROPRIETARY AND CONSIDERED CONFIDENTIAL. NO REPRODUCTION MAY BE MADE WITHOUT WRITTEN PERMISSION FROM FUJIFILM DIMATIX,INC.		FILE NAME: 27472.SLDDRW		SCALE: 2:1	SHEET: 1 OF 2

MATERIALS IN CONTACT WITH INK (IN THE FLUID PATH)	
MATERIAL	PART OR ASSEMBLY
RESIN FILLED CARBON	ACTUATOR BODY, COLLAR, MANIFOLD
POLYIMIDE (UPILEX)	FLINK, ROCK TRAP
17-7 STAINLESS STEEL	ACTUATOR AND COLLAR LAMINATES
303 STAINLESS STEEL	COLLAR BARBS
COATED NICKEL	NOZZLE PLATE
PARYLENE	ACTUATOR ASSY
FLUOROCARBON ELAST.	INK TUBING(BLK), O-RING(BRN), (CER)
TYGON 2375	INK TUBING(BLUE), (AQ)
EPDM	O-RING(PURPLE), (AQ)
SPECTRA EPOXY	ACTUATOR AND COLLAR ASSYS
BARB EPOXY	COLLAR ASSY
NYLON	FLUID CONNECTORS

MATERIALS IN OCCASIONAL CONTACT WITH INK	
MATERIAL	PART OR ASSEMBLY
ACETAL	COVER
FLUORO SILICONE	COVER SEALS
LIQUID CRYSTAL POLYMER	CONNECTOR HOUSING

TYPICAL THERMAL EXPANSION VALUES	
PART OR ASSEMBLY	THERMAL EXPANSION
NOZZLE PITCH (X)	7.1 PPM/°C
NOZZLE PITCH (Y, ROW TO ROW)	11 PPM/°C
JET 1 TO X REG SURFACE	7.8 PPM/°C
MEASURED UNCONSTRAINED	

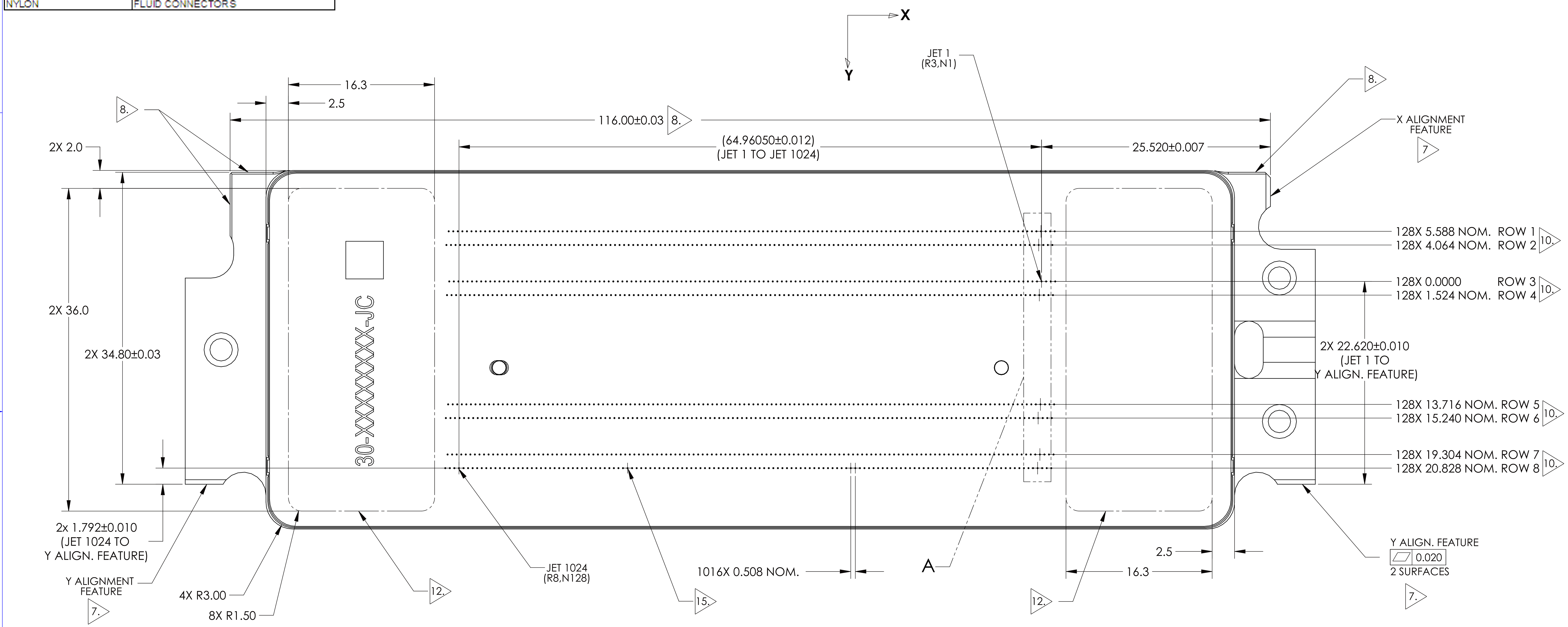
COMPONENT DETAILS	
THERMISTOR	MFG: MURATA
	PN: NXFT15X103FA2B150
HEATER (OPTION)	30W, 24VDC or AC(RMS)
LVDS RECIEVER	MFG: NATIONAL SEMICONDUCTOR
	PN: DS90C032BTM/NOPB

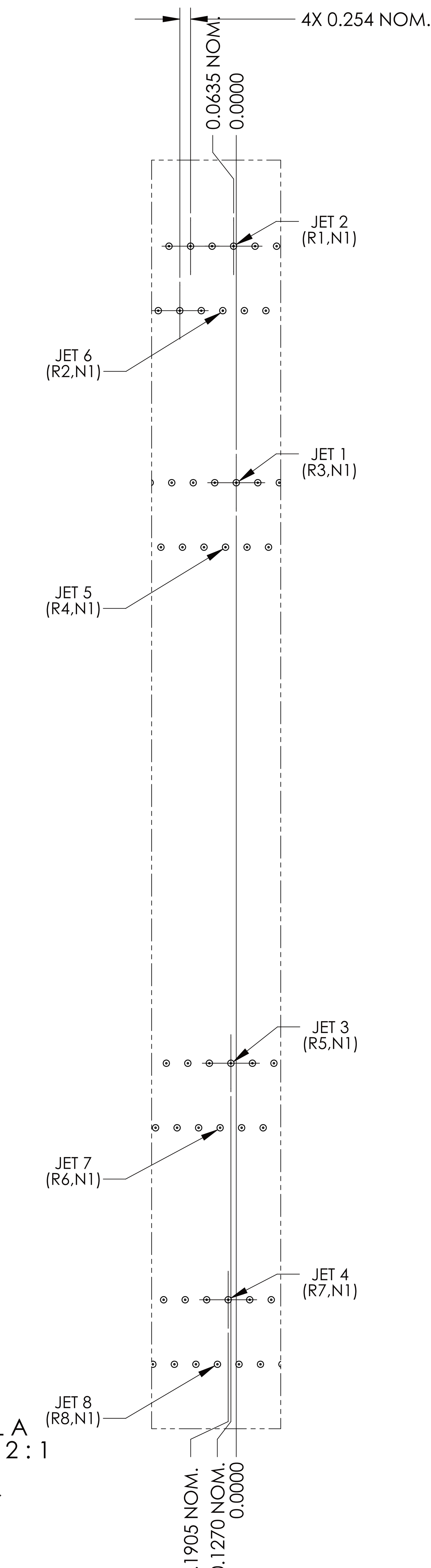
MECHANICAL PROPERTIES	
MASS	320 GM
CENTER OF GRAVITY	SEE SHEET 1 + NOTE 9
FLUID VOLUME	9.8 CC (TO TOP OF FITTINGS)

FLUID FITTING DETAILS 13.	
MFG: VALUE PLASTICS	
DESCRIPTION	MFG PN
FEMALE LUER TO 3.2 BARB (INSTALLED)	FTLL013-1
FEMALE TAPER LOC TO 6.3 BARB (INSTALLED)	FLB055-1
MALE LUER PLUG	LP4-1
MALE TAPER LOC PLUG	MLBP-1
MALE LUER TO 3.2 BARB	MTLL013-1
MALE TAPER LOC TO 6.3 BARB	MLB055-1
FEMALE LUER CAP	FTLLP-1
FEMALE TAPER LOC CAP	FLBP-1

Jet Mapping Data			
Row	Jets	Connector Pins	Pixel Numbers (column)
1	2, 10, 18, 26, ..., 1018	13, 14	1022, 1014, 1006, ... 6
2	6, 14, 22, 30, ..., 1022	15, 16	1018, 1010, 1002, ... 2
3	1, 9, 17, 25, ..., 1017	17, 18	1023, 1015, 1007, ... 7
4	5, 13, 21, 29, ..., 1021	19, 20	1019, 1011, 1003, ... 3
5	3, 11, 19, 27, ..., 1019	21, 22	1021, 1013, 1005, ... 5
6	7, 15, 23, 31, ..., 1023	23, 24	1017, 1009, 1001, ... 1
7	4, 12, 20, 28, ..., 1020	25, 26	1020, 1012, 1004, ... 4
8	8, 16, 24, 32, ..., 1024	27, 28	1016, 1008, 1000, ... 0
See product manual for complete details			

REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	See Sheet1	-	-	-





DETAIL A
SCALE 12 : 1
10.

INTERCONNECT

Samtec ASP-166916-01

Pin Num.	Connection	Description
1	GND	Head Common
2	VCC	5.0V DC Logic power for driver chips
3	GND	Head Common
4	VCC	5.0V DC Logic power for driver chips
5	CONFIG	Configuration - Low/GND: 1-color mode - High/VCC: 2-color mode
6	GND	Head Common
7	C1_CLK_N	Negative LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
8	C1_CLK_P	Positive LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
9	C2_CLK_N	Negative LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
10	C2_CLK_P	Positive LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
11	C1_LAT_N	Negative LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).

Pin Num.	Connection	Description
12	C1_LAT_P	Positive LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-
13	D0_N	Negative LVDS Data signal serial input for Row 1
14	D0_P	Positive LVDS Data signal serial input for Row 1
15	D1_N	Negative LVDS Data signal serial input for Row 2
16	D1_P	Positive LVDS Data signal serial input for Row 2
17	D2_N	Negative LVDS Data signal serial input for Row 3
18	D2_P	Positive LVDS Data signal serial input for Row 3
19	D3_N	Negative LVDS Data signal serial input for Row 4
20	D3_P	Positive LVDS Data signal serial input for Row 4
21	D4_N	Negative LVDS Data signal serial input for Row 5
22	D4_P	Positive LVDS Data signal serial input for Row 5
23	D5_N	Negative LVDS Data signal serial input for Row 6
24	D5_P	Positive LVDS Data signal serial input for Row 6
25	D6_N	Negative LVDS Data signal serial input for Row 7
26	D6_P	Positive LVDS Data signal serial input for Row 7
27	D7_N	Negative LVDS Data signal serial input for Row 8
28	D7_P	Positive LVDS Data signal serial input for Row 8

Pin Num.	Connection	Description
29	C2_LAT_N	Negative LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
30	C2_LAT_P	Positive LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
31	GND	Head Common
32	SCL	I2C Clock signal for Serial Interface
33	GND	Head Common
34	SDA	I2C Data signal for Serial Interface
35	THB	Print Head Thermistor
36	THA	Pull Up for Print Head Thermistor
37	HTRB	Ground for Print Head heater
38	HTRA	Control for Print Head Heater
39	GND	Head Common
40	GND	Head Common
41	HTRB	Ground for Print Head heater
42	HTRA	Control for Print Head Heater

Pin Num.	Connection	Description
43	GND	Head Common
44	GND	Head Common
45	GND	Head Common
46	FP0	Fire Pulse fed to Row 1
47	GND	Head Common
48	FP1	Fire Pulse fed to Row 2
49	GND	Head Common
50	FP2	Fire Pulse fed to Row 3
51	GND	Head Common
52	FP3	Fire Pulse fed to Row 4
53	GND	Head Common
54	FP4	Fire Pulse fed to Row 5
55	GND	Head Common
56	FP5	Fire Pulse fed to Row 6
57	GND	Head Common
58	FP6	Fire Pulse fed to Row 7
59	GND	Head Common
60	FP7	Fire Pulse fed to Row 8

DO NOT SCALE FROM PRINT!

INSPECTION

PART STATUS: NA

DWG INTERPRETATION: ASME Y14.5M-1994

UNLESS OTHERWISE SPECIFIED:

THIRD ANGLE PROJECTION

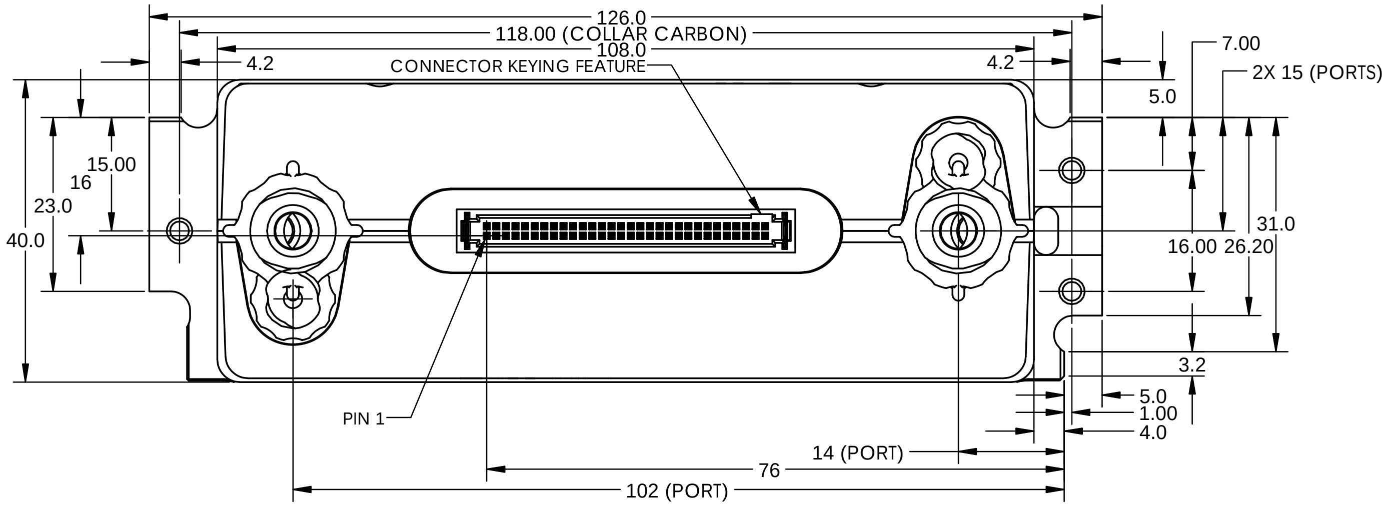
DRAWN: B WELLS	DATE: 6/3/2013	FUJIFILM Dimatix, 109 ETNA ROAD LEBANON, NH 03766 USA
CHECKED: D BRADY	DATE: 6/5/2013	TITLE: ICD,SG1024, 1 COLOR
MATERIAL: SEE NOTES		SIZE: D, DRAWING NUMBER: 27472, REV: 3
FINISH: NA		SCALE: 1:1, SHEET: 2 OF 2
FILE NAME: 27472.SLDDRW		

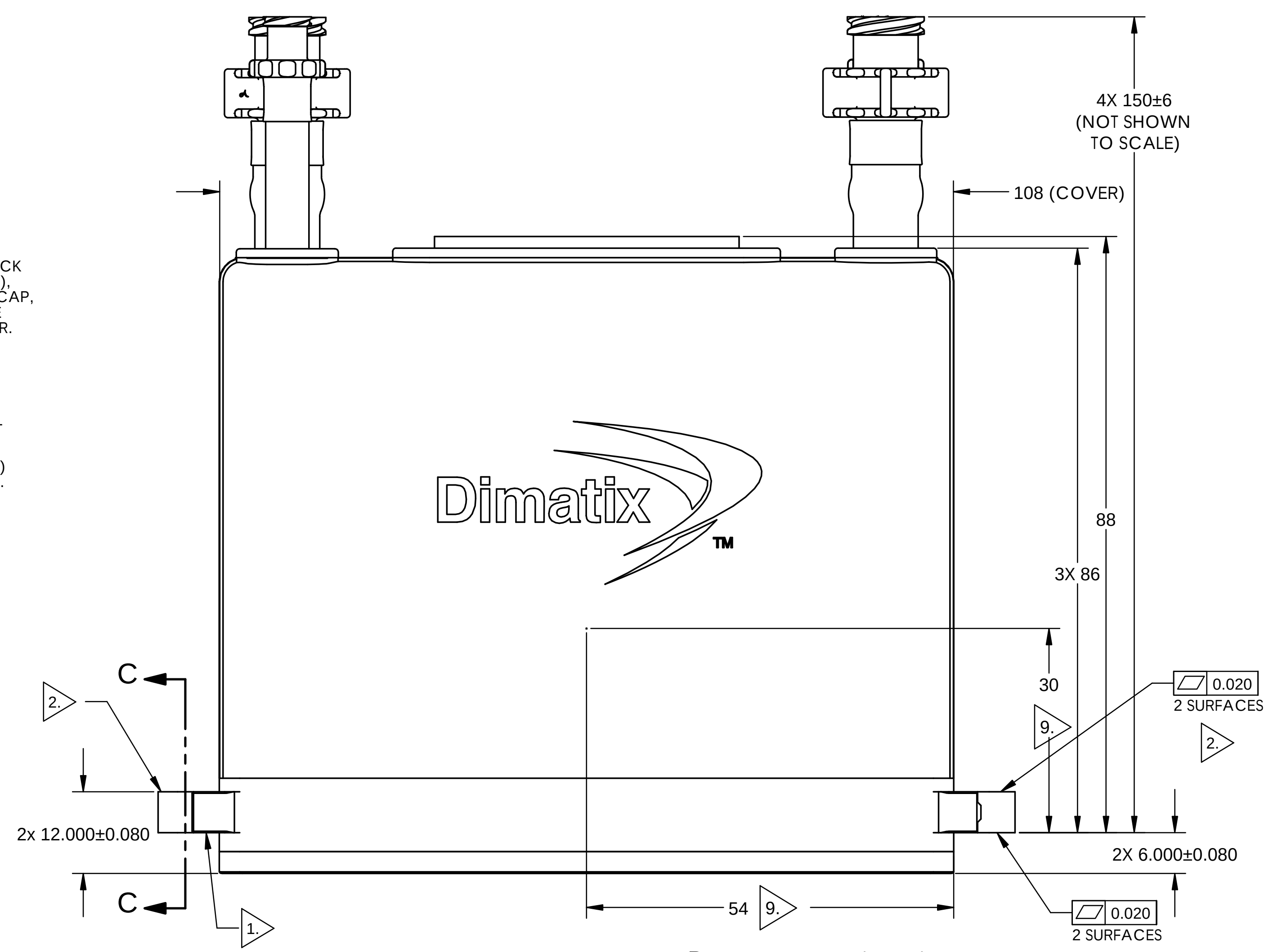
2.0 SG1024/A Two Color Printhead – ICD# 27473

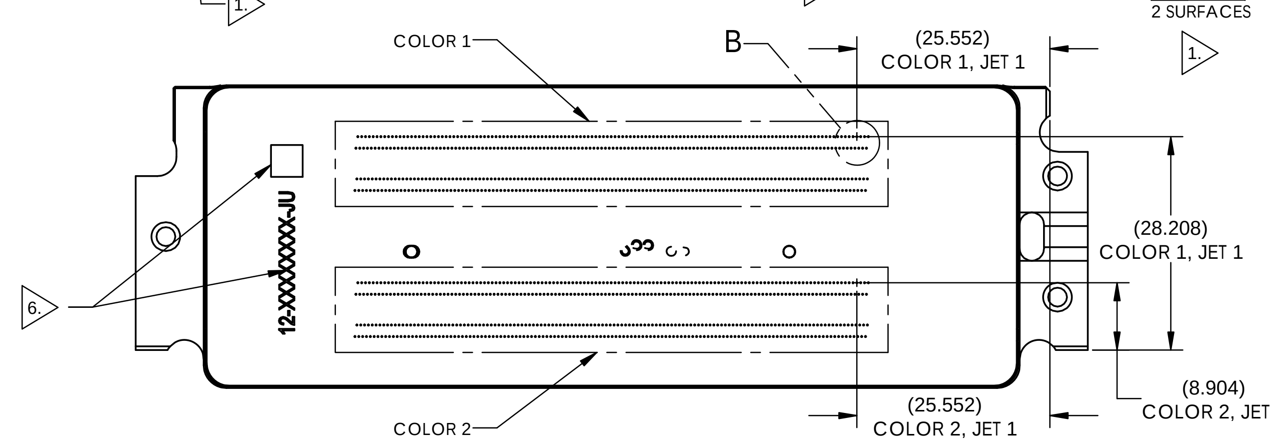
REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	DERIVED FROM 25639 REV 1	6/13/12	B WELLS	D BRADY
1	INITIAL DRAWING RELEASE PER ECO #7034	8/21/2013	B WELLS	D BRADY
2	CHANGED PER ECO #7275	11/10/2013	B WELLS	D BRADY
3	CHANGED PER ECO #7889	4/22/2014	B WELLS	D BRADY
4	CHANGE PER ECO #8015	6/18/2014	B WELLS	D BRADY

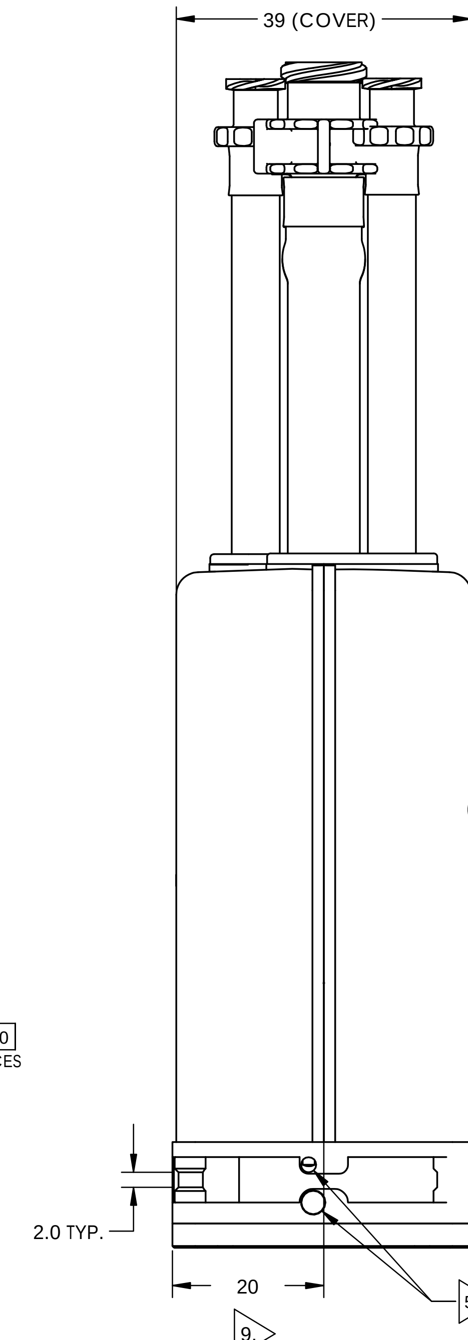
NOTES:

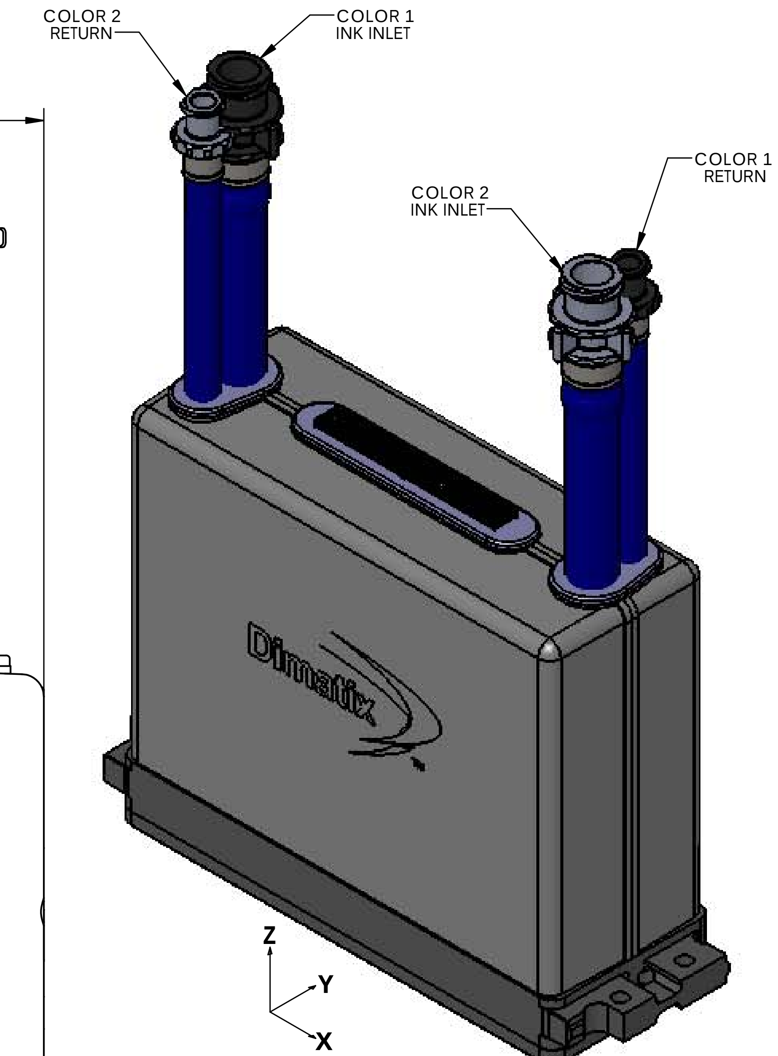
1. RECOMMENDED MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
2. ALTERNATE MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
3. ALL DIMENSIONS APPLY AT 20 DEG C
4. M3 X 0.5 CAPTIVE HEAD MOUNTING SCREW(3 SUPPLIED), 2.5 INTERNAL HEX DRIVE. SCREW MAY BE USED IN TOP DOWN OR BOTTOM UP MOUNTS. IN TOP DOWN MOUNTS, RECEIVING HOLE SHOULD BE 4.5 DEEP, FLAT BOTTOMED AND THREADED 3.5 DEEP TO ACHIEVE 12N CLAMPING FORCE WITH SUPPLIED SPRING. SEE PRODUCT MANUAL FOR DETAILS ON RECOMMENDED MOUNTING. MAX TORQUE = 0.4 N·m
5. FEATURES FOR EXTERNAL HEATER AND THERMISTOR,
   - THERMISTOR: Ø1.990±0.050, 56 DEEP
   - HEATER: Ø3.230±0.050, 84 DEEP. HEATER OPTION UTILIZES HOLE.
6. HUMAN AND MACHINE READABLE (2D CODE DATAMATRIX) SERIAL NUMBER.
7. PRECISION ALIGNMENT FEATURES
8. PRECISION SURFACE FOR APPLYING ALIGNMENT FORCE
9. LOCATION OF CENTER OF GRAVITY (C OF G)
10. DEFINITION OF JET NUMBER (JET 1) AND ROW AND NOZZLE (R3,N1)
11. THERE ARE 3 NON-FUNCTIONAL, BLANKED OFF, HOLES IN THE NOZZLE PLATE IN EACH ROW, BEFORE THE FIRST AND AFTER THE LAST FUNCTIONAL JET .
12. HIGH LOCALIZED PRESSURE, SUCH AS THE PRESSURE REQUIRED TO COMPRESS AN O-RING, SHOULD NOT BE APPLIED IN THIS AREA. SEE PRODUCT MANUAL FOR RECOMMENDATIONS.
13. FLUID FITTINGS PROVIDED WITH PRINTHEAD: WHITE AND BLACK OF EACH OF THE FOLLOWING: MALE LUER PLUG(INSTALLED), LARGE BORE MALE TAPER PLUG (INSTALLED), FEMALE LUER CAP, FEMALE LARGE BORE TAPER CAP, MALE LUER TO 3.2 ID TUBE ADAPTER, MALE LARGE BORE TAPER TO 4.8 ID TUBE ADAPTER.
14. SPRING (3 SUPPLIED):
    MATERIAL: STAINLESS STEEL. FREE LENGTH = 8.64
    OD = 5.9 ID = 4.4 SPRING RATE = 6.1 N/MM
15. ALL NOZZLES FALL WITHIN 0.012 (RADIUS) OF THEIR NOMINAL (NOM.) LOCATION.
16. DIMENSIONS WITH NO TOLERANCES EXPRESSED (E.G. X±0.0X) OR IMPLIED (BY THE TITLE BLOCK) ARE FOR REFERENCE ONLY.

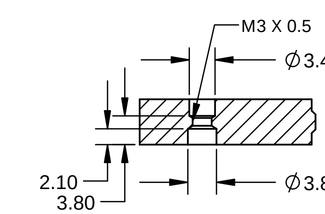






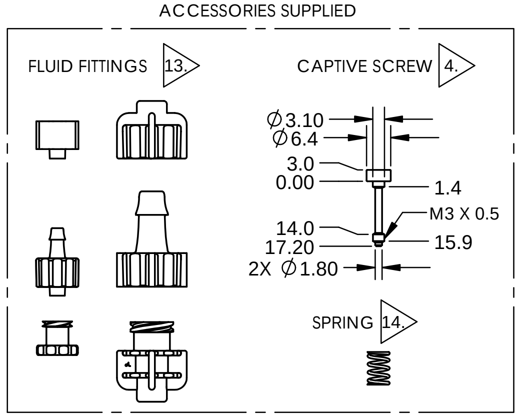


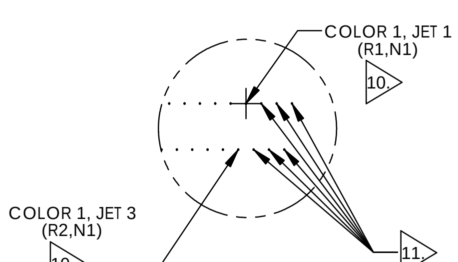




SECTION C-C

ACCESSORIES SUPPLIED





DETAIL B
SCALE 8 : 1

DO NOT SCALE FROM PRINT!	DWG INTERPRETATION: ASME Y14.5M-1994	DRAWN: B WELLS	DATE: 6/9/2013
INSPECTION	UNLESS OTHERWISE SPECIFIED:	CHECKED: D BRADY	DATE: 6/10/2013

FUJIFILM Dimatix — 109 ETNA ROAD, LEBANON, NH 03766 USA

PART STATUS: NA

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS IN:	METRIC/MM
TOTAL RUNOUT:	0.15/25MM
PERPENDICULARITY:	0.15/25MM
EDGE BREAKS:	0.10-0.40
FILLET RADII:	0.10 MAX
ANGLES:	±0°30'
SURFACE ROUGHNESS:	Ra 3.2
TOLERANCES:	
XX.X	± 0.25
XX.XX	± 0.13
XX.XXX	± 0.020

LEGEND:

**	CRITICAL DIMENSION
*	MAJOR DIMENSION
(NO *)	MINOR DIMENSION

THIRD ANGLE PROJECTION

MATERIAL: SEE NOTES

FINISH: NA

TITLE: ICD,SG1024,2 COLOR

SIZE: D | DRAWING NUMBER: 27473 | REV: 4

FILE NAME: 27473.SLDDRW | SCALE: 2:1 | SHEET: 1 OF 2

MATERIALS IN CONTACT WITH INK (IN THE FLUID PATH)	
MATERIAL	PART OR ASSEMBLY
RESIN FILLED CARBON	ACTUATOR BODY, COLLAR, MANIFOLD
POLYIMIDE (UPILEX)	FLINK, ROCK TRAP
17-7 STAINLESS STEEL	ACTUATOR AND COLLAR LAMINATES
303 STAINLESS STEEL	COLLAR BARBS
COATED NICKEL	NOZZLE PLATE
PARYLENE	ACTUATOR ASSY
FLUOROCARBON ELAST.	INK TUBING(BLK), O-RING(BRN), (CER)
TYGON 2375	INK TUBING(BLUE), (AQ)
EPDM	O-RING(PURPLE), (AQ)
SPECTRA EPOXY	ACTUATOR AND COLLAR ASSYS
BARB EPOXY	COLLAR ASSY
NYLON	FLUID CONNECTORS

MATERIALS IN OCCASIONAL CONTACT WITH INK	
MATERIAL	PART OR ASSEMBLY
ACETAL	COVER
FLUORO SILICONE	COVER SEALS
LIQUID CRYSTAL POLYMER	CONNECTOR HOUSING

TYPICAL THERMAL EXPANSION VALUES	
PART OR ASSEMBLY	THERMAL EXPANSION
NOZZLE PITCH (X)	7.1 PPM/°C
NOZZLE PITCH (Y, ROW TO ROW)	11 PPM/°C
JET 1 TO X REG SURFACE	7.8 PPM/°C
MEASURED UNCONSTRAINED	

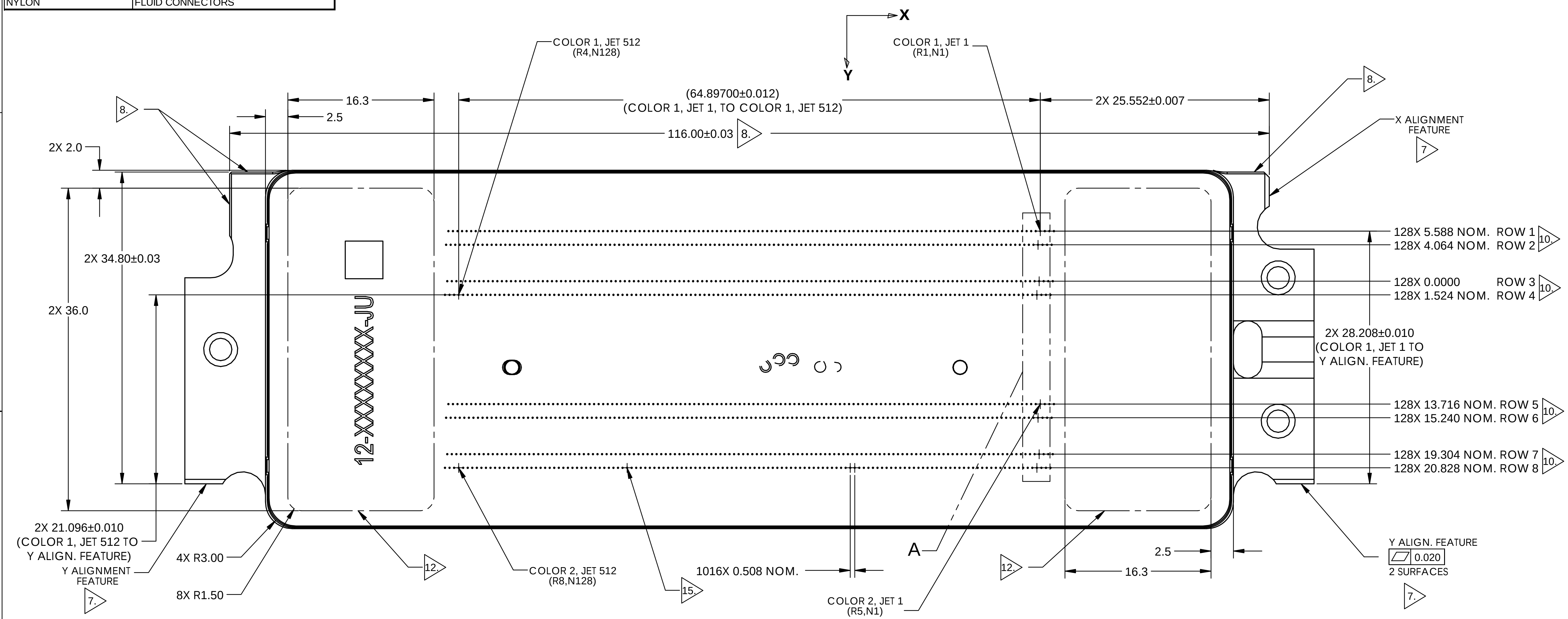
COMPONENT DETAILS	
THERMISTOR	MFG: MURATA
	PN: NXFT15XH103FA2B150
HEATER (OPTION)	30W, 24V DC or AC(RMS)
LVDS RECIEVER	MFG: NATIONAL SEMICONDUCTOR
	PN: DS90C032BTM/NOPB

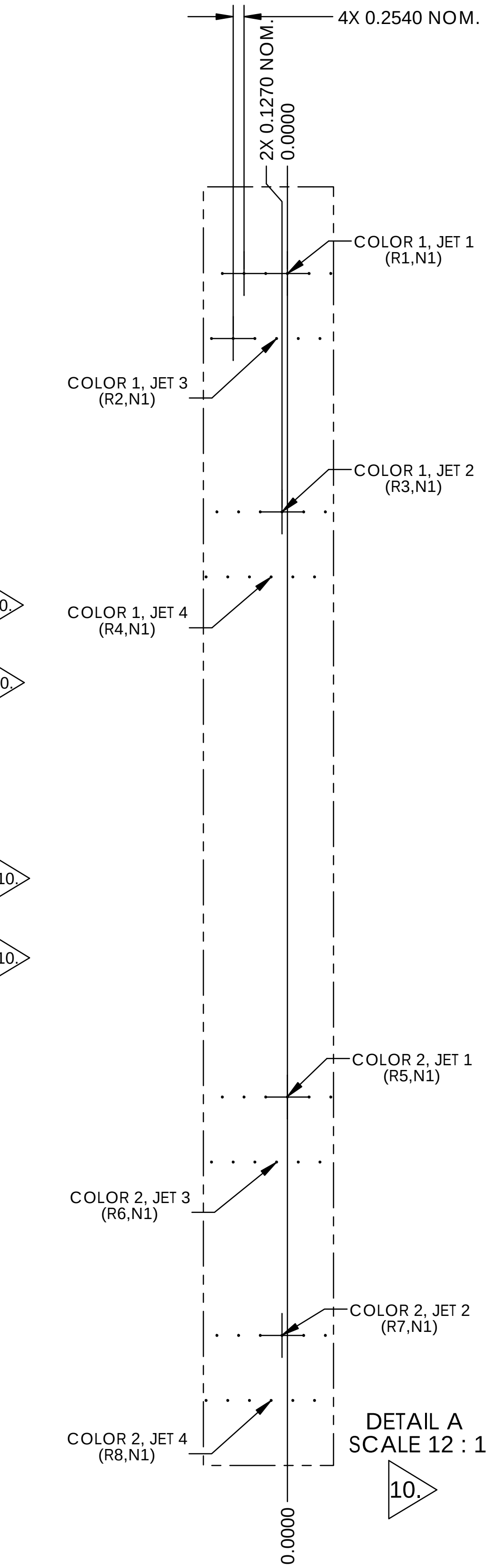
MECHANICAL PROPERTIES	
MASS	320 GM
CENTER OF GRAVITY	SEE SHEET 1 + NOTE 9
FLUID VOLUME	7.6 CC PER COLOR (TO TOP OF FITTINGS)

FLUID FITTING DETAILS 13.	
MFG: VALUE PLASTICS	
DESCRIPTION	MFG PN
FEMALE LUER TO 3.2 BARB (INSTALLED)	FTLL013-X
FEMALE LARGE TAPER TO 6.3 BARB (INSTALLED)	FLB055-X
MALE LUER PLUG	LP4-X
MALE LARGE TAPER LOC PLUG	MLBP-X
MALE LUER TO 3.2 BARB	MTLL013-X
MALE LARGE TAPER TO 4.8 BARB	MLB035-X
FEMALE LUER CAP	FTLLP-X
FEMALE LARGE TAPER CAP	FLBP-X
X = 1 FOR WHITE, X = 2 FOR BLACK	

Jet Mapping Data			
Row	Color-Jets	Connector Pins	Pixel Numbers (column)
1	C1-J1,C1-J5,...C1-509	13, 14	C1: 511, 507, 503,...3
2	C1-J3,C1-J7,...C1-511	15, 16	C1: 509, 505, 501,...1
3	C1-J2,C1-J6,...C1-J510	17, 18	C1: 510, 506, 502,...2
4	C1-J4,C1-J8,...C1-J512	19, 20	C1: 508, 504, 500,...0
5	C2-J1,C2-J5,...C2-509	21, 22	C2: 511, 507, 503,...3
6	C2-J3,C2-J7,...C2-511	23, 24	C2: 509, 505, 501,...1
7	C2-J2,C2-J6,...C2-J510	25, 26	C2: 510, 506, 502,...2
8	C2-J4,C2-J8,...C2-J512	27, 28	C2: 508, 504, 500,...0
See product manual for complete details			

REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	See Sheet1	-	-	-





DETAIL A
SCALE 12 : 1
10.

INTERCONNECT

Samtec ASP-166916-01

Pin Num.	Connection	Description
1	GND	Head Common
2	VCC	5.0V DC Logic power for driver chips
3	GND	Head Common
4	VCC	5.0V DC Logic power for driver chips
5	CONFIG	Configuration - Low/GND: 1-color mode - High/VCC: 2-color mode
6	GND	Head Common
7	C1_CLK_N	Negative LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
8	C1_CLK_P	Positive LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
9	C2_CLK_N	Negative LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
10	C2_CLK_P	Positive LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
11	C1_LAT_N	Negative LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).

Pin Num.	Connection	Description
12	C1_LAT_P	Positive LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-
13	D0_N	Negative LVDS Data signal serial input for Row 1
14	D0_P	Positive LVDS Data signal serial input for Row 1
15	D1_N	Negative LVDS Data signal serial input for Row 2
16	D1_P	Positive LVDS Data signal serial input for Row 2
17	D2_N	Negative LVDS Data signal serial input for Row 3
18	D2_P	Positive LVDS Data signal serial input for Row 3
19	D3_N	Negative LVDS Data signal serial input for Row 4
20	D3_P	Positive LVDS Data signal serial input for Row 4
21	D4_N	Negative LVDS Data signal serial input for Row 5
22	D4_P	Positive LVDS Data signal serial input for Row 5
23	D5_N	Negative LVDS Data signal serial input for Row 6
24	D5_P	Positive LVDS Data signal serial input for Row 6
25	D6_N	Negative LVDS Data signal serial input for Row 7
26	D6_P	Positive LVDS Data signal serial input for Row 7
27	D7_N	Negative LVDS Data signal serial input for Row 8
28	D7_P	Positive LVDS Data signal serial input for Row 8

Pin Num.	Connection	Description
29	C2_LAT_N	Negative LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
30	C2_LAT_P	Positive LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
31	GND	Head Common
32	SCL	I2C Clock signal for Serial Interface
33	GND	Head Common
34	SDA	I2C Data signal for Serial Interface
35	THB	Print Head Thermistor
36	THA	Pull Up for Print Head Thermistor
37	HTRB	Ground for Print Head heater
38	HTRA	Control for Print Head Heater
39	GND	Head Common
40	GND	Head Common
41	HTRB	Ground for Print Head heater
42	HTRA	Control for Print Head Heater

Pin Num.	Connection	Description
43	GND	Head Common
44	GND	Head Common
45	GND	Head Common
46	FP0	Fire Pulse tied to Row 1
47	GND	Head Common
48	FP1	Fire Pulse tied to Row 2
49	GND	Head Common
50	FP2	Fire Pulse tied to Row 3
51	GND	Head Common
52	FP3	Fire Pulse tied to Row 4
53	GND	Head Common
54	FP4	Fire Pulse tied to Row 5
55	GND	Head Common
56	FP5	Fire Pulse tied to Row 6
57	GND	Head Common
58	FP6	Fire Pulse tied to Row 7
59	GND	Head Common
60	FP7	Fire Pulse tied to Row 8

DO NOT SCALE FROM PRINT!

INSPECTION
PART STATUS: NA

DWG INTERPRETATION: ASME Y14.5M-1994
UNLESS OTHERWISE SPECIFIED: DIMENSIONS IN: METRIC/MM; TOTAL RUNOUT: 0.15/25MM; PERPENDICULARITY: 0.15/25MM; EDGE BREAKS: 0.10-0.40; FILLET RADII: 0.10 MAX; ANGLES: ±0°30'; SURFACE ROUGHNESS: Ra 3.2
TOLERANCES: X.X ± 0.25; XX.XX ± 0.13; XX.XXX ± 0.020
LEGEND: CRITICAL DIMENSION; MAJOR DIMENSION; (NO *) MINOR DIMENSION
THIRD ANGLE PROJECTION

DRAWN: B WELLS DATE: 6/9/2013
CHECKED: D BRADY DATE: 6/10/2013
MATERIAL: SEE NOTES
FINISH: NA
FILE NAME: 27473.SLDDRW

FUJIFILM Dimatix
109 ETNA ROAD
LEBANON, NH 03766 USA

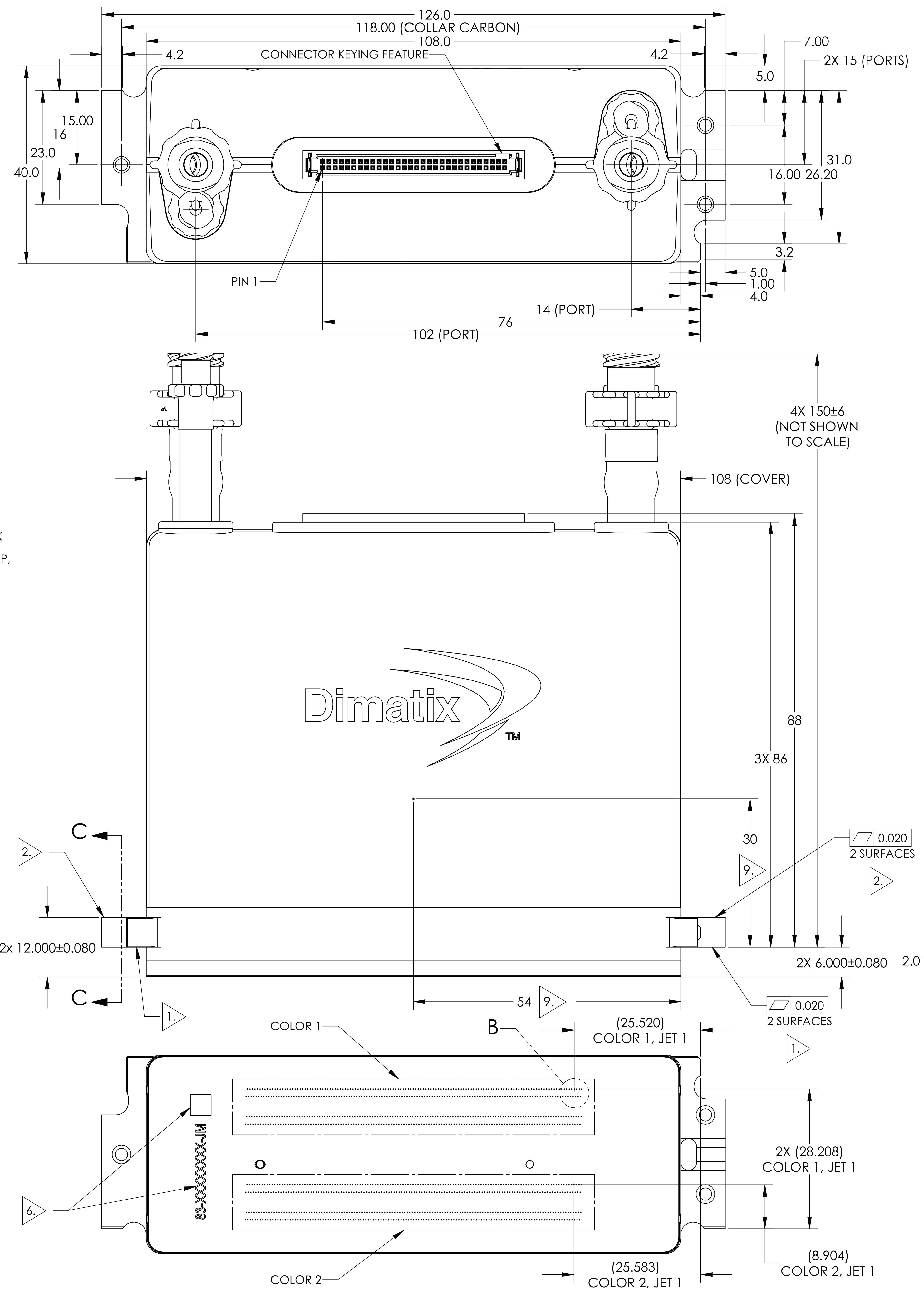
TITLE: ICD,SG1024,2 COLOR
SIZE: D DRAWING NUMBER: 27473 REV: 4
SCALE: 1:1 SHEET: 2 OF 2

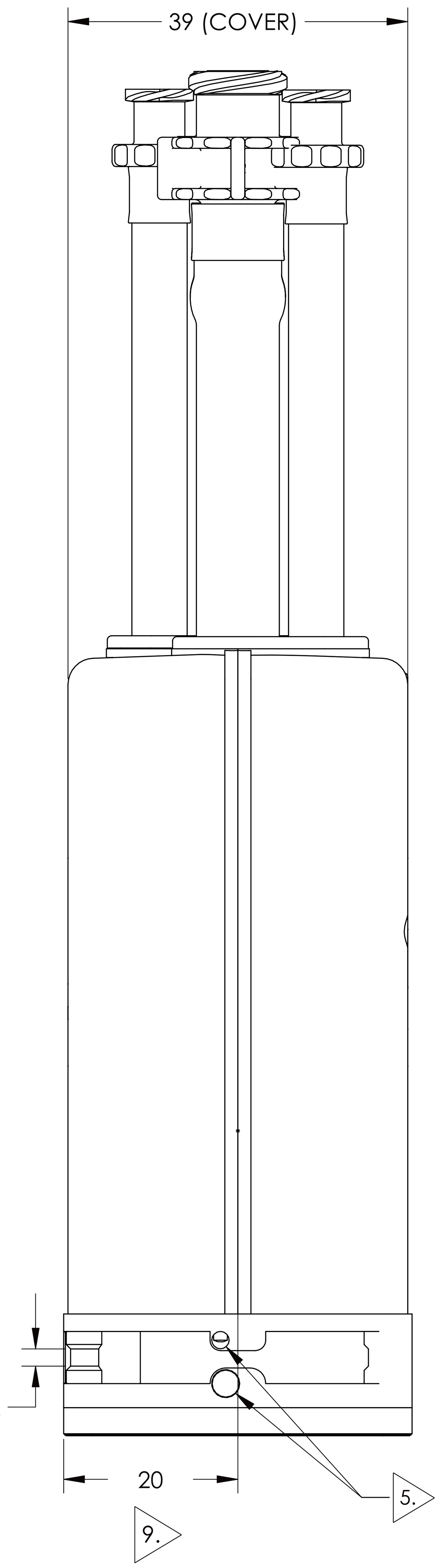
3.0 SG1024/LA2Ci Two Color Interlaced Printhead – ICD# 27474

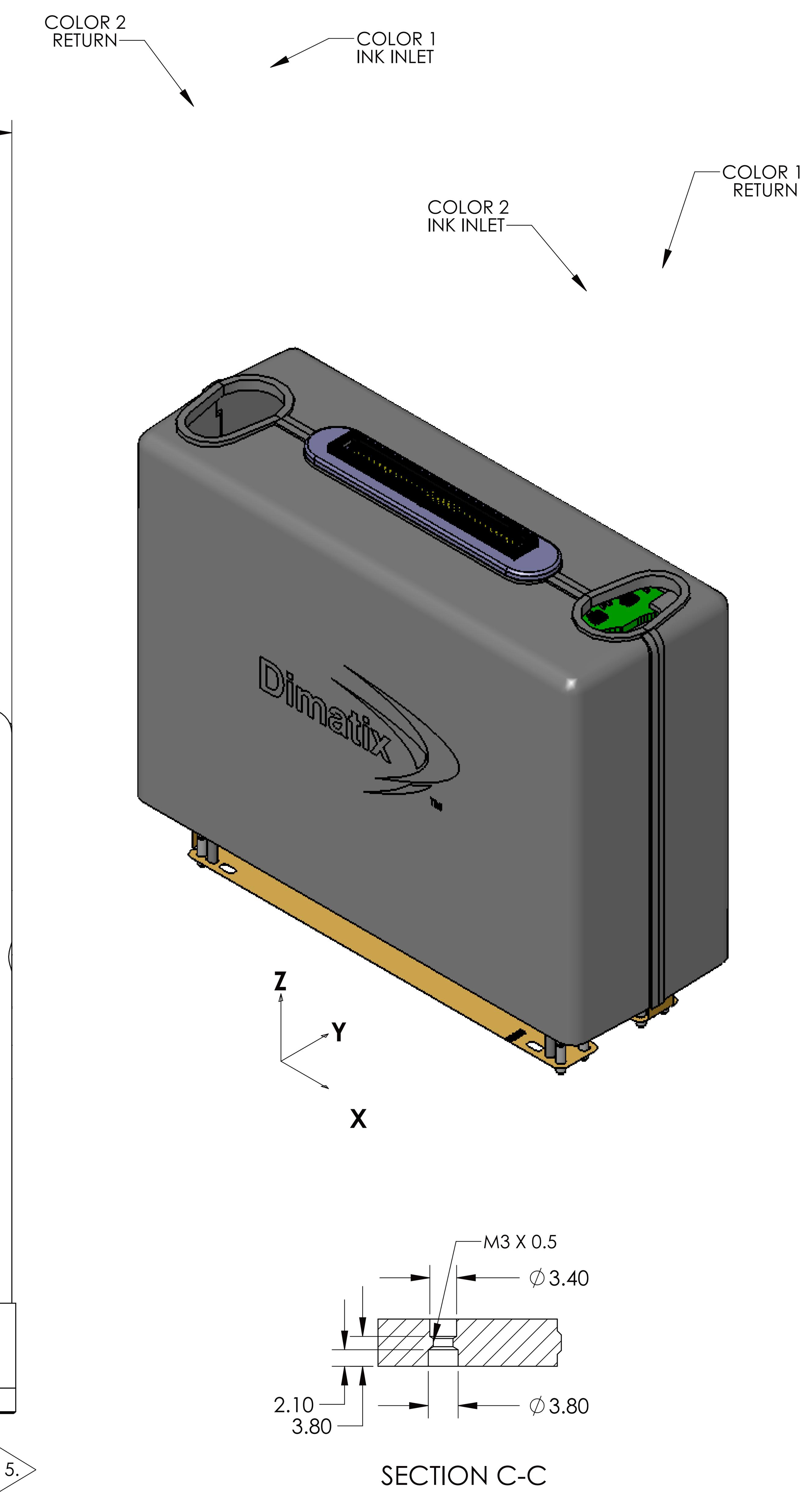
REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	DERIVED FROM 25639 REV 1	6/13/12	B WELLS	D BRADY
1	INITIAL DRAWING RELEASE PER ECO #7034	8/21/2013	B WELLS	D BRADY
2	CHANGED PER ECO #7275	11/10/2013	B WELLS	J KELLY
3	CHANGED PER ECO #7889	4/22/2014	B WELLS	D BRADY
4	CHANGE PER ECO #8015	6/18/2014	B WELLS	D BRADY

NOTES:

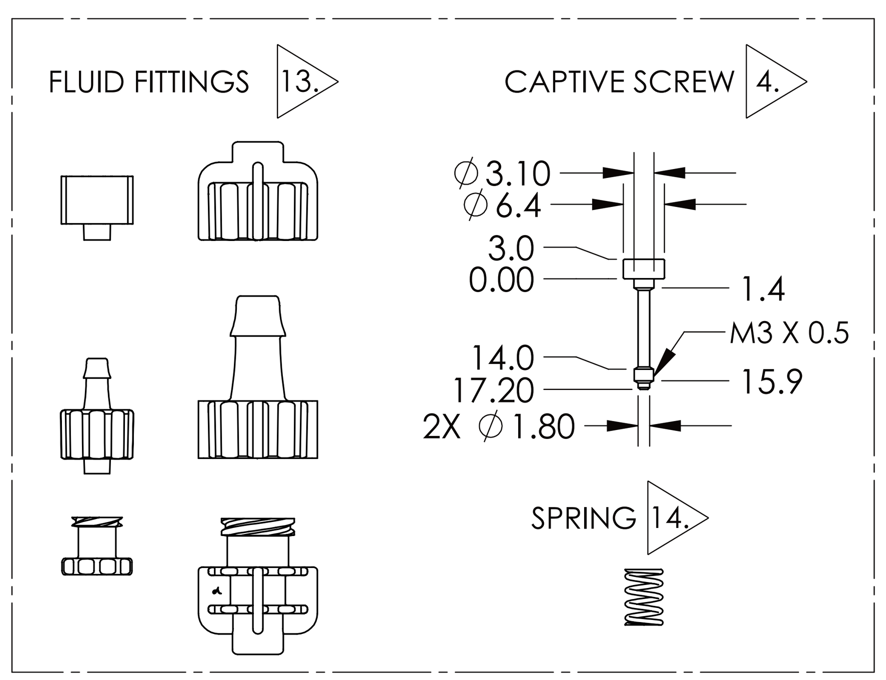
1. RECOMMENDED MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
2. ALTERNATE MOUNTING SURFACES. CUSTOMER MATING SURFACE SHOULD BE FLAT TO 0.06MM
3. ALL DIMENSIONS APPLY AT 20 DEG C
4. M3 X 0.5 CAPTIVE HEAD MOUNTING SCREW(3 SUPPLIED), 2.5 INTERNAL HEX DRIVE. SCREW MAY BE USED IN TOP DOWN OR BOTTOM UP MOUNTS. IN TOP DOWN MOUNTS, RECEIVING HOLE SHOULD BE 4.5 DEEP, FLAT BOTTOMED AND THREADED 3.5 DEEP TO ACHIEVE 12N CLAMPING FORCE WITH SUPPLIED SPRING. SEE PRODUCT MANUAL FOR DETAILS ON RECOMMENDED MOUNTING. MAX TORQUE = 0.4 N·m
5. FEATURES FOR EXTERNAL HEATER AND THERMISTOR,
   - THERMISTOR: ∅1.990±0.050, 56 DEEP
   - HEATER: ∅3.230±0.050, 84 DEEP. HEATER OPTION UTILIZES HOLE.
6. HUMAN AND MACHINE READABLE (2D CODE DATAMATRIX) SERIAL NUMBER.
7. PRECISION ALIGNMENT FEATURES
8. PRECISION SURFACE FOR APPLYING ALIGNMENT FORCE
9. LOCATION OF CENTER OF GRAVITY (C OF G)
10. DEFINITION OF JET NUMBER (JET 1) AND ROW AND NOZZLE (R3,N1)
11. THERE ARE 3 NON-FUNCTIONAL, BLANKED OFF, HOLES IN THE NOZZLE PLATE IN EACH ROW, BEFORE THE FIRST AND AFTER THE LAST FUNCTIONAL JET .
12. HIGH LOCALIZED PRESSURE, SUCH AS THE PRESSURE REQUIRED TO COMPRESS AN O-RING, SHOULD NOT BE APPLIED IN THIS AREA. SEE PRODUCT MANUAL FOR RECOMMENDATIONS.
13. FLUID FITTINGS PROVIDED WITH PRINTHEAD: WHITE AND BLACK OF EACH OF THE FOLLOWING: MALE LUER PLUG(INSTALLED), LARGE BORE MALE TAPER PLUG (INSTALLED), FEMALE LUER CAP, FEMALE LARGE BORE TAPER CAP, MALE LUER TO 3.2 ID TUBE ADAPTER, MALE LARGE BORE TAPER TO 4.8 ID TUBE ADAPTER.
14. SPRING (3 SUPPLIED):
    MATERIAL: STAINLESS STEEL. FREE LENGTH = 8.64
    OD = 5.9 ID = 4.4 SPRING RATE = 6.1 N/MM
15. ALL NOZZLES FALL WITHIN 0.012 (RADIUS) OF THEIR NOMINAL (NOM.) LOCATION.
16. DIMENSIONS WITH NO TOLERANCES EXPRESSED (E.G. X±0.0X) OR IMPLIED (BY THE TITLE BLOCK) ARE FOR REFERENCE ONLY.

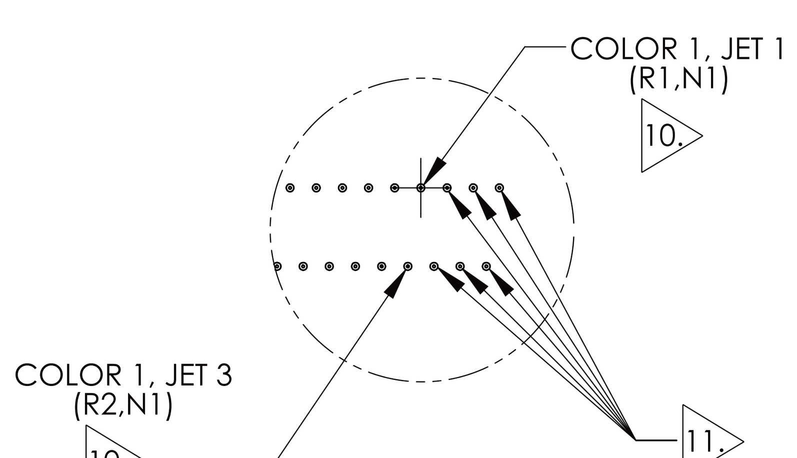






ACCESSORIES SUPPLIED





DETAIL B
SCALE 8 : 1

DO NOT SCALE FROM PRINT!	DWG INTERPRETATION: ASME Y14.5M-1994	DRAWN: B WELLS	DATE: 6/9/2013	FUJIFILM Dimatix	109 ETNA ROAD LEBANON, NH 03766 USA
INSPECTION	UNLESS OTHERWISE SPECIFIED:	CHECKED: D BRADY	DATE: 6/10/2013		
PART STATUS: NA	DIMENSIONS IN: METRIC/MM TOTAL RUNOUT: 0.15/25MM PERPENDICULARITY: 0.15/25MM EDGE BREAKS: 0.10-0.40 FILLET RADII: 0.10 MAX ANGLES: ±0°30' SURFACE ROUGHNESS: Ra 3.2	MATERIAL: SEE NOTES		TITLE: ICD,SG1024, 2 COLOR,INTERLACED	
LEGEND: ** CRITICAL DIMENSION * MAJOR DIMENSION (NO *) MINOR DIMENSION	TOLERANCES: XX.X ± 0.25 XX.XX ± 0.13 XX.XXX ± 0.020	FINISH: NA		SIZE: D	DRAWING NUMBER: 27474 REV: 4
THIS DRAWING IS PROPRIETARY AND CONSIDERED CONFIDENTIAL. NO REPRODUCTION MAY BE MADE WITHOUT WRITTEN PERMISSION FROM FUJIFILM DIMATIX,INC.	THIRD ANGLE PROJECTION	FILE NAME: 27474.SLDDRW		SCALE: 2:1	SHEET: 1 OF 2

MATERIALS IN CONTACT WITH INK (IN THE FLUID PATH)	
MATERIAL	PART OR ASSEMBLY
RESIN FILLED CARBON	ACTUATOR BODY, COLLAR, MANIFOLD
POLYIMIDE (UPILEX)	FLINK, ROCK TRAP
17-7 STAINLESS STEEL	ACTUATOR AND COLLAR LAMINATES
303 STAINLESS STEEL	COLLAR BARBS
COATED NICKEL	NOZZLE PLATE
PARYLENE	ACTUATOR ASSY
FLUOROCARBON ELAST.	INK TUBING(BLK), O-RING(BRN), (CER)
TYGON 2375	INK TUBING(BLUE), (AQ)
EPDM	O-RING(PURPLE), (AQ)
SPECTRA EPOXY	ACTUATOR AND COLLAR ASSYS
BARB EPOXY	COLLAR ASSY
NYLON	FLUID CONNECTORS

MATERIALS IN OCCASIONAL CONTACT WITH INK	
MATERIAL	PART OR ASSEMBLY
ACETAL	COVER
FLUORO SILICONE	COVER SEALS
LIQUID CRYSTAL POLYMER	CONNECTOR HOUSING

TYPICAL THERMAL EXPANSION VALUES	
PART OR ASSEMBLY	THERMAL EXPANSION
NOZZLE PITCH (X)	7.1 PPM/°C
NOZZLE PITCH (Y, ROW TO ROW)	11 PPM/°C
JET 1 TO X REG SURFACE	7.8 PPM/°C
MEASURED UNCONSTRAINED	

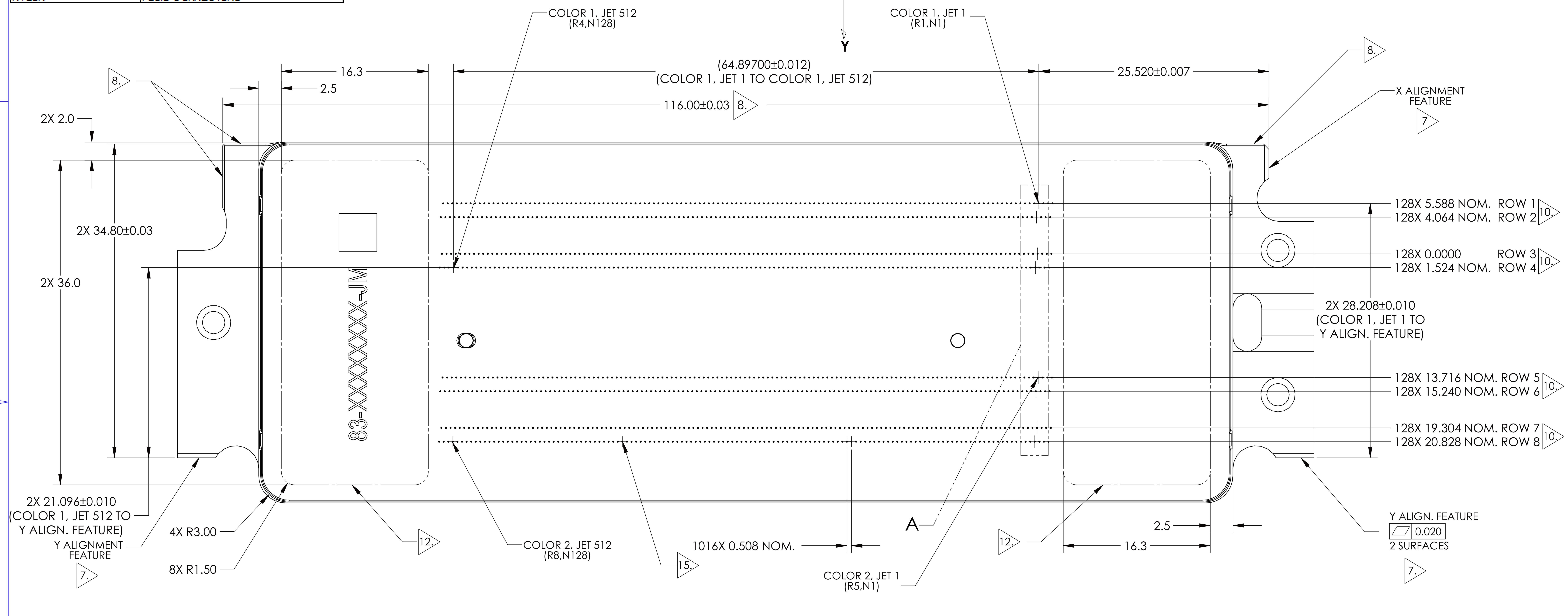
COMPONENT DETAILS	
THERMISTOR	MFG: MURATA PN: NXFT15X103FA2B150
HEATER (OPTION)	30W, 24V DC or AC(RMS)
LVDS RECIEVER	MFG: NATIONAL SEMICONDUCTOR PN: DS90C032BTM/NOPB

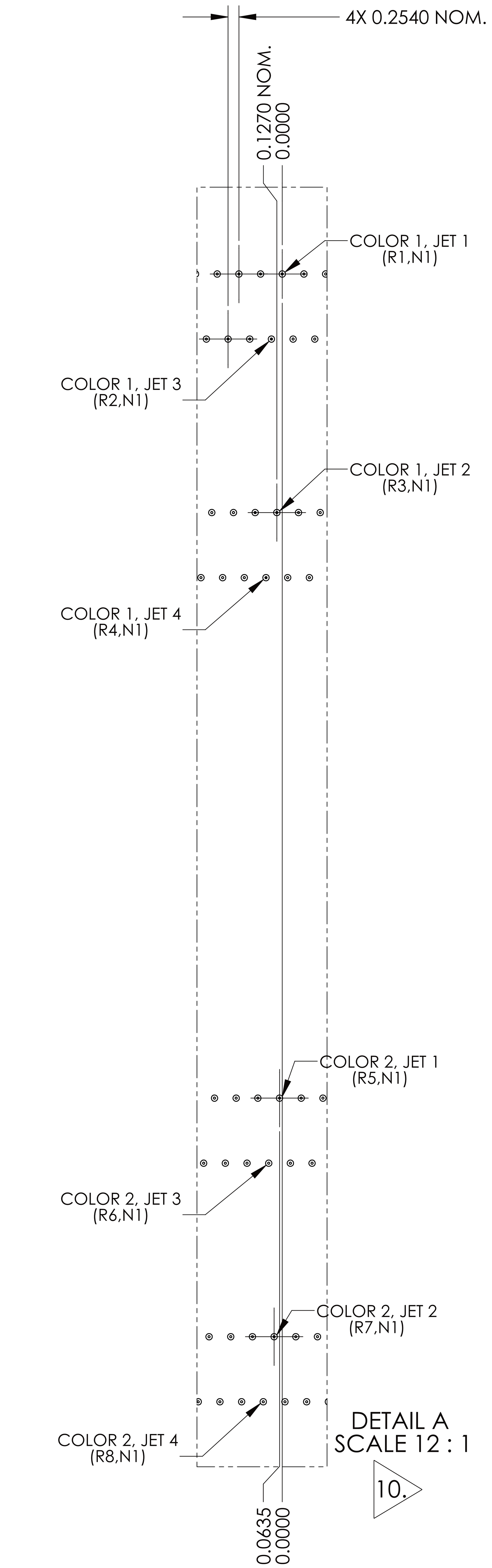
MECHANICAL PROPERTIES	
MASS	320 GM
CENTER OF GRAVITY	SEE SHEET 1 + NOTE 9
FLUID VOLUME	7.6 CC PER COLOR (TO TOP OF FITTINGS)

FLUID FITTING DETAILS 13.	
MFG: VALUE PLASTICS	
DESCRIPTION	MFG PN
FEMALE LUER TO 3.2 BARB (INSTALLED)	FTLL013-X
FEMALE LARGE TAPER TO 6.3 BARB (INSTALLED)	FLB055-X
MALE LUER PLUG	LP4-X
MALE LARGE TAPER LOC PLUG	MLBP-X
MALE LUER TO 3.2 BARB	MTLL013-X
MALE LARGE TAPER TO 4.8 BARB	MLB035-X
FEMALE LUER CAP	FTLLP-X
FEMALE LARGE TAPER CAP	FLBP-X
X = 1 FOR WHITE, X = 2 FOR BLACK	

Jet Mapping Data			
Row	Color-Jets	Connector Pins	Pixel Numbers (column)
1	C1-J1,C1-J5,...C1-509	13, 14	C1: 511, 507, 503,...3
2	C1-J3,C1-J7,...C1-511	15, 16	C1: 509, 505, 501,...1
3	C1-J2,C1-J6,...C1-J510	17, 18	C1: 510, 506, 502,...2
4	C1-J4,C1-J8,...C1-J512	19, 20	C1: 508, 504, 500,...0
5	C2-J1,C2-J5,...C2-509	21, 22	C2: 511, 507, 503,...3
6	C2-J3,C2-J7,...C2-511	23, 24	C2: 509, 505, 501,...1
7	C2-J2,C2-J6,...C2-J510	25, 26	C2: 510, 506, 502,...2
8	C2-J4,C2-J8,...C2-J512	27, 28	C2: 508, 504, 500,...0
See product manual for complete details			

REV	DESCRIPTION	DATE	REVISED BY	CHECKED BY
-	See Sheet1	-	-	-





DETAIL A
SCALE 12 : 1
10.

INTERCONNECT

Samtec ASP-166916-01

Pin Num.	Connection	Description
1	GND	Head Common
2	VCC	5.0V DC Logic power for driver chips
3	GND	Head Common
4	VCC	5.0V DC Logic power for driver chips
5	CONFIG	Configuration - Low/GND: 1-color mode - High/VCC: 2-color mode
6	GND	Head Common
7	C1_CLK_N	Negative LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
8	C1_CLK_P	Positive LVDS Data Clock Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).
9	C2_CLK_N	Negative LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
10	C2_CLK_P	Positive LVDS Data Clock Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
11	C1_LAT_N	Negative LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode).

Pin Num.	Connection	Description
12	C1_LAT_P	Positive LVDS Data Latch Signal for Color 1 (Drives all rows in 1-color mode and rows 1-4 in 2-color mode)
13	D0_N	Negative LVDS Data signal serial input for Row 1
14	D0_P	Positive LVDS Data signal serial input for Row 1
15	D1_N	Negative LVDS Data signal serial input for Row 2
16	D1_P	Positive LVDS Data signal serial input for Row 2
17	D2_N	Negative LVDS Data signal serial input for Row 3
18	D2_P	Positive LVDS Data signal serial input for Row 3
19	D3_N	Negative LVDS Data signal serial input for Row 4
20	D3_P	Positive LVDS Data signal serial input for Row 4
21	D4_N	Negative LVDS Data signal serial input for Row 5
22	D4_P	Positive LVDS Data signal serial input for Row 5
23	D5_N	Negative LVDS Data signal serial input for Row 6
24	D5_P	Positive LVDS Data signal serial input for Row 6
25	D6_N	Negative LVDS Data signal serial input for Row 7
26	D6_P	Positive LVDS Data signal serial input for Row 7
27	D7_N	Negative LVDS Data signal serial input for Row 8
28	D7_P	Positive LVDS Data signal serial input for Row 8

Pin Num.	Connection	Description
29	C2_LAT_N	Negative LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
30	C2_LAT_P	Positive LVDS Data Latch Signal for Color 2 (Drives rows 5-8 in 2-color mode, ignored in 1-color mode).
31	GND	Head Common
32	SCL	I2C Clock signal for Serial Interface
33	GND	Head Common
34	SDA	I2C Data signal for Serial Interface
35	THB	Print Head Thermistor
36	THA	Pull Up for Print Head Thermistor
37	HTRB	Ground for Print Head heater
38	HTRA	Control for Print Head Heater
39	GND	Head Common
40	GND	Head Common
41	HTRB	Ground for Print Head heater
42	HTRA	Control for Print Head Heater

Pin Num.	Connection	Description
43	GND	Head Common
44	GND	Head Common
45	GND	Head Common
46	FP0	Fire Pulse tied to Row 1
47	GND	Head Common
48	FP1	Fire Pulse tied to Row 2
49	GND	Head Common
50	FP2	Fire Pulse tied to Row 3
51	GND	Head Common
52	FP3	Fire Pulse tied to Row 4
53	GND	Head Common
54	FP4	Fire Pulse tied to Row 5
55	GND	Head Common
56	FP5	Fire Pulse tied to Row 6
57	GND	Head Common
58	FP6	Fire Pulse tied to Row 7
59	GND	Head Common
60	FP7	Fire Pulse tied to Row 8

DO NOT SCALE FROM PRINT!

INSPECTION

PART STATUS: NA

LEGEND:
** CRITICAL DIMENSION
* MAJOR DIMENSION
(NO *) MINOR DIMENSION

DWG INTERPRETATION: ASME Y14.5M-1994
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS IN: METRIC/MM
TOTAL RUNOUT: 0.15/25MM
PERPENDICULARITY: 0.15/25MM
EDGE BREAKS: 0.10-0.40
FILLET RADII: 0.10 MAX
ANGLES: ±0°30'
SURFACE ROUGHNESS: Ra 3.2
TOLERANCES:
XX.X ± 0.25
XX.XX ± 0.13
XX.XXX ± 0.020

THIRD ANGLE PROJECTION

DRAWN: B WELLS	DATE: 6/9/2013		
CHECKED: D BRADY	DATE: 6/10/2013		
MATERIAL: SEE NOTES			
FINISH: NA			
FILE NAME: 27474.SLDDRW			

FUJIFILM Dimatix
109 ETNA ROAD
LEBANON, NH 03766 USA

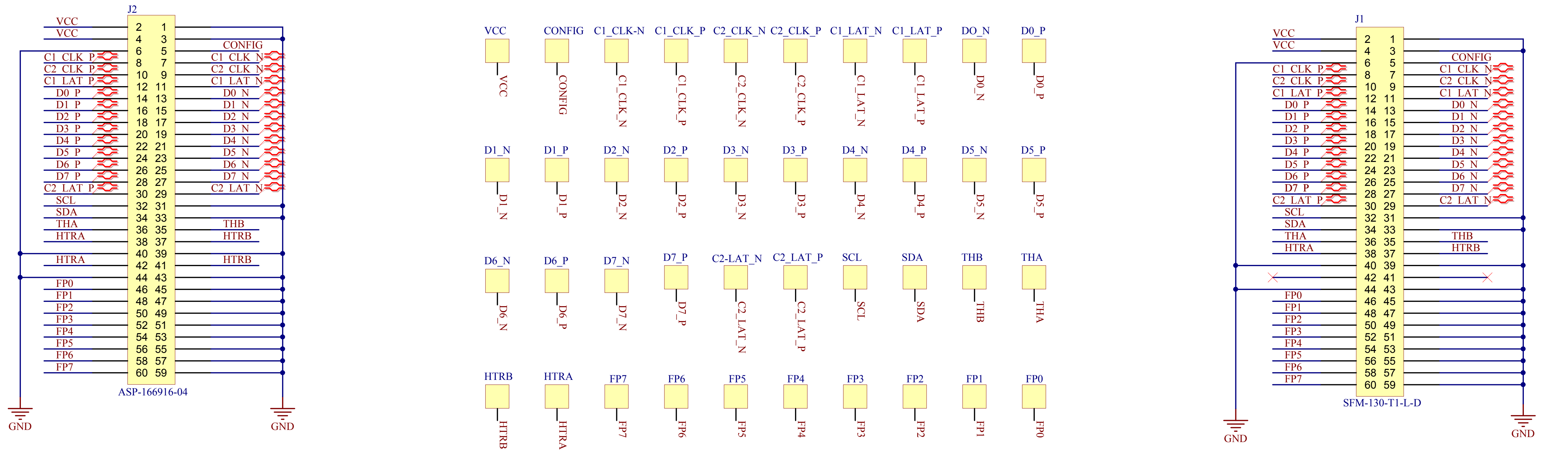
TITLE: ICD,SG1024, 2 COLOR,INTERLACED

SIZE:	DRAWING NUMBER:	REV:
D	27474	4
SCALE: 1:1		SHEET: 2 OF 2

4.0 Break out Board Schematic – P/N 28539

ZONE	LTR	DESCRIPTION	DATE	REVISED BY
	1	NOT RELEASED	4/29/2014	T MILLS
	2	INITIAL RELEASE PER ECO #9328	4/17/2015	I WASHBURN

REVISIONS



DRAWN	DATE
T MILLS	10/22/2013
CHECKED	DATE
T PRIESTLEY	10/25/2013

Dimatix FUJIFILM
109 ETNA ROAD
LEBANON, NH 03766

TITLE

SCHEM, SG1024, IN-LINE TEST

SIZE: B
28539
REV: 2

SCALE: NONE
SHEET 1 OF 1

Specifications

1.0 SG1024/A Printhead Product Specification – P/N 2100026522

FUJIFILM Dimatix

Product Specification
SG – 1024 Aqueous Family

1. SCOPE

1.1. This document describes the performance and interface requirements for the SG-1024 Aqueous Family of printheads. The SG-1024 Aqueous Family is designed for use with aqueous inks as well as UV and solvent inks. The material sets are specific to these applications as are the jetting performance targets.

2. RELATED MATERIAL

2.1. Interface Control Drawings
- 2.1.1. SG-1024XSA & SG-1024SA, SG-1024MA & SG-1024LA : 2100027472
- 2.1.2. SG-1024SA-2C & SG-1024MA-2C : 2100027473
- 2.1.3. SG-1024LA-2Ci : 2100027474

2.2. Final Acceptance Test Procedure using XL-30 Test Fluid

2.3. Waveform files

2.4. Product Manuals

3. DEFINITIONS

3.1. Crosstalk: The impact of firing neighboring jets on drop volume and velocity. This document refers to velocity crosstalk only. Crosstalk is measured as a percent change in jet velocity of a given jet when neighboring jets are turned on, $(V_{many}-V_{alone})/V_{alone}$.

3.2. Velocity Crosstalk, Average: This is the average cross talk of the entire population of printheads manufactured. This value is intended to indicate typical printhead performance.

3.3. Velocity Crosstalk, Average, max: This is the upper specification limit for the average cross talk of any individual printhead. This average indicates the average of each jet on an individual printhead.

3.4. Drop Mass Variability: Drop mass variability is the measured difference between each individual PZT drop mass (4 modules, 2 PZTs per module) from the average of all PZT drop mass results where the individual PZT drop mass is measured using the calibration voltage (FPA). The PZT average is the sum of the 8 drop mass values/8 or $(DM_{PZT\ 1\text{-}8})/8$.

3.5. Drop Velocity: The drop velocity is calculated by dividing a given standoff distance by the time it takes from the initiation of a fire pulse (including multi-pulse waveforms) for a drop to travel to the specified standoff.

3.6. FPA: Calibration voltage to achieve the target drop mass for single pulse at standard test conditions.

3.7. HADM: Head Average Drop Mass, defined as the average drop mass for all jets on all PZTs.

3.8. HIB: Head Interface Board.

3.9. ICD: Interface Control Drawing.

3.10. Jet Straightness: The angular trajectory error for each jet in the printhead. The measurement for each jet is made by printing with the head stationary and calculating the deviation from a best-fit line for drop placement across the entire head. Knowing the standoff distance, the drop placement error is translated to an angle.

3.11. Line Width: The measured width of lines printed on a coupon. The line width measurements are normalized by the average line width of all jets and reported as a %.

3.12. Meniscus Pressure: The amount of negative pressure required to maintain the free surface in the nozzles of the printhead. Meniscus pressure is usually controlled in the ink reservoir (with a free surface) that supplies the printhead.

3.13. mrad: Milliradian.
3.14. ng: Nanogram.
3.15. VersaDrop™ Maximum Productivity (ng·kHz): This is calculated by multiplying drop volume (in ng) by jetting frequency (in kHz). Maximum productivity is determined by the following jet sustainability criteria:

3.15.1. **80% stochastic**…….A single drop size, 10,000 pixel **stochastic** image is printed continuously at 80% duty cycle for 5 minutes. The VersaDrop™ Maximum Productivity specification allows for no more than a single jet dropout and/or single weak jet (4 printhead average) at selected frequency/mass combinations, up to the max operating frequency listed in 5.1.6.

3.15.2. **80% all (block)** ……A single drop size, 10,000 pixel **block** image is printed continuously at 80% duty cycle (8,000 pixels on/2,000 pixels off) for 5 minutes. The VersaDrop™ Maximum Productivity specification allows for no more than a single jet dropout and/or single weak jet (4 printhead average) at selected frequency/mass combinations, up to the max operating frequency listed in 5.1.6.

3.16. PADM: PZT Average Drop Mass, defined as the average drop mass for all jets on a single PZT.
3.17. pF: picoFarad.
3.18. Standoff: the distance measured between the nozzle plate and the substrate.
3.19. Recirculation: the movement of ink through the printhead where ink, in excess of that required for printing, is introduced to the printhead and then pulled through the printhead to be fed back to the ink delivery system.

4. STANDARD TEST CONDITIONS

4.1. *Common Conditions for All Drop Sizes and Product Models:*

4.1.1. **Meniscus pressure** ....-2.5 cm H_2O (-1.0 in. H_2O, 0.5 kPa) at the nozzle plate
4.1.2. **Orientation**....................................down spitting
4.1.3. **Standoff; line width & straightness measurements**..1.5mm (0.060 in.)
4.1.4. **Standoff; velocity measurements** 0.75 mm (0.030 in.)
4.1.5. **Test fluid**..Dimatix XL-30 (Red)
4.1.6. **Operating temperature** ....33ºC (to achieve 10-11 cP fluid viscosity)
4.1.7. **Recirculation pressure** ....51 cm H_2O below inlet pressure (5 kPa, 20 in H_2O)
4.1.8. **Deaeration device (contactor)**......2X6 contactor manufactured by Membrana (Membrana Superphobic Membrane Contactor). Vacuum supplied is 20 inches to 22 inches of mercury (20-22 inHg vacuum).

4.2. *Specific Conditions*

Product	Drop Size	Waveform (.csv)	Frequency (kHz)	Target Drop Mass (ng)	Slew Rate (V/µs)
SG-1024XSA	Small	2100020668	8	6 +/-1	30
	Large	2100301786	8	20 +/-1	20
SG-1024SA & SG-1024SA-2C	Small	2100026627	8	12 +/-1	30
	Large	2100027185	8	33 +/-1	30
SG-1024MA & SG-1024MA-2C	Small	2100025996	8	30 +/-1	30
	Large	2100025997	8	80 +/-2	30
SG-1024LA & SG-1024LA-2Ci	Small	2100025788	8	80 +/-2	30

5. SPECIFICATIONS

5.1. *General Product Description*

5.1.1. **Number Of Jets**

5.1.1.1. SG-1024XSA & **SG-1024SA & SG-1024MA & SG-1024LA**....1024 x 1 color

5.1.1.2. **SG-1024SA-2C & SG-1024MA-2C & SG-1024LA-2Ci**.....512 x 2 colors

5.1.2. **Nozzle Arrangement**

5.1.2.1. SG-1024XSA & **SG-1024SA & SG-1024MA & SG-1024LA..**…………..8 rows of 128 nozzles x 1 color

5.1.2.2. **SG-1024SA-2C & SG-1024MA-2C & SG-1024LA-2Ci**..... 4rows of 128 nozzles x 2 colors

5.1.3. **Nozzle Spacing**

5.1.3.1. SG-1024XSA & **SG-1024SA & SG-1024MA & SG-1024LA**…………..0.0635 mm (0.0025 in.)

5.1.3.2. **SG-1024SA-2C & SG-1024MA-2C & SG-1024LA-2Ci**…..0.1270mm (0.0050in.)

5.1.4. **Print Width**

5.1.4.1. SG-1024XSA & **SG-1024SA & SG-1024MA**…………...64.9605 mm (2.5575 in.)

5.1.4.2. **SG-1024SA-2C & SG-1024MA-2C & SG-1024LA-2Ci** …..64.897mm (2.5550 in.)

5.1.5. **VersaDrop™ Maximum Productivity**

5.1.5.1. **SG-1024SA & SG-1024SA-2C**………..300 ng-kHz

5.1.5.2. **SG-1024SA & SG-1024SA-2C**………..600 ng-kHz with drop sizes between 12 and 33ng.

5.1.5.3. **SG-1024MA & SG-1024MA-2C**……...900 ng-kHz with drop sizes between 30 and 80ng.

5.1.5.4. **SG-1024LA & SG-1024LA-2Ci**……...1500 ng-kHz with drop sizes between 80 and 200ng

5.1.6. **Maximum frequency**

5.1.6.1. **SG-1024XSA**

5.1.6.1.1. **Small drop (Native)**……….50 kHz
5.1.6.2. **SG-1024SA & SG-1024SA-2C**
5.1.6.2.1. **Small drop (Native)**……….50 kHz
5.1.6.2.2. **Large drop** ....……………...18 kHz
5.1.6.3. **SG-1024MA & SG-1024MA-2C**
5.1.6.3.1. **Small drop (Native)**………..30 kHz
5.1.6.3.2. **Large drop** ....………………12 kHz
5.1.6.4. **SG-1024LA & SG-1024LA-2Ci**
5.1.6.4.1. **Small drop (Native)**………..20 kHz
5.1.6.4.2. **Large drop** ....………………8 kHz
5.1.7. **Range of Fire Pulse Amplitude (FPA) for Single Pulse Operation**
5.1.7.1. **SG-1024XSA**…………65 to 115 volts
5.1.7.2. **SG-1024SA & SG-1024SA-2C**…………75 to 115 volts
5.1.7.3. **SG-1024MA & SG-1024MA-2C**….…....70 to 110 volts
5.1.7.4. **SG-1024LA**………………………………85 to 125 volts
5.1.7.5. **SG-1024LA-2Ci ……….80 to 120 volts**
5.1.8. **VersaDrop**™ **Pulse Amplitude, Maximum**
5.1.8.1. **All products**……………………………...130 volts
5.1.9. **Operating Temperature, Maximum** …………....50°C
5.1.10. **Recirculation Port Pressure** ....……………….-5 kPa (50.8 cm H2O, 20 ± 2 inches H_2O). Can be operated over a broad range of pressures.

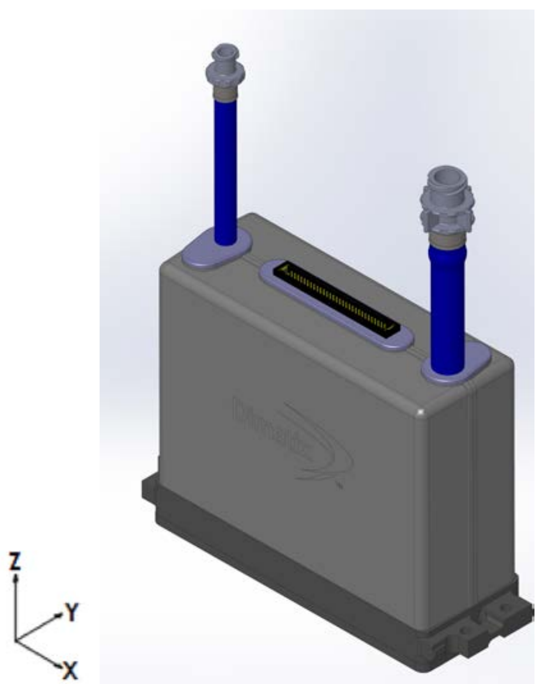


Figure 1: SG-1024SA

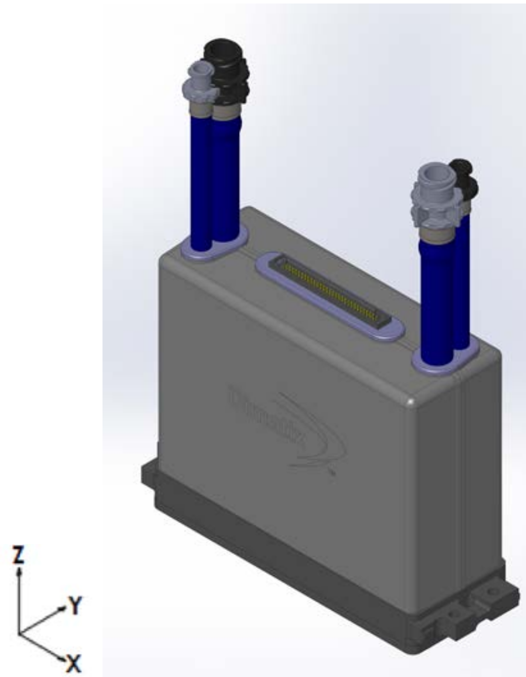


Figure 1: SG-1024SA-2C

Specific Product Descriptions

	SG-1024XSA	SG-1024SA & SG-1024SA-2C	
Drop Size	**Small**	**Small**	**Large**
Drop Mass Variability, Absolute, maximum (%)	16	10	10
Line Width, maximum deviation from mean (%), ±	12	12	12
Line Width variability, one **σ** (%), max, by module, by module	4	4	4
Line Width variability, one **σ** (%), max, by module, by PH	4	4	4
Drop Velocity, Mean, range of population (m/s), by PZT	4-9	5-10	4-7
Drop Velocity Variability, one **σ**, m/s, by PZT	0.80	0.80	0.50
Velocity Crosstalk, Average (%)	>-18	>-12	>-12
Velocity Crosstalk, Average, max (%)	-30	-17	-15
Jet Straightness, X-axis Error, maximum(See Figure 1, mrad), ±	30	30	30
Jet Straightness, X-axis Variability, one **σ**, max (mrad)	4.0	3.0	3.0

	SG-1024MA & SG-1024MA-2C		SG-1024LA & SG1024LA-2Ci	
Drop Size	**Small**	**Large**	**Small**	**Large**
Drop Mass Variability, Absolute, maximum (%)	10	10	10	10
Line Width, maximum deviation from mean (%), ±	12	12	12	12
Line Width variability, one **σ** (%), max, by module, by module	4	4	4	4
Line Width variability, one **σ** (%), max, by module, by PH	4	4	4	4
Drop Velocity, Mean, range of population (m/s), by PZT	6-10	4-7	5-10	4-7
Drop Velocity Variability, one **σ**, m/s, by PZT	0.50	0.50	0.50	0.50
Velocity Crosstalk, Average (%)	>-12	>-12	>-12	>-12
Velocity Crosstalk, Average, max (%)	-15	-15	-15	-15
Jet Straightness, X-axis Error, maximum(See Figure 1, mrad), ±	30	30	30	30
Jet Straightness, X-axis Variability, one **σ**, max (mrad)	3.0	3.0	3.0	3.0

5.2. *Reliability*

5.2.1. **Product Life** .... The product is tested using standard test conditions to confirm product life of 12 months with normal exposure to compatible fluids where the head average drop mass degrades by less than 10%. Printheads can be repaired.

5.3. *Materials Compatibility*

5.3.1. **Jetted and Flushing Fluid Materials**…...The products have been designed to be compatible with fluids of the following type:

5.3.1.1. Aqueous, and UV inks*

5.3.1.2. Dimatix XL-30, red test fluid

*****Performance and reliability with any given fluid must not be assumed without assurance of sufficient testing of that fluid with this product. Please inquire with Dimatix Technical Support.

* Inks with high conductivity and characteristics that have the ability to penetrate polyimide are known to cause shorts in a small percentage of printheads.

5.4. *Operating Environmental Conditions at Printhead*

5.4.1. **Temperature** ....10 – 50 °C

5.4.2. **Humidity** ....10 –90% R.H., non-condensing

5.4.3. **Dust**...Care should be taken to reduce dust and particulate in the environment adjacent to the printhead. Reductions in airborne particulate will reduce overall maintenance required.

5.4.4. **Acceleration** ....Product designed for applications where the printhead is stationary. Some deterioration in jetting performance is expected if required to print during acceleration. Evaluate product performance if using in non-stationary application.

5.5. *Mechanical Interface*

5.5.1. The mechanical interface with dimensions of the products is defined on the Interface Control Drawings.

5.6. *Electrical Interface*

5.6.1. **Fire Pulse Amplitude, maximum**... The products will not suffer permanent damage up to 150 volts. Fire Pulse Amplitudes are dependant upon the application and should be evaluated prior to system design.

5.6.2. **Slew Rate, maximum**...................The products will not suffer permanent damage up to a maximum slew rate of 80 volts/µsec. The slew rate is dependant upon the application and should be evaluated prior to system design.

5.6.3. **Capacitance**

5.6.3.1. **SG-1024XSA & SG-1024SA & SG-1024SA-2C**……..The typical equivalent capacitance for any channel is 85pF, with a maximum equivalent capacitance of no more than 100pF at room temperature (~23°C).

5.6.3.2. **SG-1024MA & SG-1024MA-2C**……. The typical equivalent capacitance for any channel is 145pF, with a maximum equivalent capacitance of no more than 165pF at room temperature (~23°C).

5.6.3.3. **SG1024LA & SG-1024LA-2Ci**……The typical equivalent capacitance for any channel is 210pF, with a maximum equivalent capacitance of no more than 235pF at room temperature (~23°C).

5.6.4. **Thermistor** .... An active thermistor is permanently mounted in the middle of the head and is electrically accessible through the main printhead connector. See the ICD and the SG-1024 HIB Electrical Specification for interface and thermistor properties.

5.6.5. **Heater(s)**.......................................Heating is facilitated through the mounting features as described on the ICD. A heater is also part of the assembly and accessed through the main connector of the printhead. See the ICD and product manual for details and recommended implementation.

5.6.6. **Data Path**......................................Refer to the SG-1024 Electrical section in the product manual.

5.6.7. **Data Chip** ....Refer to the SG-1024 product manual, Appendix D, for more detailed information. The following information is contained on the data chip on each module (8X): tested level part number, serial number (collar serial number), date, calibration voltage (entire 1024-jet head), drop mass offset (for this flex), nozzle pitch (mm) and edge to jet 1 distance (mm).

5.7. ***Maintenance***

5.7.1. **Nozzle Plate Maintenance** ....Nozzle face of printhead will accommodate common industry procedures of wiping, capping, and vacuum purging. See the ICD for design considerations for capping the printhead.

5.7.2. **Purge Pressure, maximum**........30 kPa (0.30 bar, 4 psig)

5.8. ***Regulatory Compliance***

5.8.1. **CE, UL** ....Products are not tested for regulatory compliance (either CE or UL). The OEM is responsible for ensuring the end product is compliant with the appropriate regulatory requirements.

5.8.2. **RoHS/WEEE**.............................Printhead is RoHS/WEEE compliant. Please contact Dimatix Technical Support for the specific standard and supporting data.

5.9. ***Shipping & Packaging***

5.9.1. **Temperature** .... The products can be shipped or stored at temperatures between –40 and 65°C.

5.9.2. **Humidity** .... 10 – 90% non-condensing relative humidity

5.9.3. **Packaging** .... The product is packaged in a two piece RPET box with anti-static properties. Fittings and screws are included in the box for use with the printhead. See the product manual for more information.

5.9.4. **Altitude**... Suitable to be shipped by air.

5.9.5. **Residual Fluids** .... Product will be shipped with a residual amount of test fluid.

5.9.6. **Product Marking**......................... The product's packaging is clearly marked with the Dimatix part number, serial number, FPA, and Pitch. The Dimatix® logo is visible on the printhead.

5.9.7. **Serial Number**.............................. Product serial number is indicated with both human readable and barcode markings on printhead and on the packaging.

5.9.8. **Shelf Life** .... 12 months.

5.9.9. **Shock and Vibration** .... as defined in ISTA 1A 2001 3A

5.9.10. **Print Test Coupon** .... Provided.

5.10. ***Refurbishment***

5.10.1. This product is designed to facilitate refurbishment. Please contact Dimatix for the service policy for this product.

5.11. ***Disposal***

5.11.1. This product is constructed with materials containing lead and needs to be disposed in accordance with the RoHS/WEEE and/or other applicable regional regulations.

2.0 SG1024 Flex EEPROM Data Format and Interface Specification

SG-1024 Flex EEPROM Data Format and Interface Specification

Table of Contents

1 Introduction

This document describes the interface to the SG-1024 flex EPROM and the format of the data stored in this EEPROM. The physical memory is the on-chip EEPROM of a Microchip PIC 16F1823 14-pin TSSOP microprocessor mounted on the print head's flex. Firmware running on this micro supports read/write access to the data via an I2C interface (see the Host/Print Head Data Manager interface section for the details of this interface). Each of the SG-1024's flexes has its own EEPROM used to store data related the flex For the purpose of this spec, the chip and firmware package are referred to as the Print Head Data Manager.

Each flex of the print head assembly's 8 flexes has a unique address. These addresses [0x50..0x57] are determined by 3 address lines from the HIB. The HIB is designed so that rows 1, 2, 3, 4, 5, 6, 7, 8 correspond to addresses 0x50, 0x51, 0x52, 0x53, 0x54, 0x55, 0x56, 0x57. Each flex's Print Head Data Manager reads the address lines during initialization and determines its address.

The Print Head Data Manager also stores the PZT/calibration information (up to 61 bytes) in the PIC's EEPROM. The PZT information is similar to the module ID information that is currently stored on a Sapphire module's Dallas EEPROM chip. There is also a 64 byte area of EEPROM reserved for customer use. The host controller can read and write to the 64 byte area of EEPROM reserved for customer use at any time, but access to the 61 bytes of PZT information is read-only.

EEPROM address 0xFF is the control register. The host can command the Print Head Data Manager to perform a variety of functions by writing specific values to this register.

2 Host/Print Head Data Manager Interface

The host/Print Head Data Manager communications protocol is I2C. This requires only three wires: data (SDA), clock (SCL), and ground return. SCL and SDA must be pulled up to 5 V by the host using 10K pull up resistors. The mode is 7 bit addressing, 100 KHz speed, and clock stretching is supported (see I2C-Bus Specification for details). The I2C-Bus Specification is available online at: http://www.nxp.com/documents/user_manual/UM10204.pdf. The host controller is the bus master and initiates all transactions. All transactions are either read or write transactions. If the Print Head Data Manager is busy and not able to receive a read/write command (possibly during power up sequence or EEPROM access), it alerts the host (holds I2C clock low) and the host will wait until the Print Head Data Manager is ready to receive again.

EEPROM address 0xFF is the control register. The host can command the Print Head Data Manager to perform a variety of functions by writing specific values to this register.

The Print Head Data Manager holds the I2C clock line low until it completes executing each command received. This prevents the host from sending another command before the Print Head Data Manager is ready.

2.1 Physical I2C bus

The physical I2C bus is just two wires, called SCL and SDA. SCL is the clock line. It is used to synchronize all data transfers over the I2C bus. SDA is the data line. Both SDA and SCL are bidirectional lines, connected to a 5 V supply via a 10K current-source or pull-up resistor. The output stages of the host must have an open-drain or open-collector to perform the wired-AND function. What this means is that the host can drive its outputs low, but it cannot drive them high. If the pull-up resistors are missing, the SCL and SDA lines will always be low - nearly 0 volts - and the I2C bus will not work.

Some implementations of the I2C may not use bidirectional lines for SCL. These implementations rely on delays instead of clock stretching for synchronization. This approach is not recommended. We recommend using bidirectional lines with clock-stretching supported.

2.2 Write Transactions

Each write transaction consists of the following single byte transfers:

1. Host sends a start sequence
2. Host sends I2C address of the flex with the R/W bit low. The device address is stored in the upper 7 bits and the R/W bit is in bit0 (0= write, appears as even address).
3. Host sends the EEPROM address (0x0000..0x00FF) of the byte you want to write to. This is referred to as the sub address field. It is a 2-byte field with the MSB sent first.
4. The host sends the data byte to the Print Head Data Manager.
5. The host may continue to sending data bytes to the Print Head Data Manager. The firmware increments the sub address (EEPROM byte address) by 1 on each consecutive transfer.
6. The host terminates the transaction by sending the stop sequence.

2.3 Read Transactions

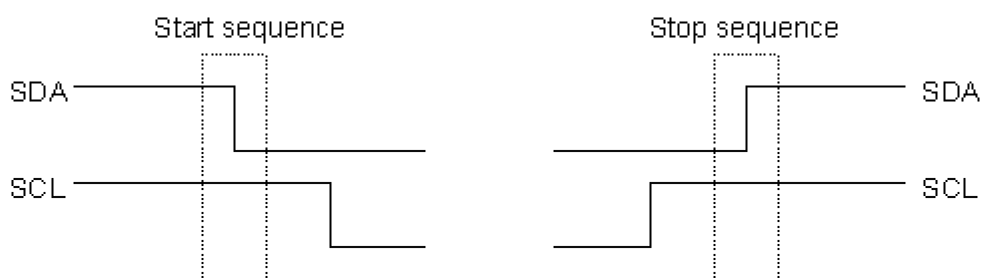
Each read transaction consists of the following single byte transfers:

1. The host sends a start sequence
2. Host sends the device address (I2C device address of the flex) with the R/W bit low (write). The device address is stored in the upper 7 bits and the R/W bit is in bit0.

3. Host sends the address (0x0000..0x00FF – MSB first) of the EEPROM byte that you want to read.
4. Host sends a start sequence again (repeated start). A start sequence is considered a repeated start if the previous transaction has not been terminated by a stop sequence.
5. Host sends I2C address of the flex with the R/W bit high. The device address is stored in the upper 7 bits and the R/W bit is in bit0 (1= read, appears as odd address).
6. The Print Head Data Manager holds the clock line low until it has read the byte at the requested address and is ready to transmit it to the host. When it is ready to transmit, the Print Head Data Manager releases the clock line and begins transmitting the requested byte, bit by bit, on consecutive clock pulses.
7. Host reads the data byte from the Print Head Data Manager.
8. The host may continue to read data bytes from the Print Head Data Manager by continuing to drive the clock without sending a stop sequence. The sub address (EEPROM byte address) is incremented by 1 on each consecutive transfer.
9. Host sends the stop sequence.

2.4 Start and Stop Sequence

A start (or restart) sequence is one of two special sequences defined for the I2C bus, the other being the stop sequence. The start (or restart) sequence and stop sequence are special in that these are the only places where the SDA (data line) is allowed to change while the SCL (clock line) is high. When data is being transferred, SDA must not change while SCL is high.



3 EEPROM Layout

0x00	Reserved
	• • • • •
0x7F	Reserved
0x80 0xBF	Reserved for Customer
0xC0 0xFC	PZT/Calibration Info
0xFD	Firmware Version
0xFE	Blank & Polarity
0xFF	Control Register

3.1 Customer Area

EEPROM byte addresses 0x80 to 0xBF are reserved for customer use. This area of EEPROM may be read or written at any time by the host. It is the customer's responsibility to mange access to this area in the host software.

3.2 PZT/Calibration Information

The upper 61 bytes of EEPROM (byte addresses 0xC0 to 0xFC) are reserved for storing the PZT info. This area of EEPROM may be read at any time by the host. This data is intended to be written once only during manufacture. This area of EEPROM is locked (write protected).

PZT/Calibration Information Data Format

- Data length – 1 Byte HEX
- File Format – ASCII
- Printhead tested level part number – ASCII
- Printhead serial number (collar serial number) – ASCII
- Date – ASCII
- Printhead calibration voltage (entire 1024-jet head) – ASCII

- Printhead drop mass offset (for this flex) – ASCII
- Nozzle pitch (mm) – ASCII
- Edge to jet 1 distance(mm) – ASCII
- Checksum – 1 Byte HEX

All fields except for the data length and Checksum are ASCII strings. The Data length and Checksum fields are single bytes (unsigned 8-bit integers). All fields are separated by commas (‘,’ or 0x2C) except for the data length byte and the file format. There is no delimiter between the data length byte and the file format. The checksum byte (1) and the data length byte (1) are not included in the data length value; the length byte indicates data length only.

3.3 Firmware Revision

EEPROM address 0xFD is the firmware revision register. This byte holds a value between 0 and 254 to identify the firmware revision. The host may read this byte at any time. 255 is not a valid firmware version number.

3.4 Control Register

EEPROM address 0xFF is the control register. The host can command the Print Head Data Manager to perform a variety of functions by writing specific values to this register. The host can command the Print Head Data Manager to reset by writing a value of 0xF0 to the control register.

4 Multiple Head Systems

Each flex of the print head assembly’s 8 flexes has a unique address. These addresses [0x50..0x57] are determined by 3 address lines from the HIB. Since the flex addresses are determined by 3 address lines, the maximum number of unique addresses is 8. Each device on an I2C bus must have a unique address. This means that multiple heads may not be connected through a single I2C bus.

In systems where each head is connected to a separate controller card, there should not be any problem communicating with multiple heads. Each controller card would communicate with its head’s 8 Print Head Data Managers over an I2C bus. The communications between the print head controller card and the host could be fiber, LVDS, or something else. The key is that each controller card is an I2C master and it communicates with the 8 flexes (slave devices) of the print head it is controlling. Each head / controller card uses its own I2C bus.

Another option for systems where a card controls more than 1 head could be to use a multiplexer to switch the I2C link from head to head. The PCA9547 is an 8-channel I2C multiplexer made by NXP. For a data sheet go to:

http://www.nxp.com/documents/data_sheet/PCA9547.pdf

SG1024/A Performance

The performance information contained in this appendix is the result of our test results using XL-30 Model Fluid. The following sections provide information about the XL-30 Model Fluid, the waveforms used in the testing, and the performance curves.

1.0 XL-30 Model Fluid

The performance curves shown later in this appendix were created jetting XL-30 Model Fluid. XL-30 is a more suitable test fluid for applications using UV and aqueous jetting fluid applications. The following table details the physical properties of the XL-30 test fluid and shows the comparative values of 7060 and Prova model fluids. XL-30 model fluid is the reference fluid for the printhead specifications and for the performance measurements shown in the following sections. Ink providers should provide analogous data measured for their jetting fluids, to assist the optimization of printhead performance with the chosen ink.

Table C-1 Physical Properties of Model Fluids

Properties	XL-30	7060	Prova
Viscosity (cP)	10.6 @ 30° C	11.1 @ 70° C	11.4 @ 30° C
Density (g/cm^3)	1.082 @ RT	1.008 @ RT	0.950 @ RT
Surface Tension ($dynes/cm^2$)	38 @ RT	35 @ RT	32 @ RT
Speed of Sound (m/sec)	1380 @ RT	1924 @ RT	1329 @ RT

The following graph shows the Viscosity Sweep for the XL-30 Model Fluid.

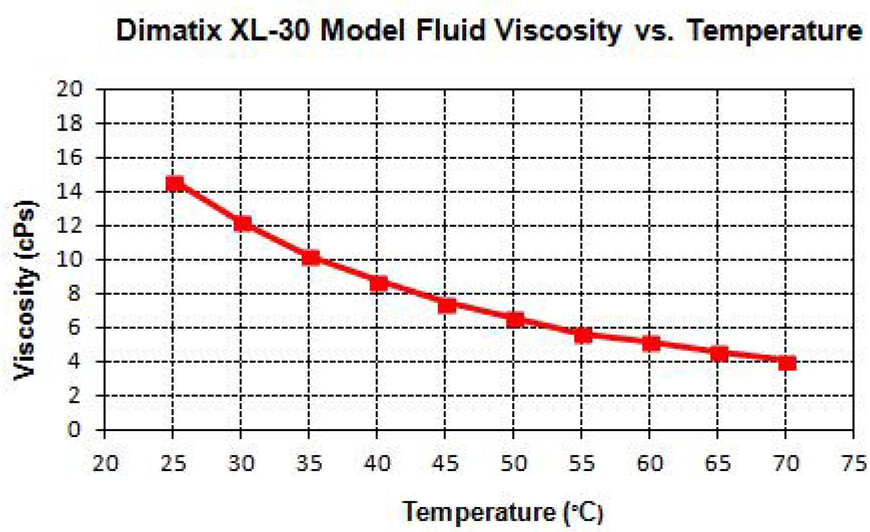


Figure C-1 XL-30 Viscosity Sweep

The following graph shows the XL-30 Model Fluid shear rate.

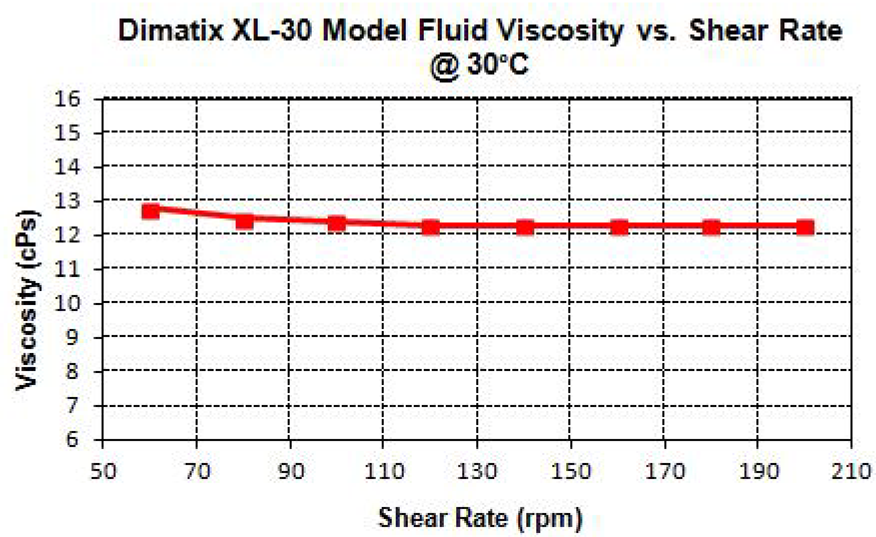


Figure C-2 XL-30 Shear Rate

2.0 Performance Attributes

2.1 Drop Mass

For imaging applications, adequate drop mass is essential in order to achieve solid area fill and to mask drop placement errors. Jet to jet drop mass uniformity should be considered when developing the image model. Average drop mass may vary with respect to jetting frequency.

2.2 Jet Straightness

Drop trajectory errors are the angular deviation from the ideal (perpendicular to the nozzle plate). Process direction straightness, in conjunction with drop velocity uniformity, determines edge raggedness, but in most cases this is not as critical as cross-process jet straightness.

Reducing the standoff distance between the nozzles and the substrate as much as possible minimizes jet-straightness drop placement errors.

2.3 Drop Velocity

For imaging applications, adequate drop velocity and velocity uniformity are essential for accurate drop placement in the process direction. For a given velocity variability, drop placement errors are directly proportional to the process velocity and standoff distance, and inversely proportional to the drop velocity. Drop velocity varies with frequency and is affected by both fire pulse amplitude and fire pulse width.

Reducing the standoff distance between the nozzles and the substrate as much as possible minimizes velocity related placement errors.

2.4 Crosstalk

Another contributor to jet-to-jet variability is crosstalk, or the affect on the drop mass/velocity of one channel from the simultaneous operation of neighboring jets. Crosstalk effects can be either negative (decreasing the drop mass/velocity) or positive (increasing the drop mass/velocity). The specified maximum crosstalk value is the combined effect from all causes: electrical, fluidic, and mechanical. It is measured as the velocity variation between one jet vs. all jets firing.

2.5 Frequency Response

We typically show Frequency Response curves for drop mass, drop velocity, and cross talk. These curves are shown with either measured units or normalized values relative to the value at a reference frequency such as 8 kHz. The low frequency portion is flat, suggesting that the typical response at which values will vary at frequencies above 10 kHz. Use the frequency response and sustainability to identify “sweet/sour” frequency bands. Performance may be modulated by use of voltage amplitude or pulse width in these regions.

3.0 SG1024/XSA Performance Data

The performance curves shown in the following sections were created using XL-30 Model Fluid heated to 33° C at the nozzle plate. The recirculation vacuum was set to 20 inches H_2O and a large contactor (20-25 inches Hg) was used for degassing.

3.1 Jetting Characteristics – SG1024/XSA – Single Pulse with JSP

The single pulse performance curves shown for the SG1024/XSA printhead were produced using waveform, part number 2100026626. This waveform has a trailing jet straightening pulse. It is a 4.5µs single pulse with a 30 V/µs slew rate..

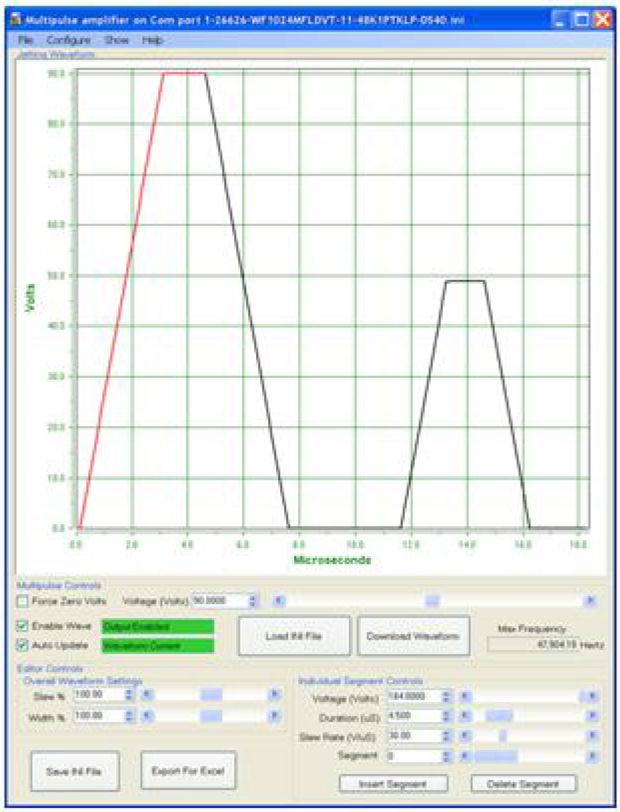


Figure C-3 Single pulse waveform P/N 2100026626 with JSP

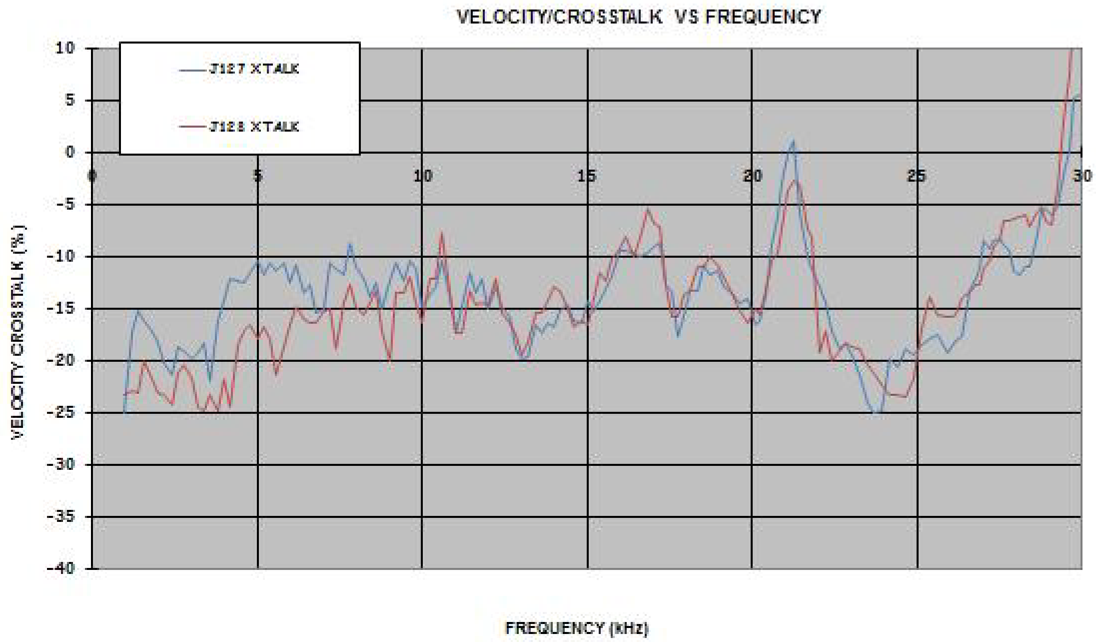


Figure C-4 SG1024/XSA Frequency vs. Velocity/Crosstalk with JSP

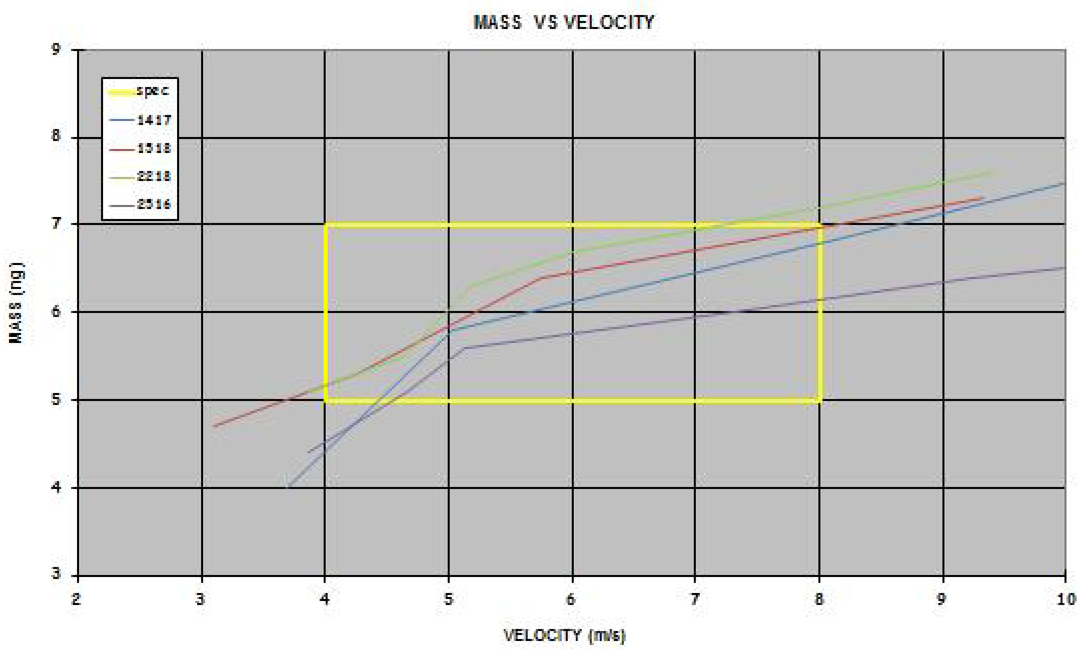


Figure C-5 SG1024/XSA Mass vs Velocity with JSP

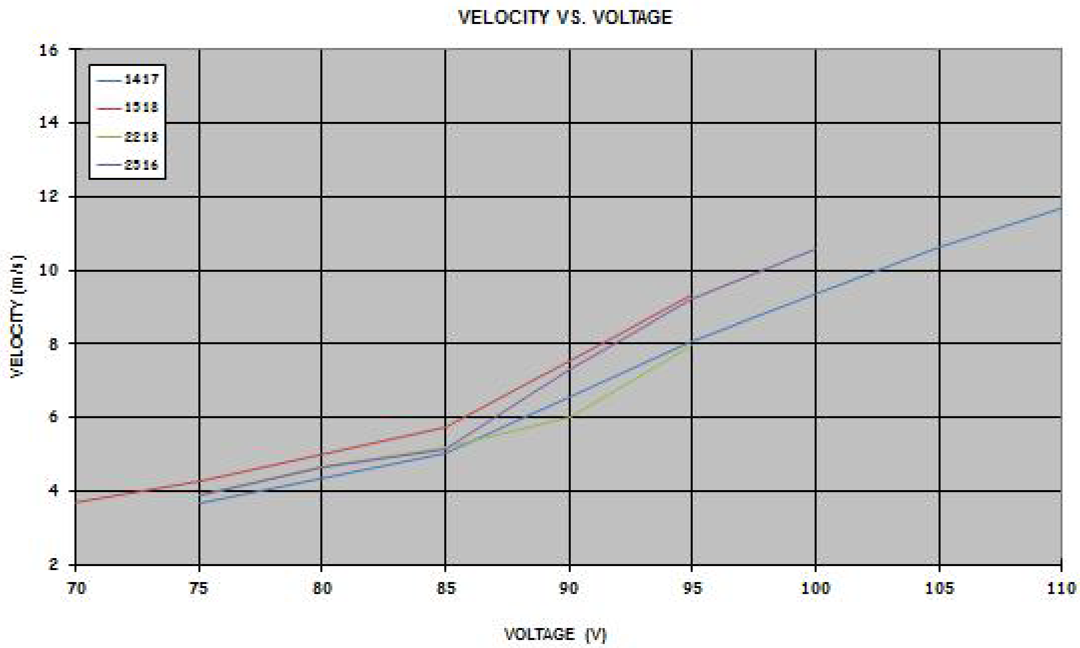


Figure C-6 SG1024/XSA Velocity vs Voltage with JSP

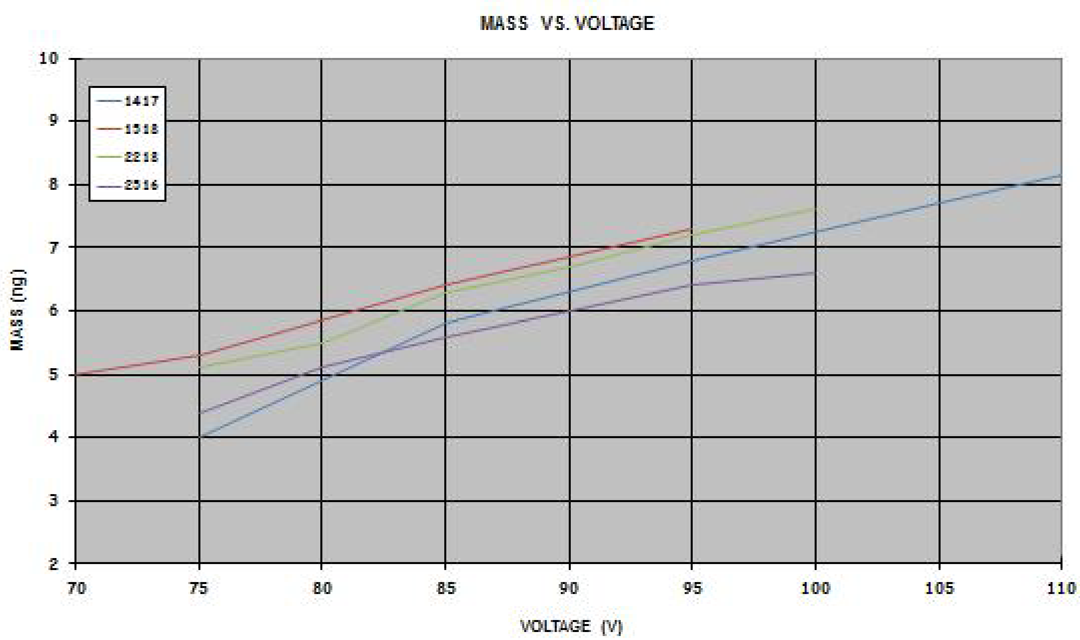


Figure C-7 SG1024/XSA Mass vs Voltage with JSP

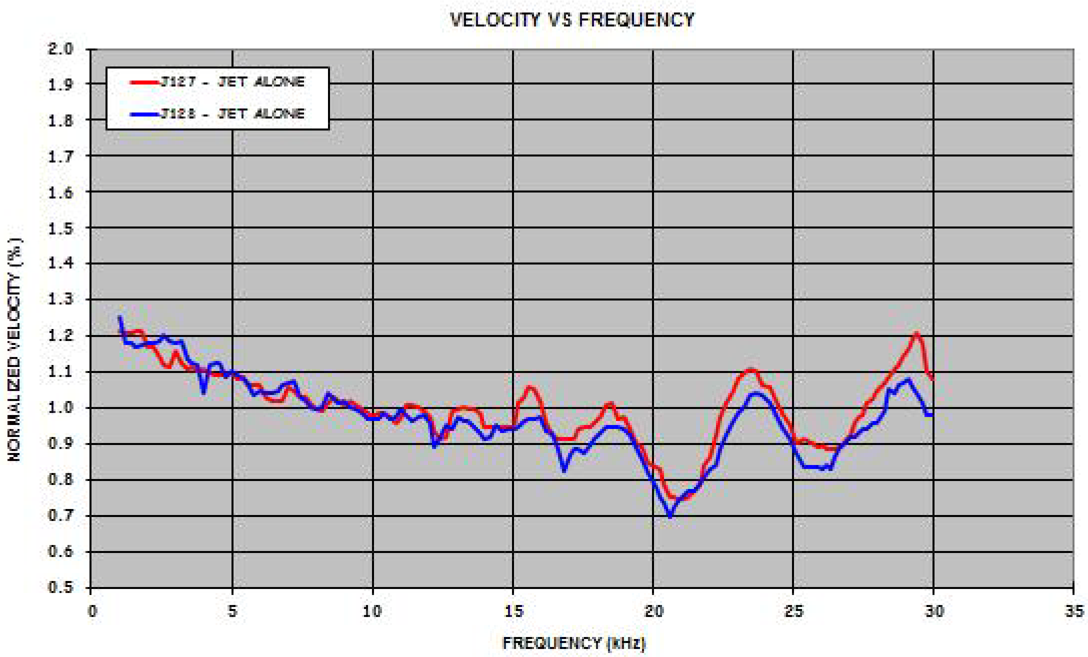


Figure C-8 SG1024/XSA Velocity vs Frequency – alone with JSP

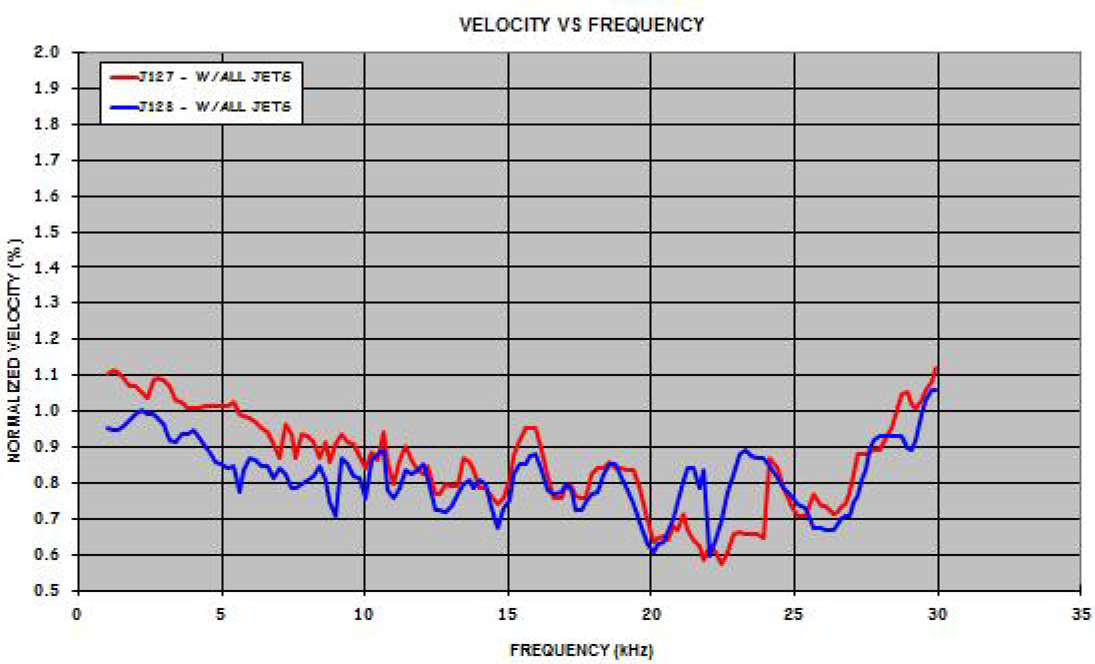


Figure C-9 SG1024/XSA Velocity vs Frequency – all with JSP

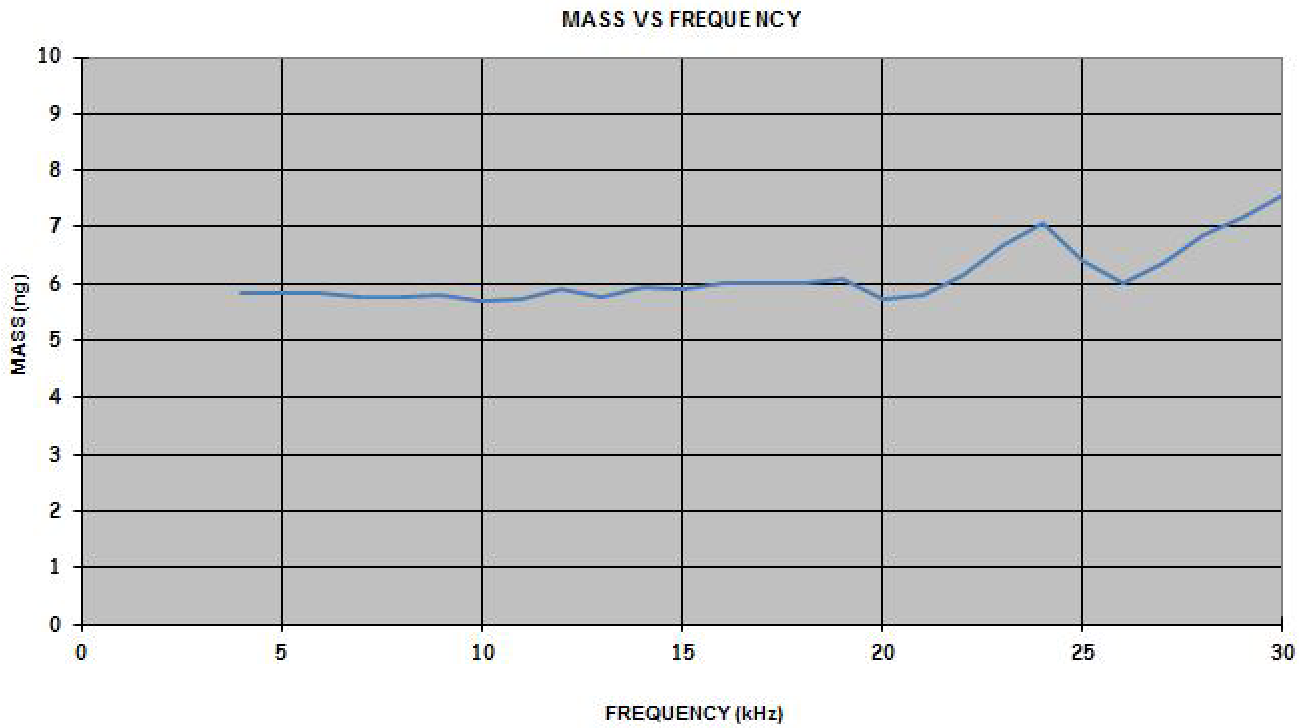


Figure C-10 SG1024/XSA Mass vs Frequency with JSP

3.2 Jetting Characteristics – SG1024/XSA – Single Pulse without JSP

The single pulse performance curves in this section for the SG1024/XSA printhead were produced using waveform, part number 2100026064. The waveform did not have a trailing jet straightening pulse. It is a 4.5 µs single pulse with a 30 V/µs slew rate.

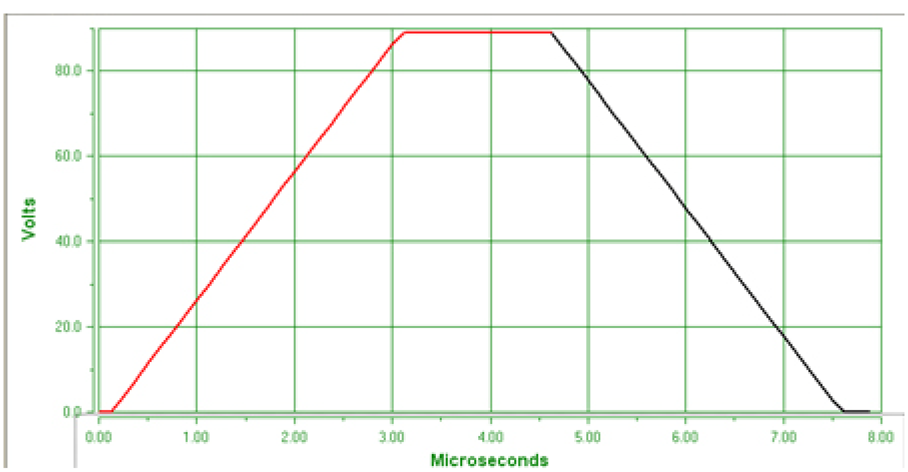


Figure C-11 Single pulse waveform P/N 2100026064 without JSP

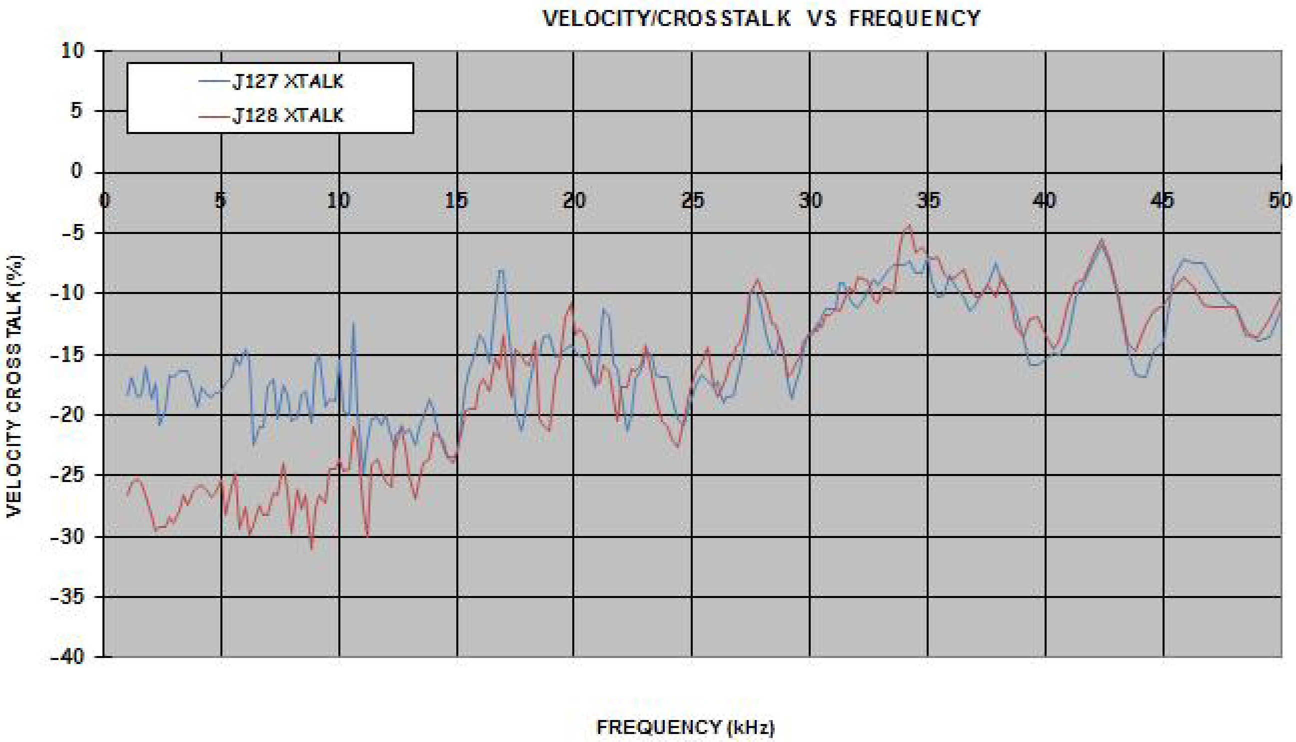


Figure C-12 SG1024/XSA Frequency vs. Velocity showing Percent Crosstalk without JSP

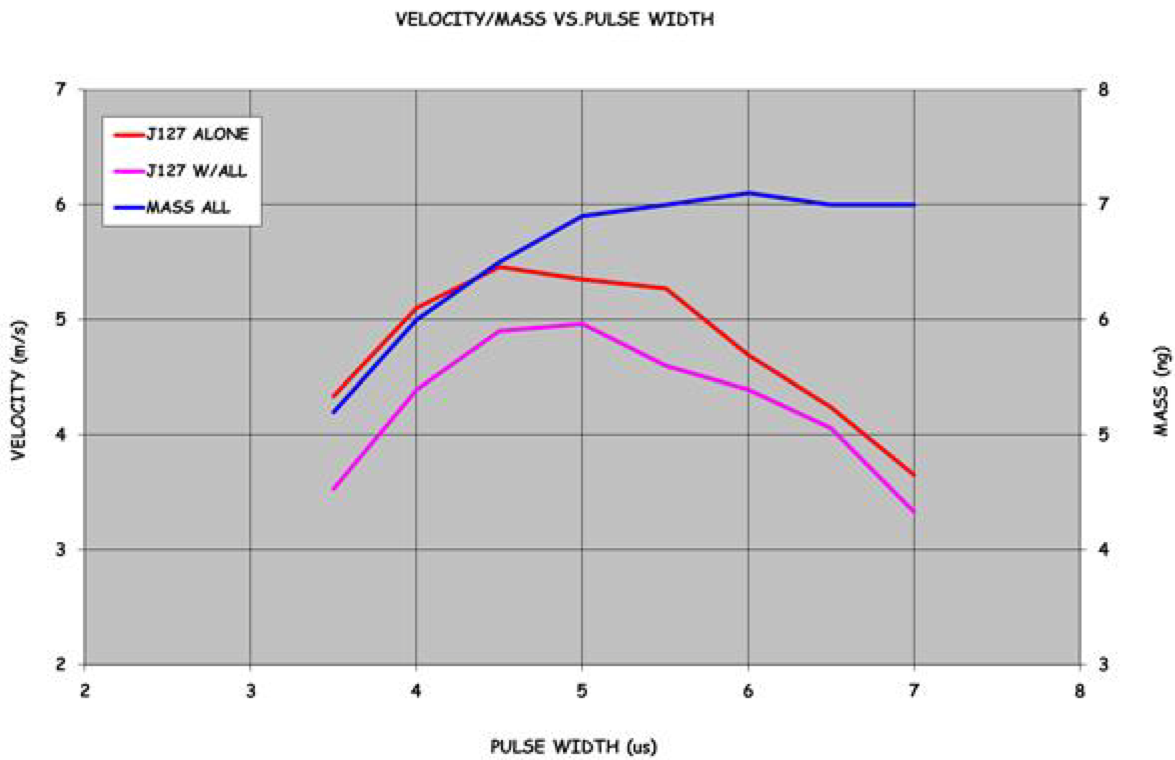


Figure C-13 SG1024/XSA Velocity and Mass vs Pulse Width without JSP

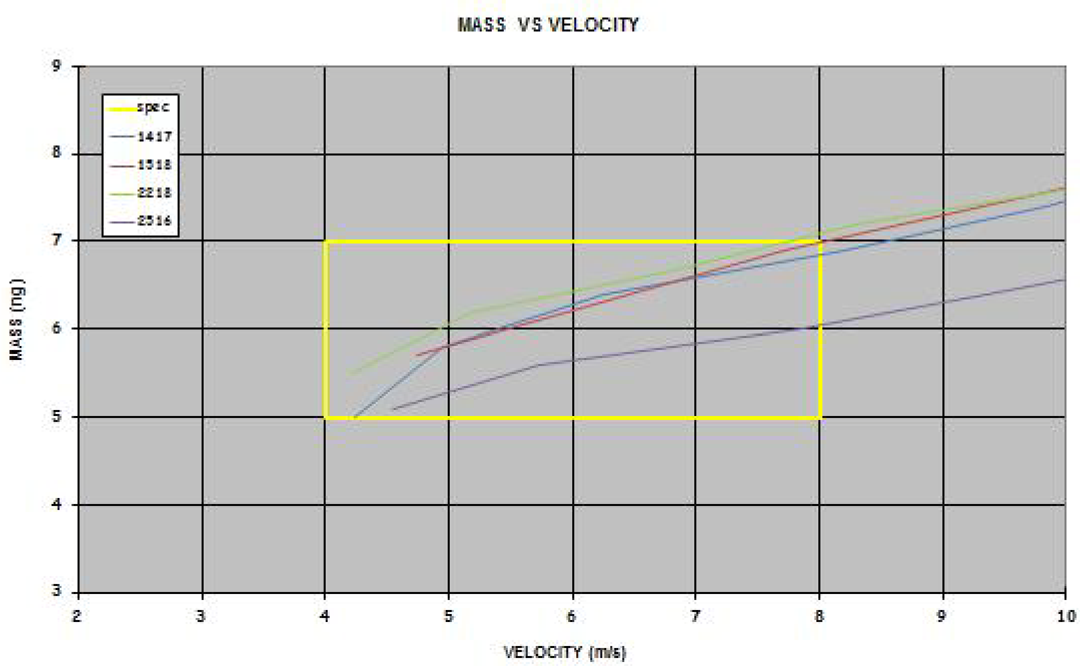


Figure C-14 SG1024/XSA Mass vs Velocity without JSP

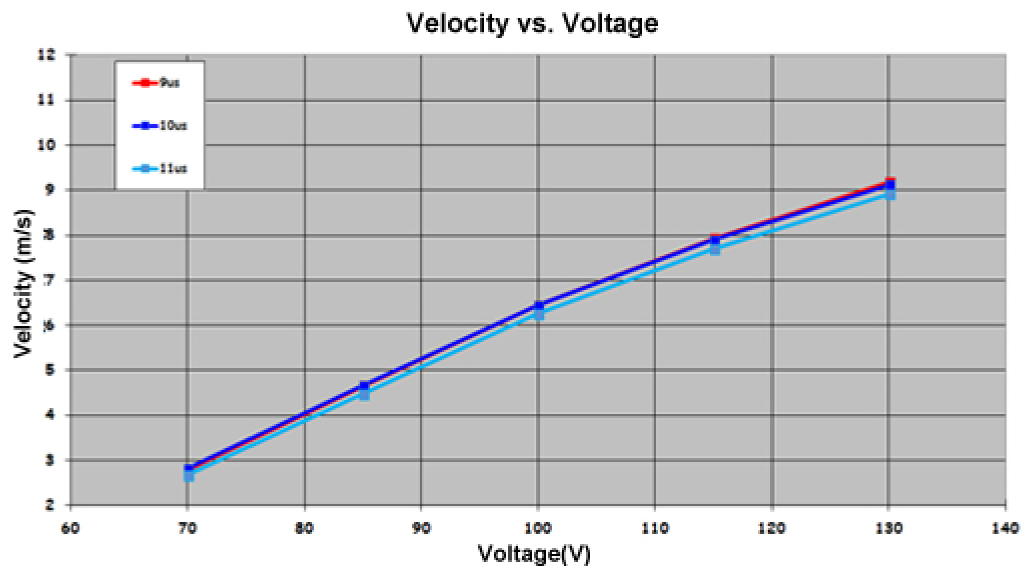


Figure C-15 SG1024/XSA Velocity vs Voltage without JSP

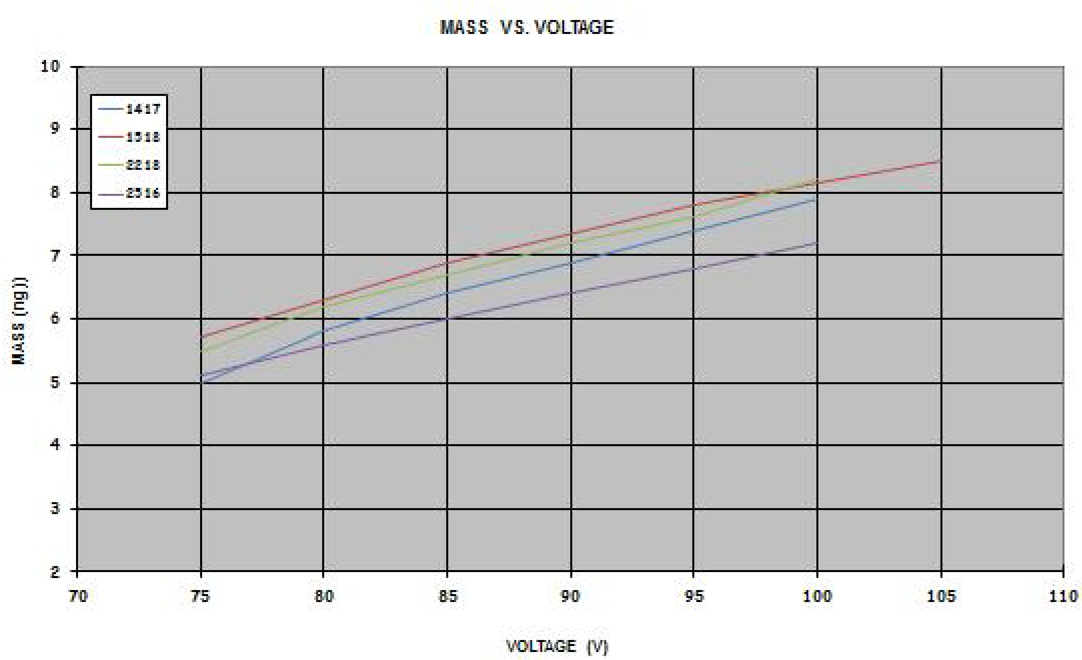


Figure C-16 SG1024/XSA Mass vs Voltage without JSP

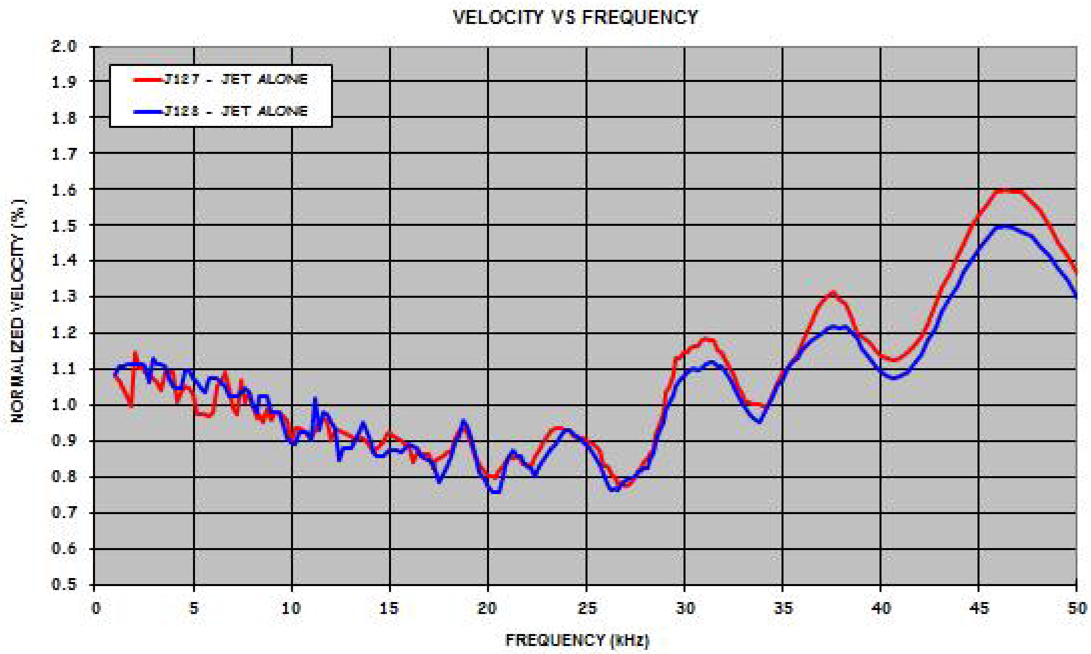


Figure C-17 SG1024/XSA Velocity vs Frequency – alone without JSP

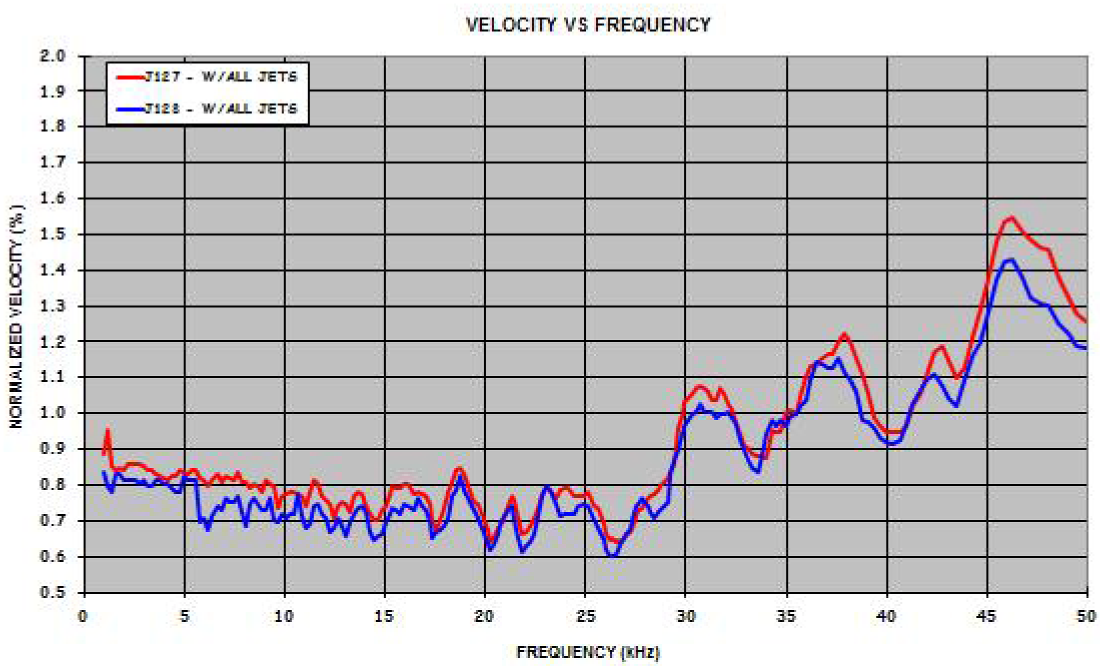


Figure C-18 SG1024/XSA Velocity vs Frequency – all without JSP

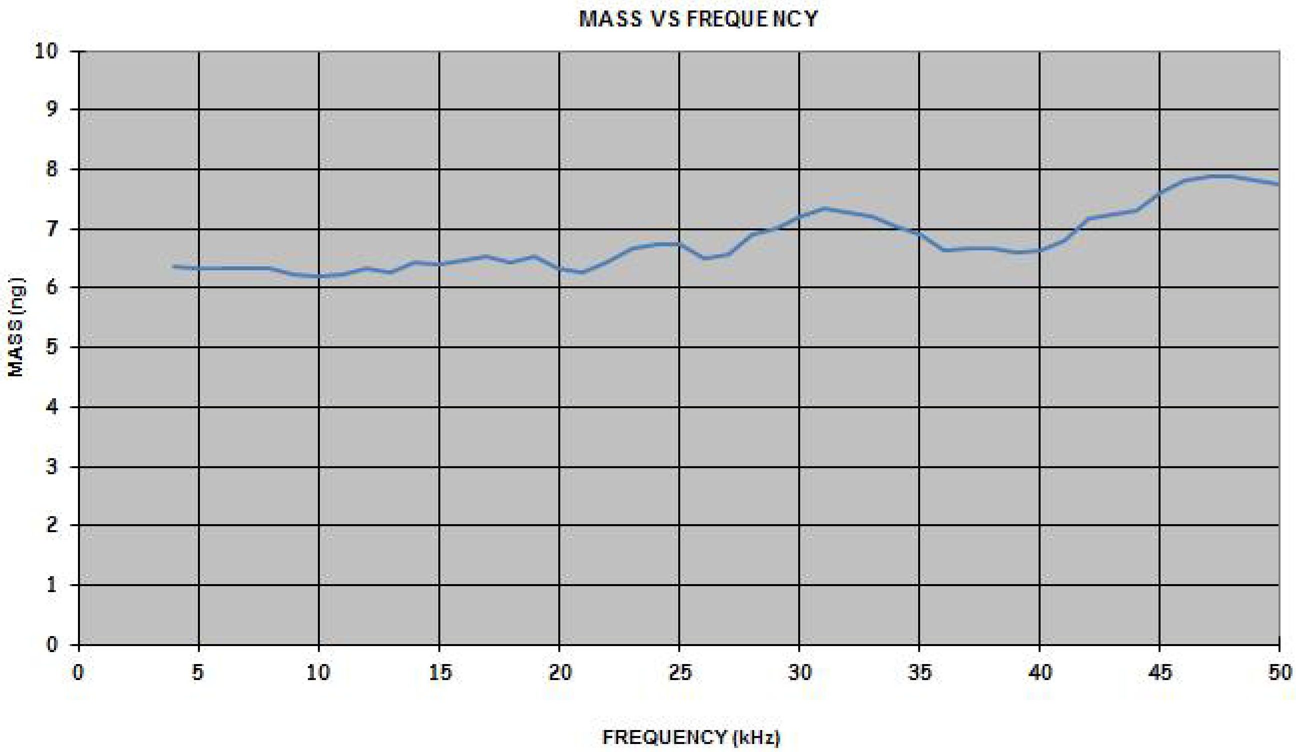


Figure C-19 SG1024/XSA Mass vs Frequency without JSP

4.0 SG1024/SA Performance Data

The performance curves shown in the following sections were created using XL-30 Model Fluid heated to 33° C at the nozzle plate. The recirculation vacuum was set to 20 inches H2O and a large contactor (20-25 inches Hg) was used for degassing.

4.1 Jetting Characteristics – SG1024/SA – Single Pulse with JSP

The single pulse performance curves shown for the SG1024/SA printhead were produced using waveform, part number 2100026626. This waveform has a trailing jet straightening pulse. It is a 4.5µs single pulse with a 30 V/µs slew rate. The drop mass has been calibrated to 11 ng at 8 kHz.

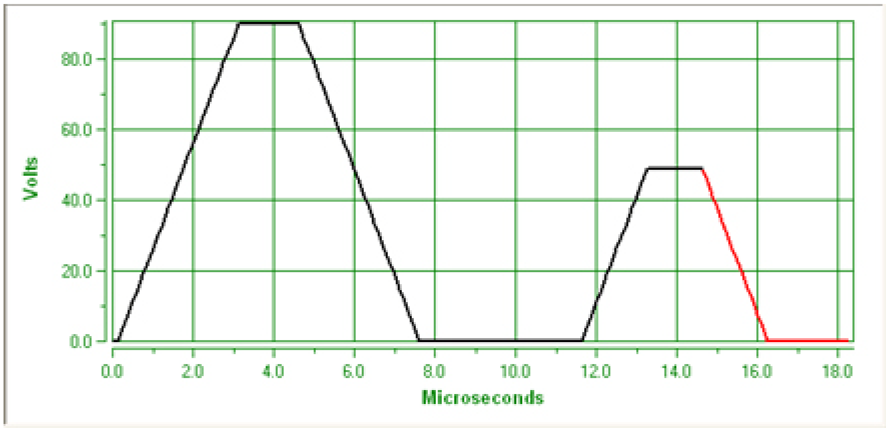


Figure C-20 Single pulse waveform P/N 2100026626 with JSP

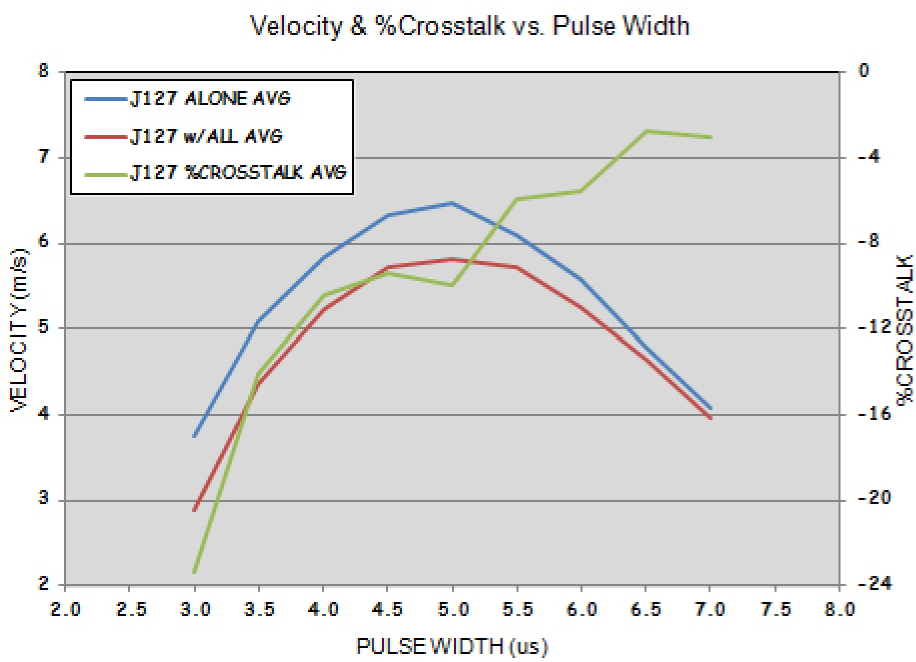


Figure C-21 SG1024/SA Pulse Width vs. Velocity showing Percent Crosstalk with JSP

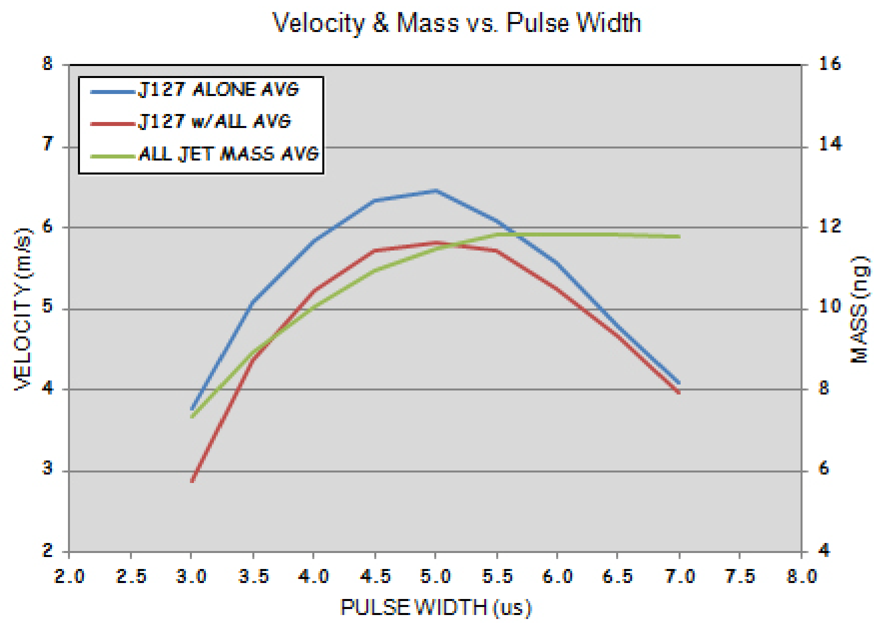


Figure C-22 SG1024/SA Velocity and Mass vs Pulse Width with JSP

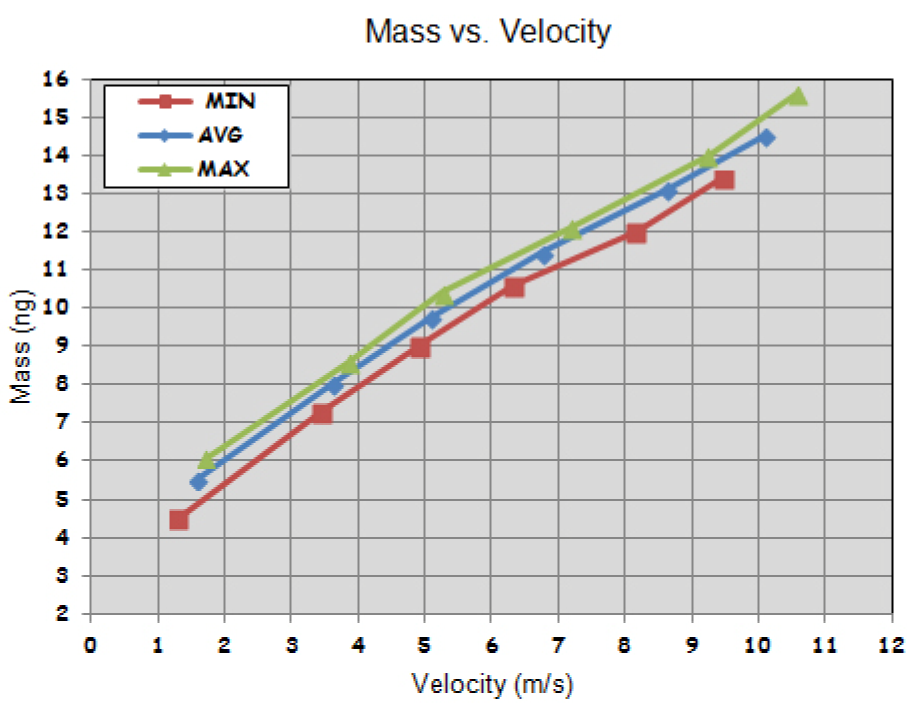


Figure C-23 SG1024/SA Mass vs Velocity with JSP

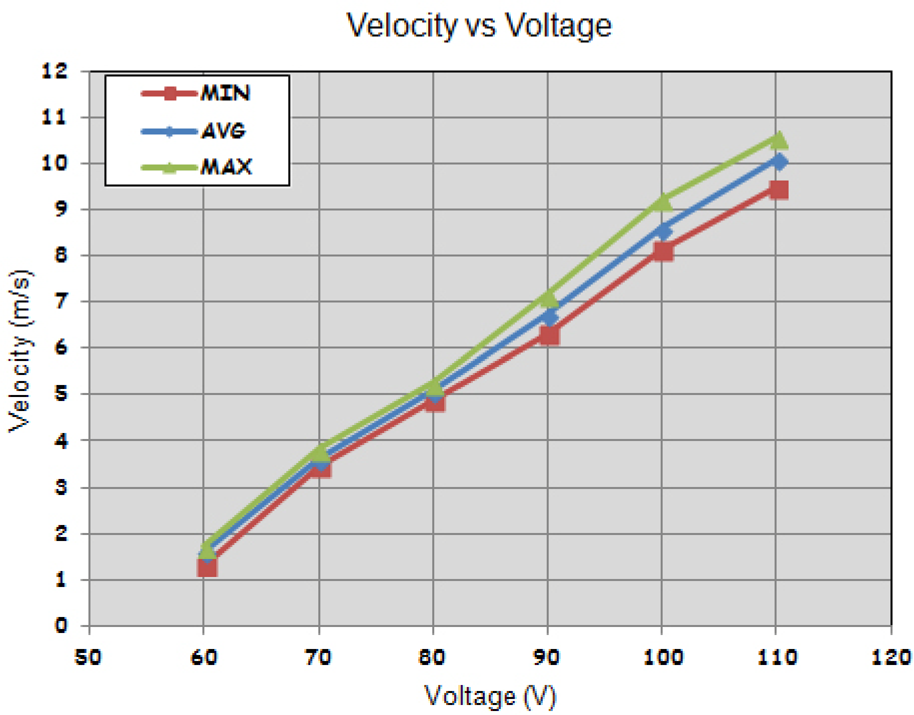


Figure C-24 SG1024/SA Velocity vs Voltage with JSP

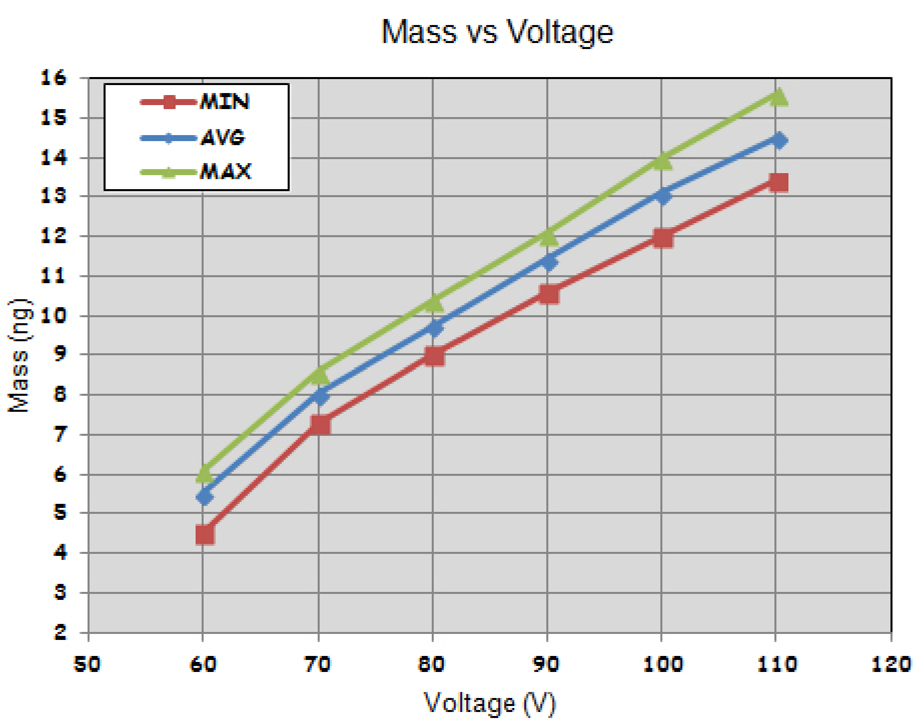


Figure C-25 SG1024/SA Mass vs Voltage with JSP

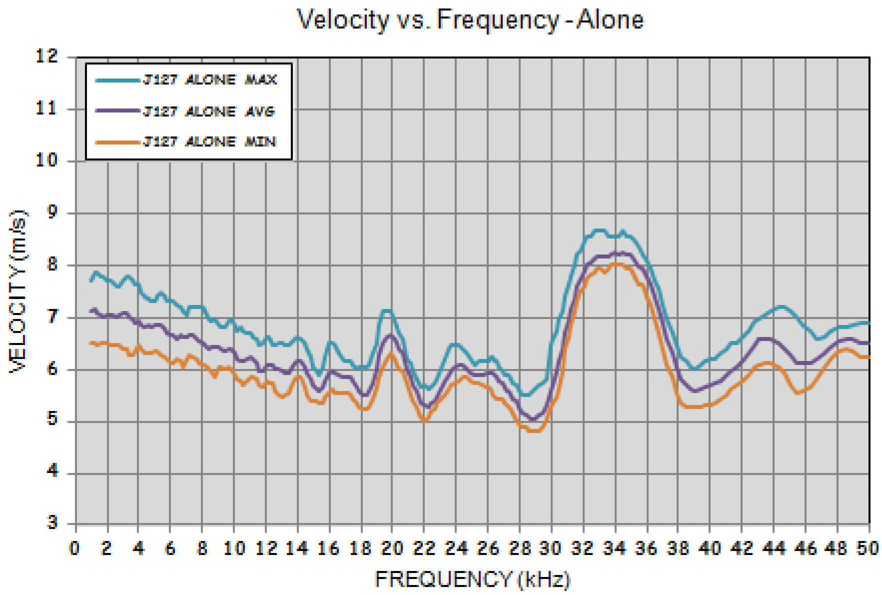


Figure C-26 SG1024/SA Velocity vs Frequency – alone with JSP

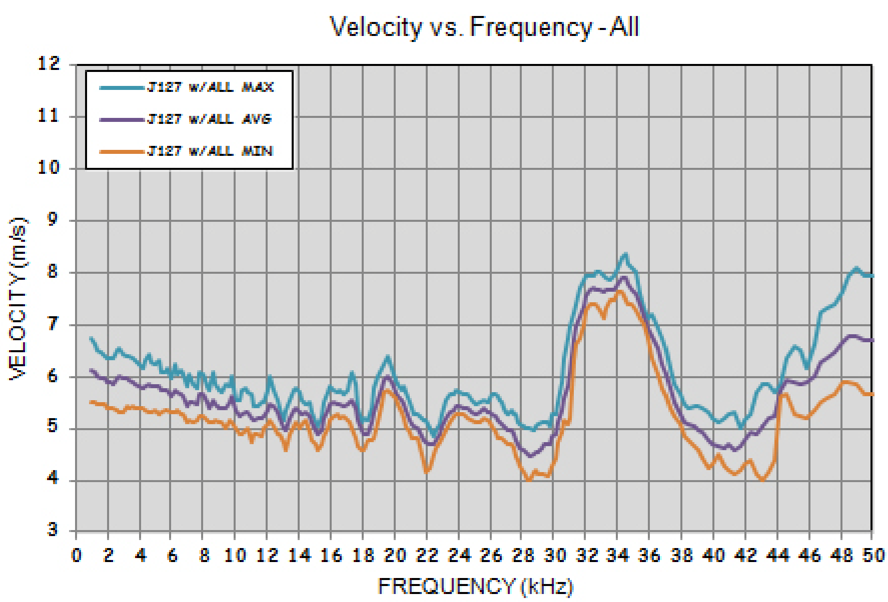


Figure C-27 SG1024/SA Velocity vs Frequency – all with JSP

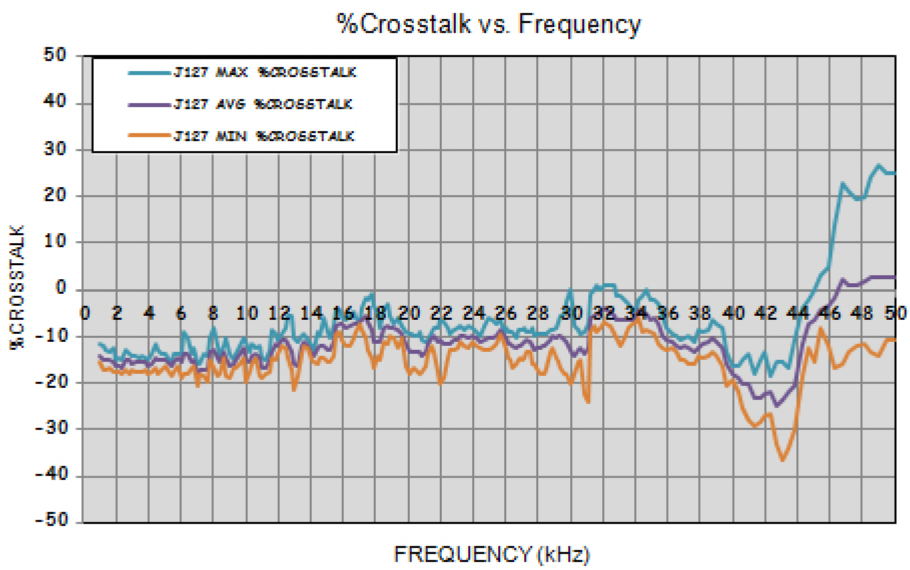


Figure C-28 SG1024/SA Percent Crosstalk vs Frequency with JSP

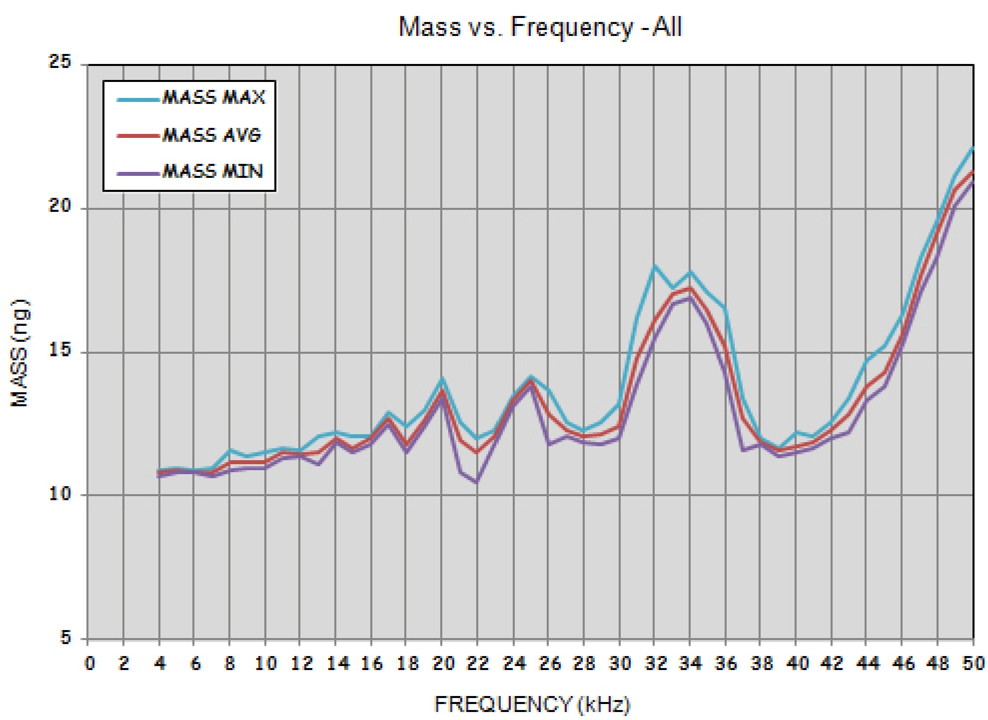


Figure C-29 SG1024/SA Mass vs Frequency with JSP

4.2 Jetting Characteristics – SG1024/SA – Single Pulse without JSP

The single pulse performance curves in this section for the SG1024/SA printhead were produced using waveform, part number 2100026064. The waveform did not have a trailing jet straightening pulse. It is a 4.5 µs single pulse with a 30 V/µs slew rate. The drop mass was calibrated to 11 ng at 8 kHz.

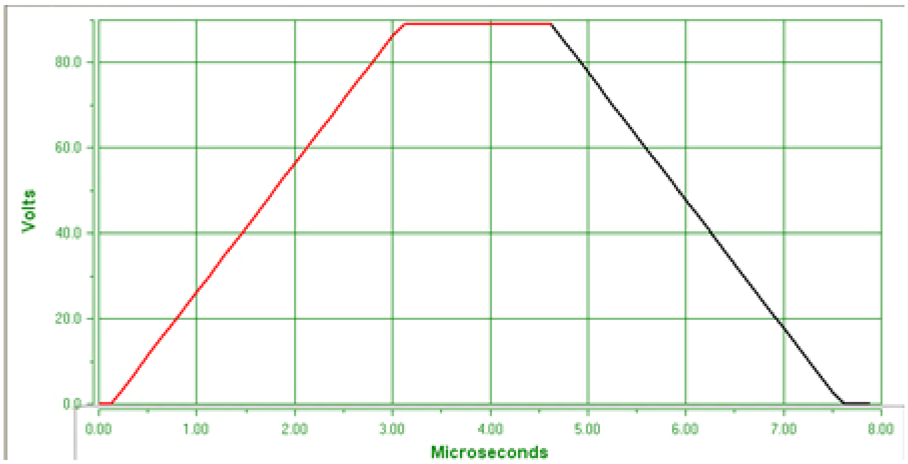


Figure C-30 Single pulse waveform P/N 2100026064 without JSP

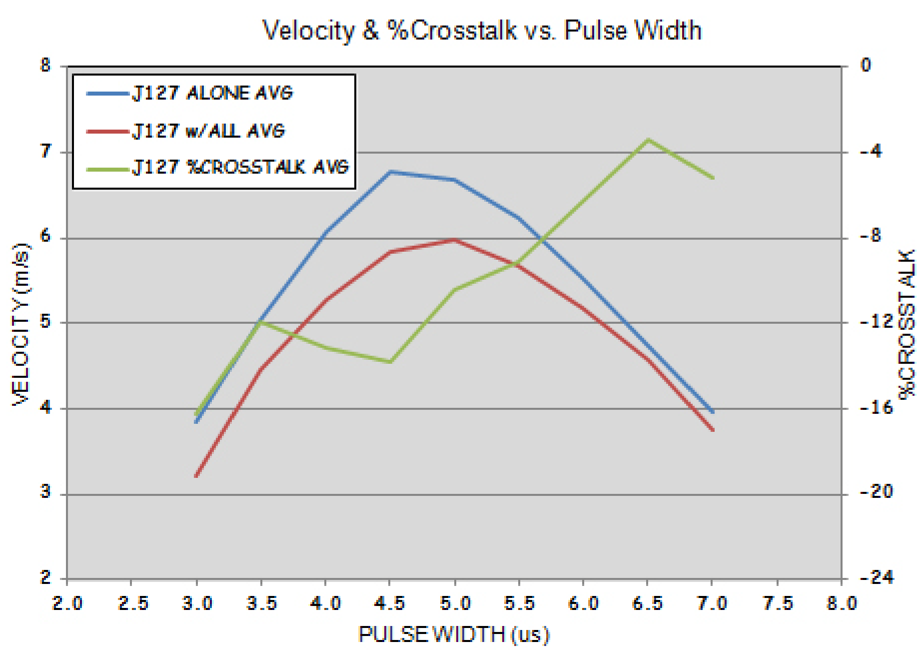


Figure C-31 SG1024/SA Pulse Width vs. Velocity showing Percent Crosstalk without JSP

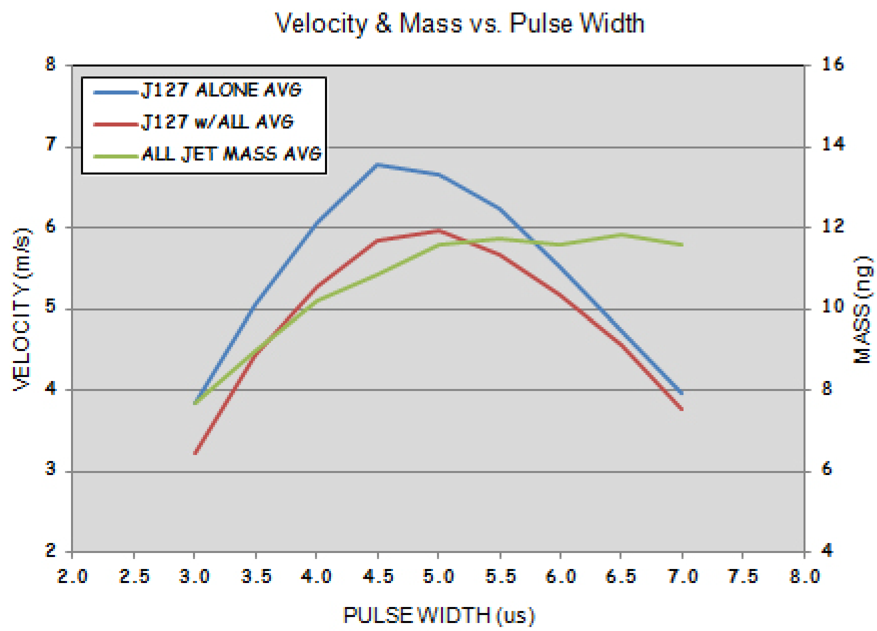


Figure C-32 SG1024/SA Velocity and Mass vs Pulse Width without JSP

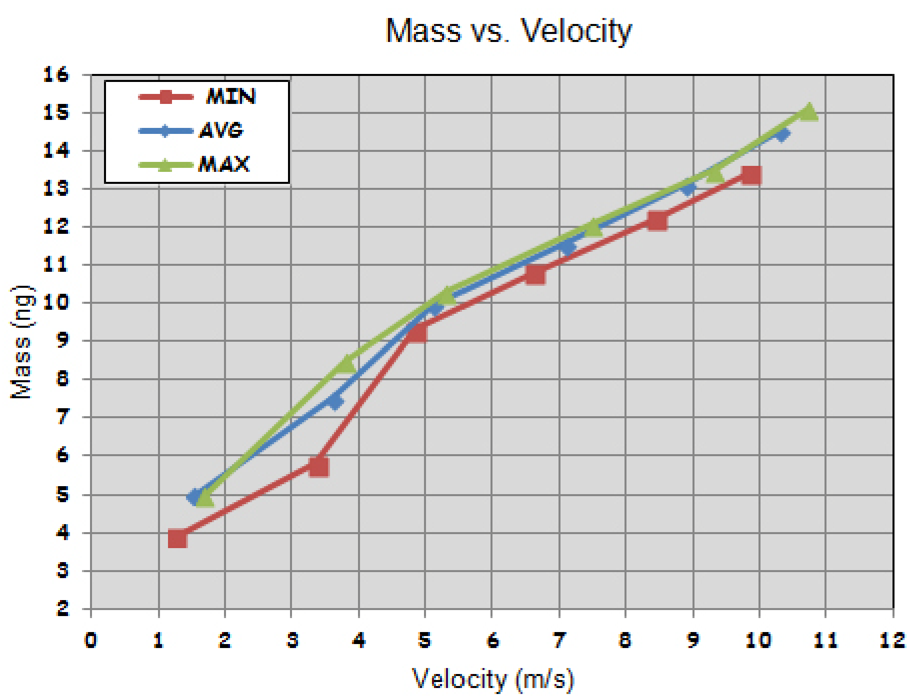


Figure C-33 SG1024/SA Mass vs Velocity without JSP

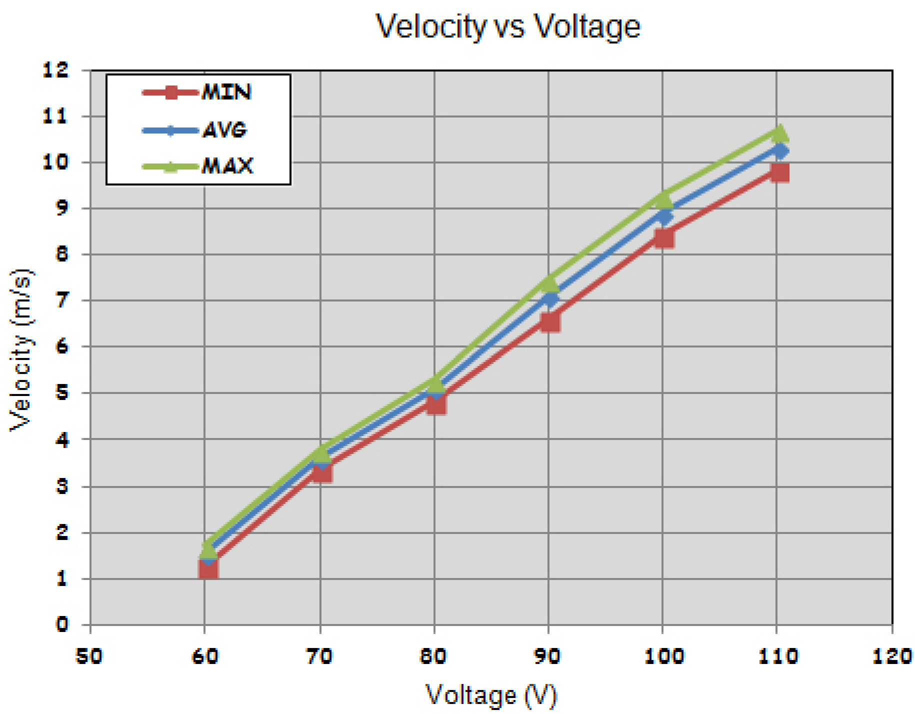


Figure C-34 SG1024/SA Velocity vs Voltage without JSP

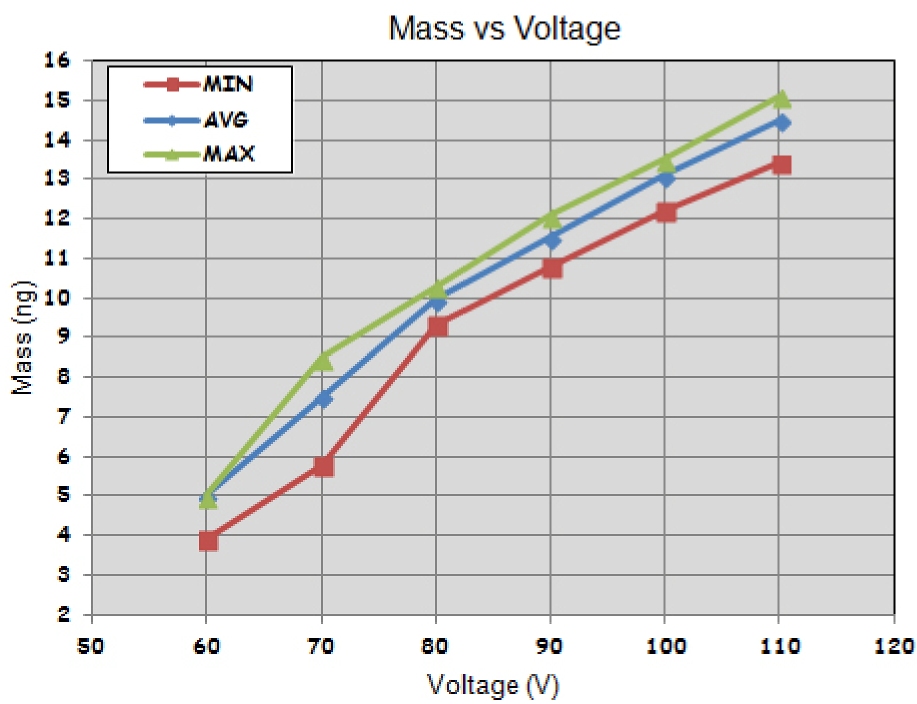


Figure C-35 SG1024/SA Mass vs Voltage without JSP

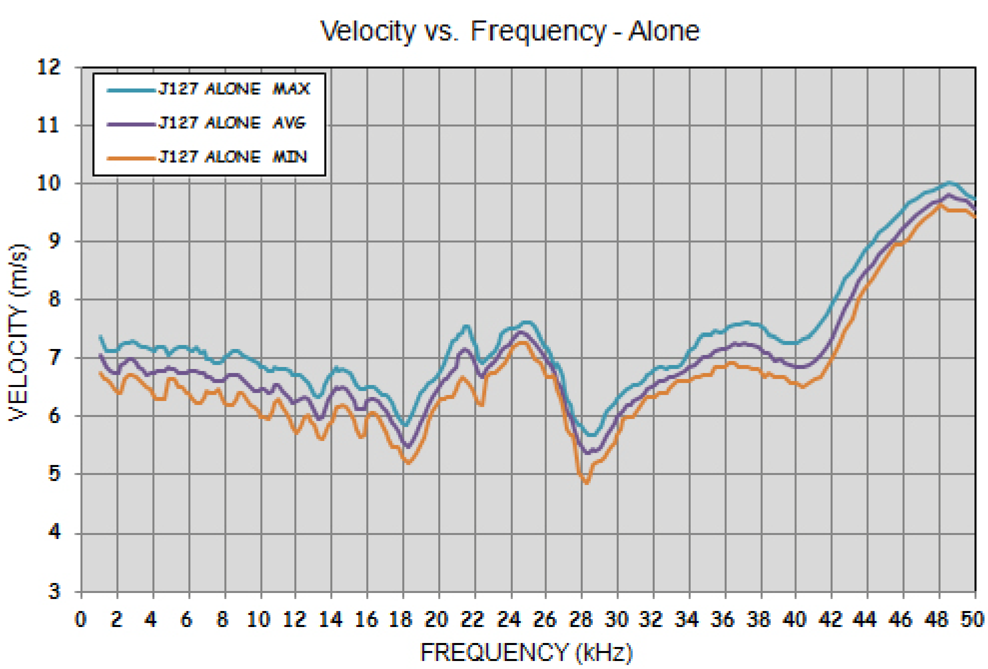


Figure C-36 SG1024/SA Velocity vs Frequency – alone without JSP

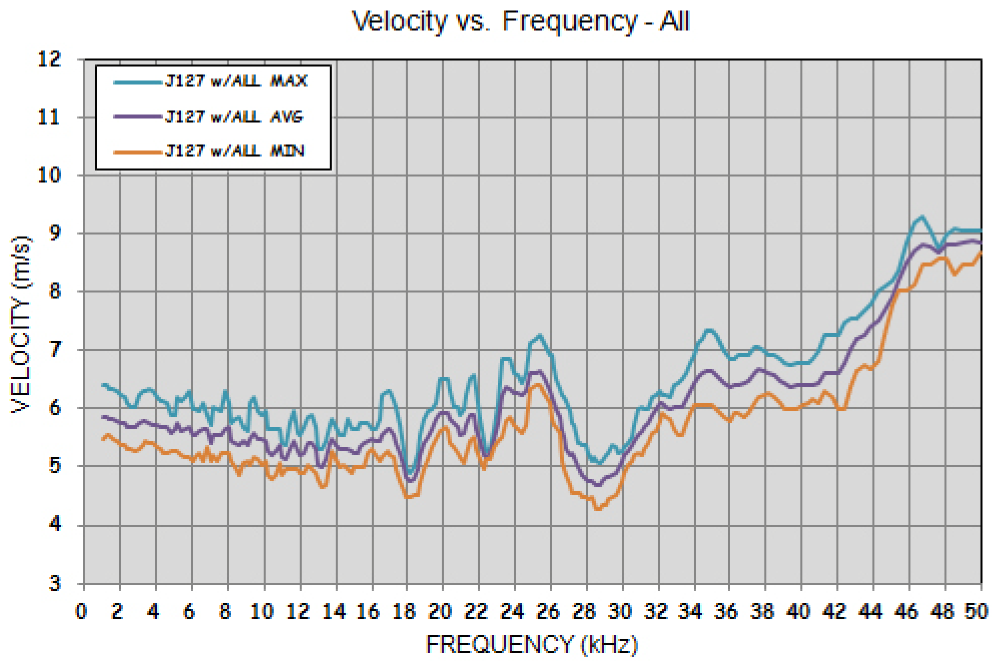


Figure C-37 SG1024/SA Velocity vs Frequency – all without JSP

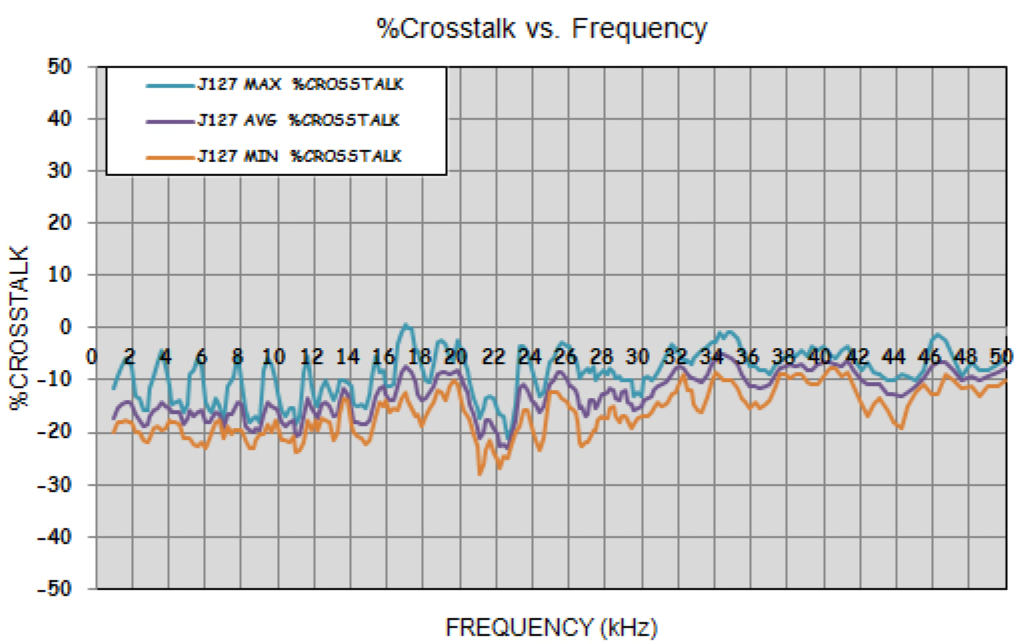


Figure C-38 SG1024/SA Percent Crosstalk vs Frequency without JSP

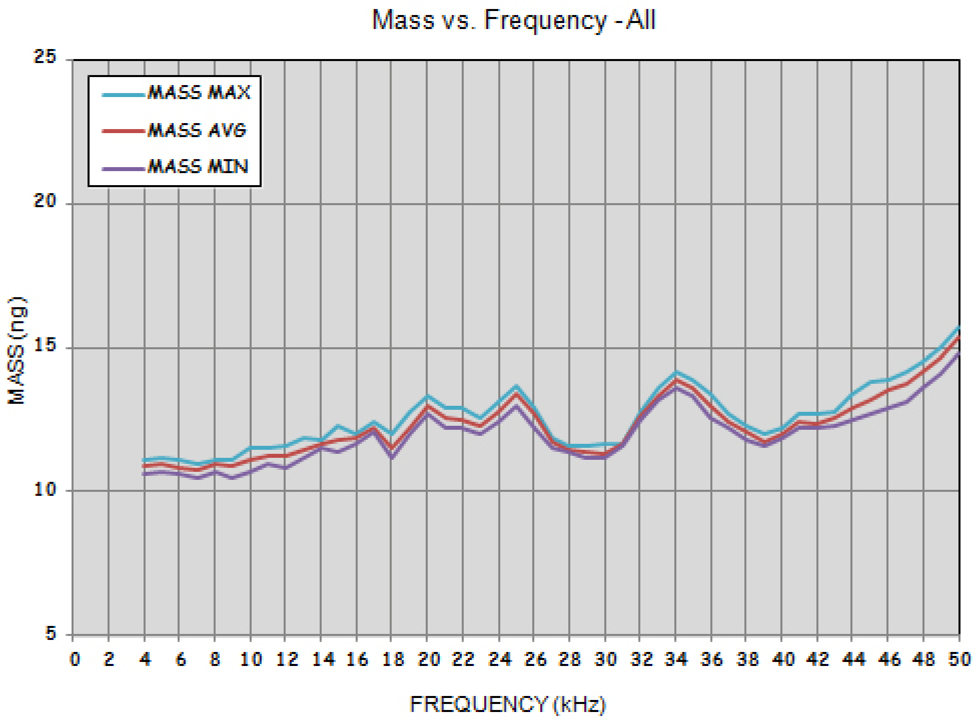


Figure C-39 SG1024/SA Mass vs Frequency without JSP

4.3 Jetting Characteristics – SG1024/SA – Multi Pulse

The multi pulse performance curves shown for the SG1024/SA printhead in this section were produced using waveform, part number 2100027184. It is a three pulse waveform with a 30 V/µs slew rate. The drop mass was calibrated to 33 ng at 8kHz.

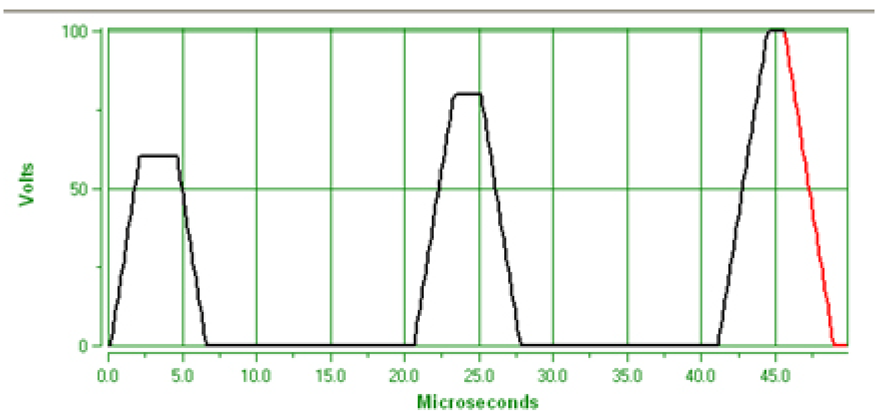


Figure C-40 Multi pulse waveform P/N 2100027184

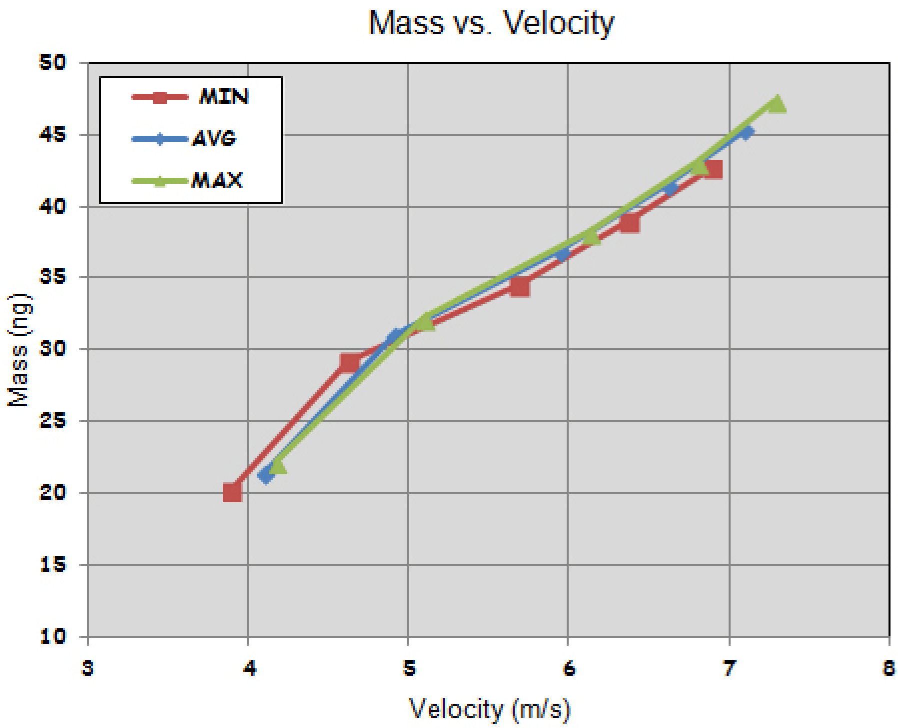


Figure C-41 SG1024/SA Mass vs Velocity – multi pulse

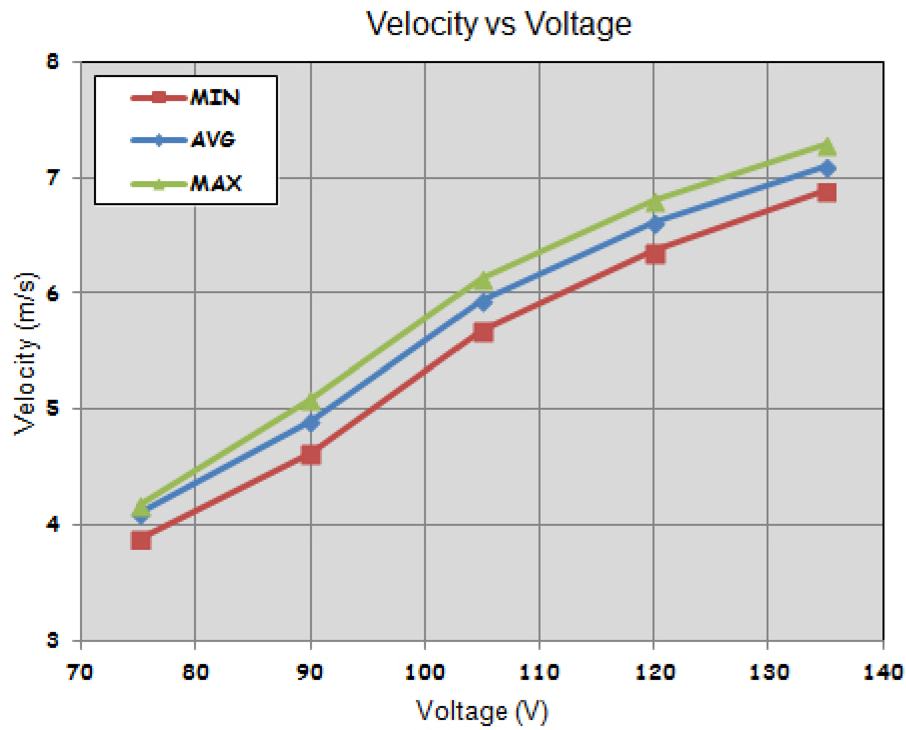


Figure C-42 SG1024/SA Velocity vs Voltage – multi pulse

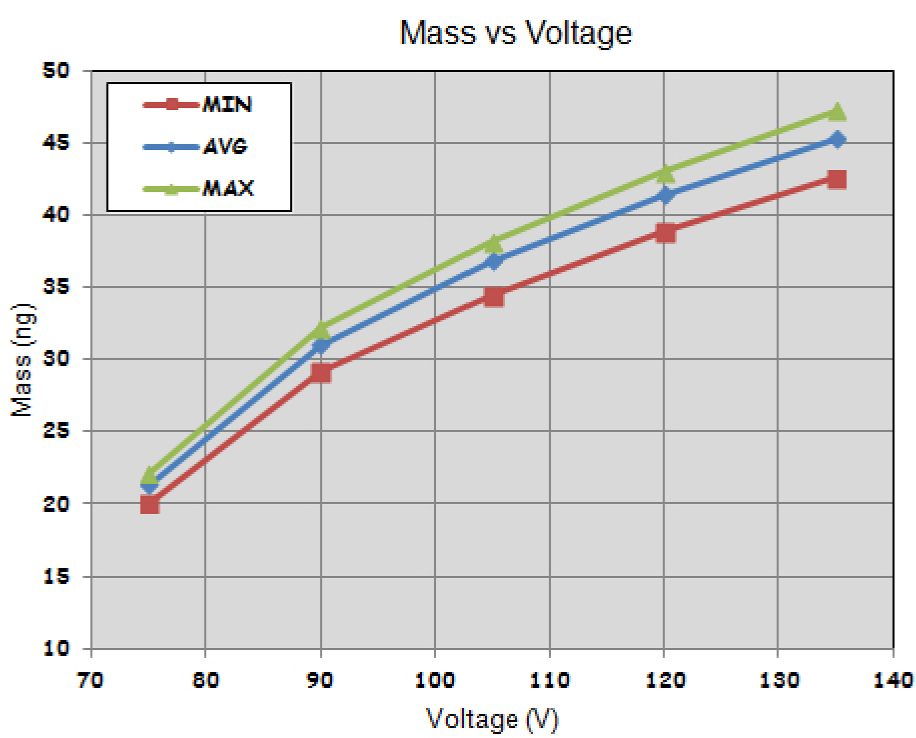


Figure C-43 SG1024/SA Mass vs Voltage – multi pulse

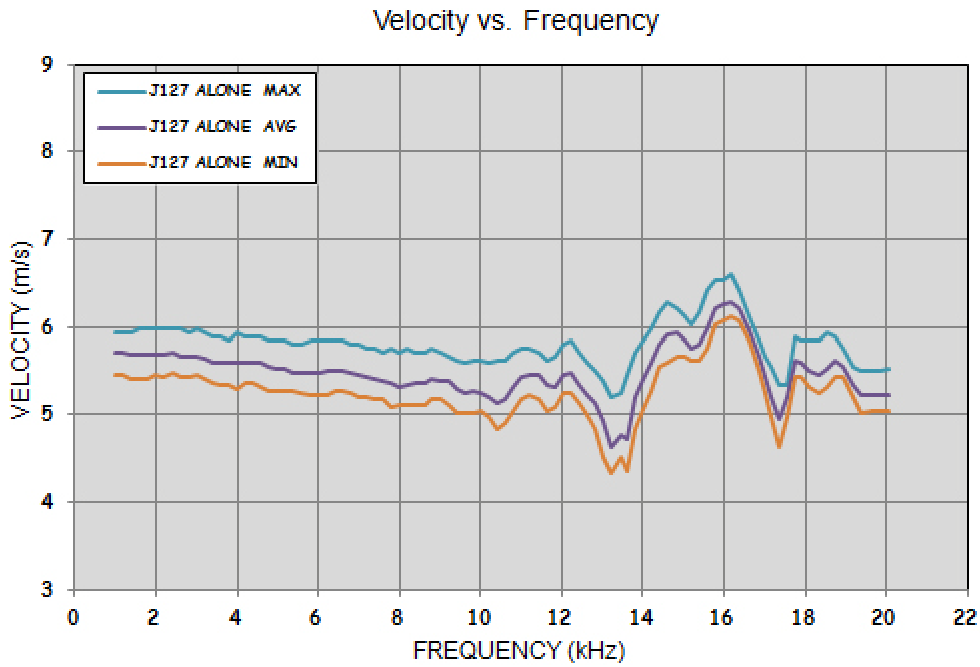


Figure C-44 SG1024/SA Velocity vs Frequency – alone – multi pulse

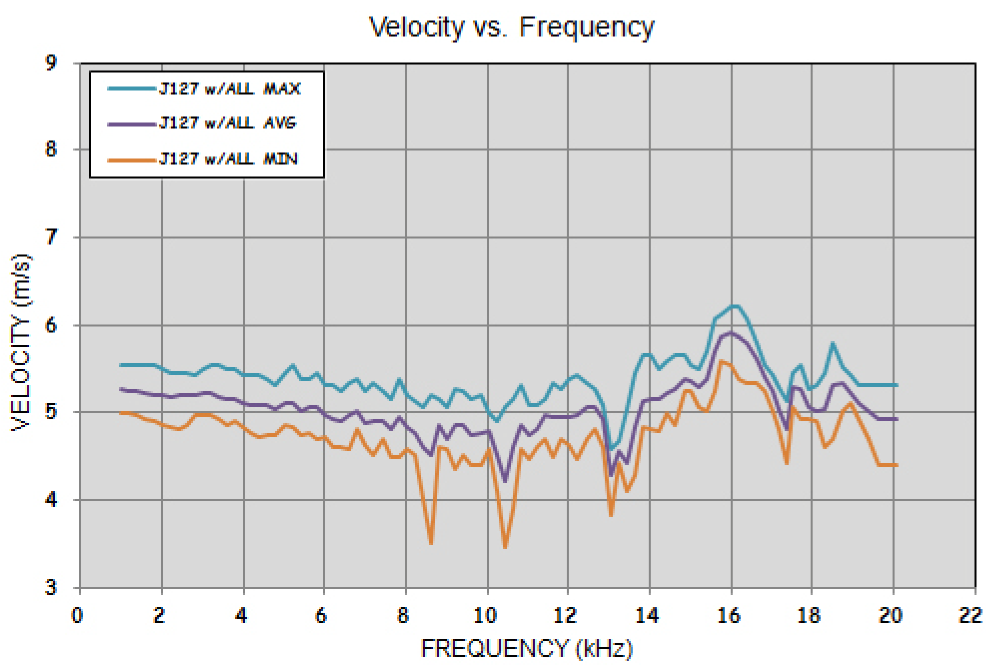


Figure C-45 SG1024/SA Velocity vs Frequency – all – multi pulse

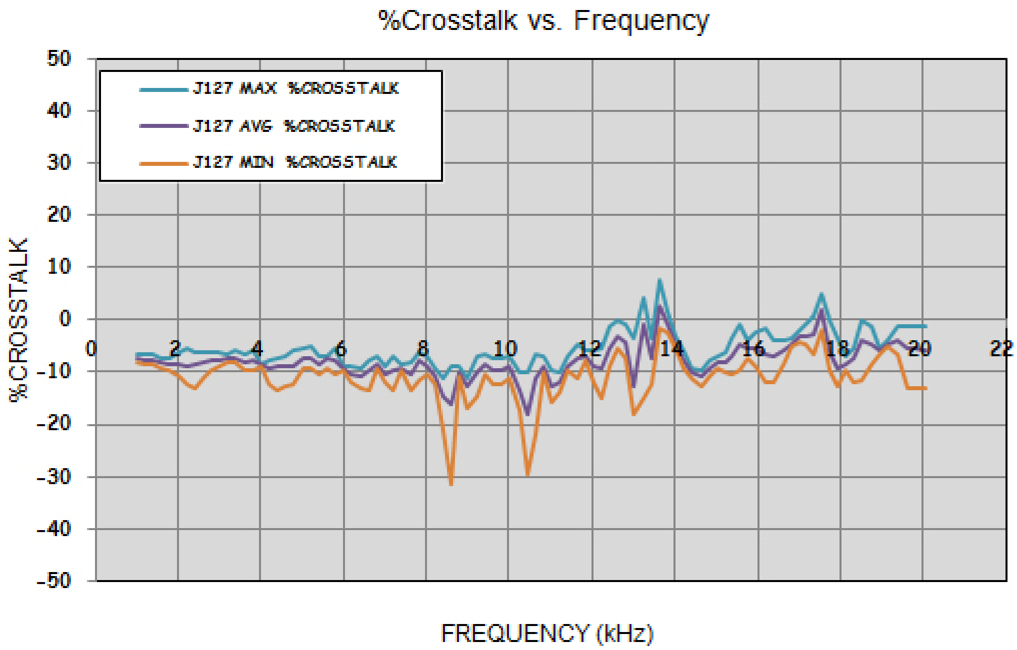


Figure C-46 SG1024/SA Percent Crosstalk vs Frequency – multi pulse

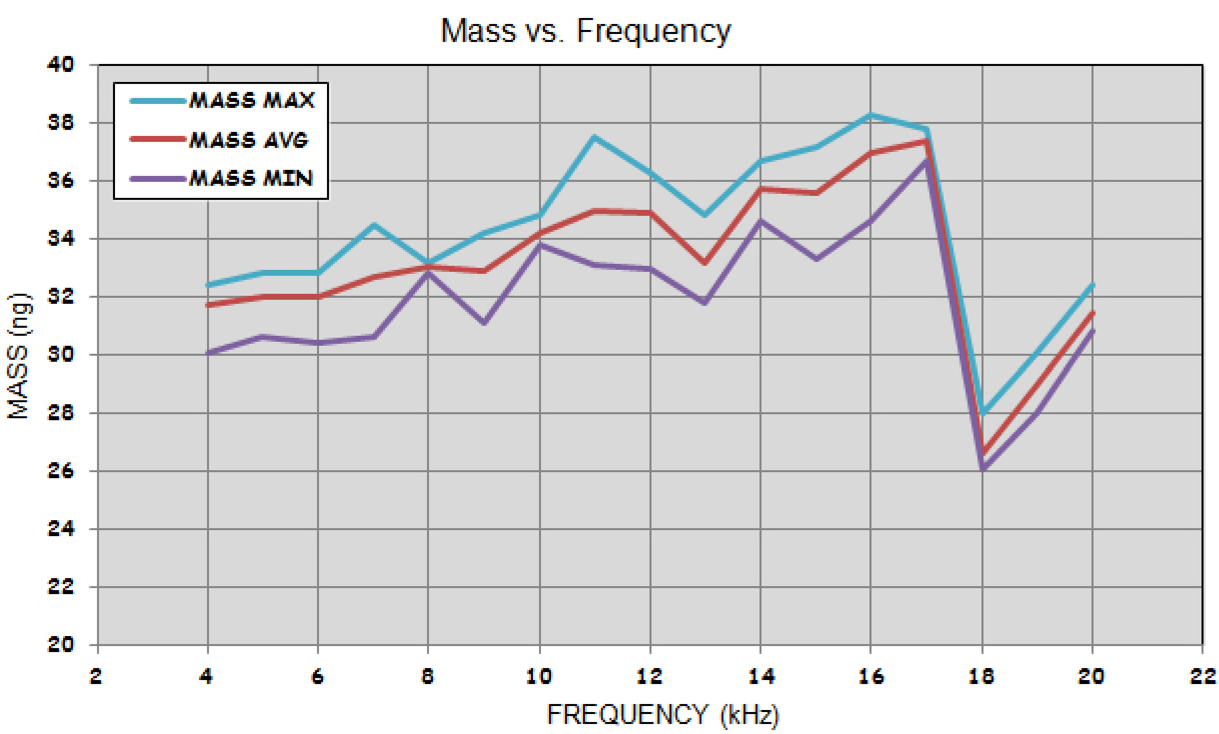


Figure C-47 SG1024/SA Mass vs Frequency – multi pulse

5.0 SG1024/MA Performance Data

The performance curves shown in the following sections were created using XL-30 Model Fluid heated to 33° C at the nozzle plate. The recirculation vacuum was set to 20 inches of H_20 and a large contactor (20-25 Hg) was used for degassing.

5.1 Jetting Characteristics – SG1024/MA – Single Pulse

The single pulse performance curves shown for the SG1024/MA printhead were produced using waveform, part number 2100024368. It is a 7µs single pulse with a 30 V/µs slew rate. The drop mass was calibrated to 30 ng at 8 kHz.

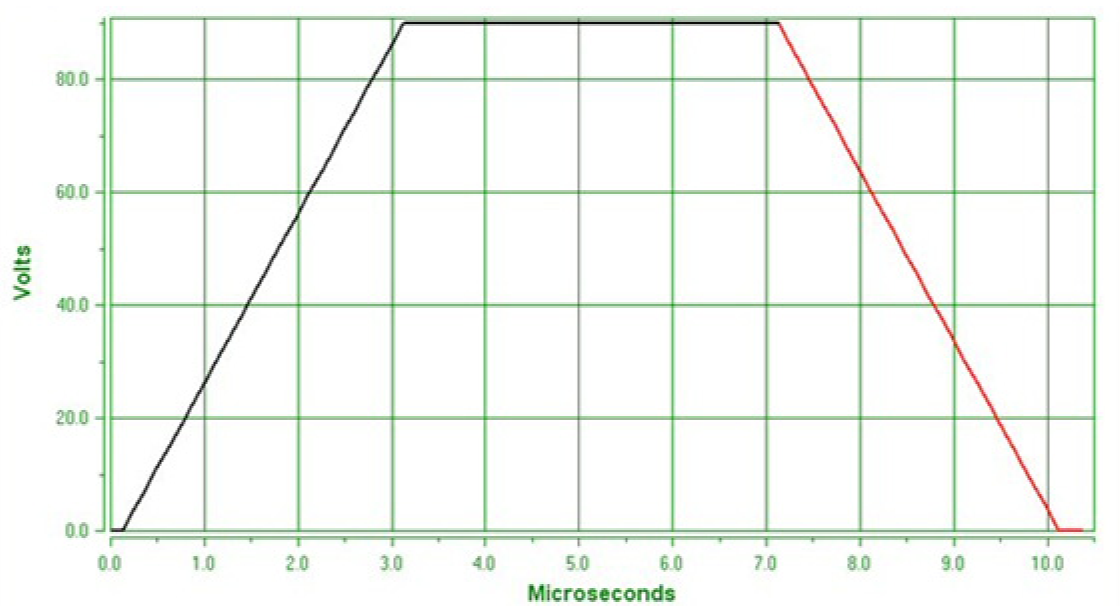


Figure C-48 Single pulse waveform P/N 2100024368

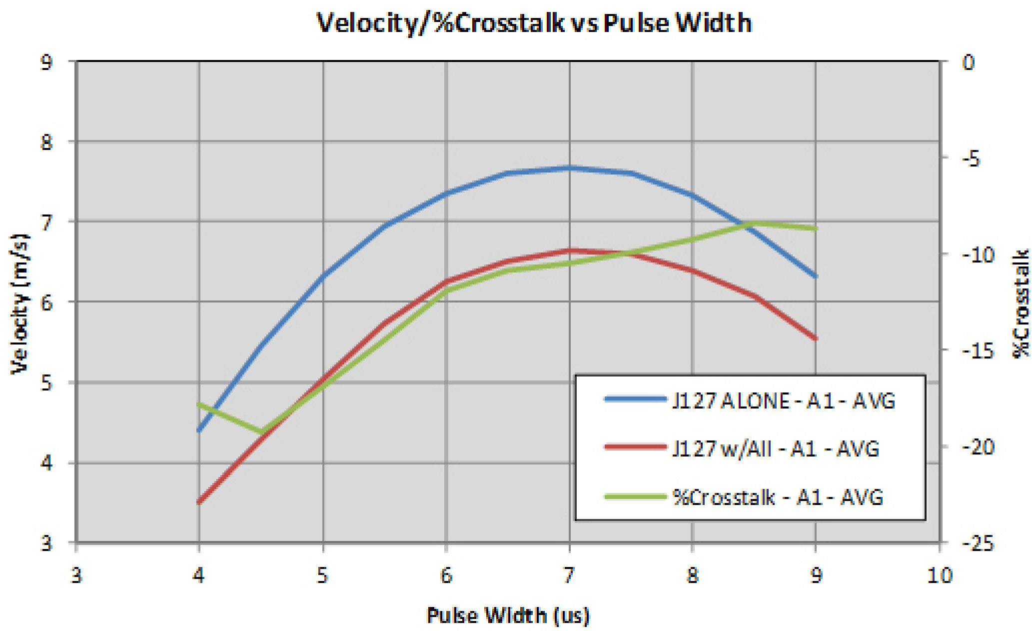


Figure C-49 SG1024/MA Pulse Width vs. Velocity showing Percent Crosstalk

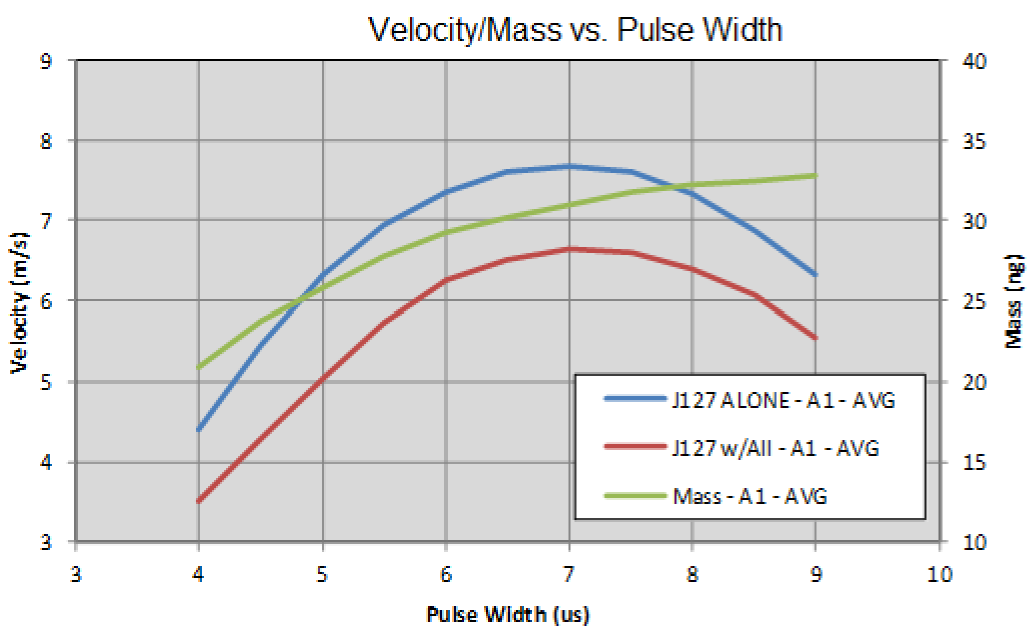


Figure C-50 SG1024/MA Velocity and Mass vs Pulse Width

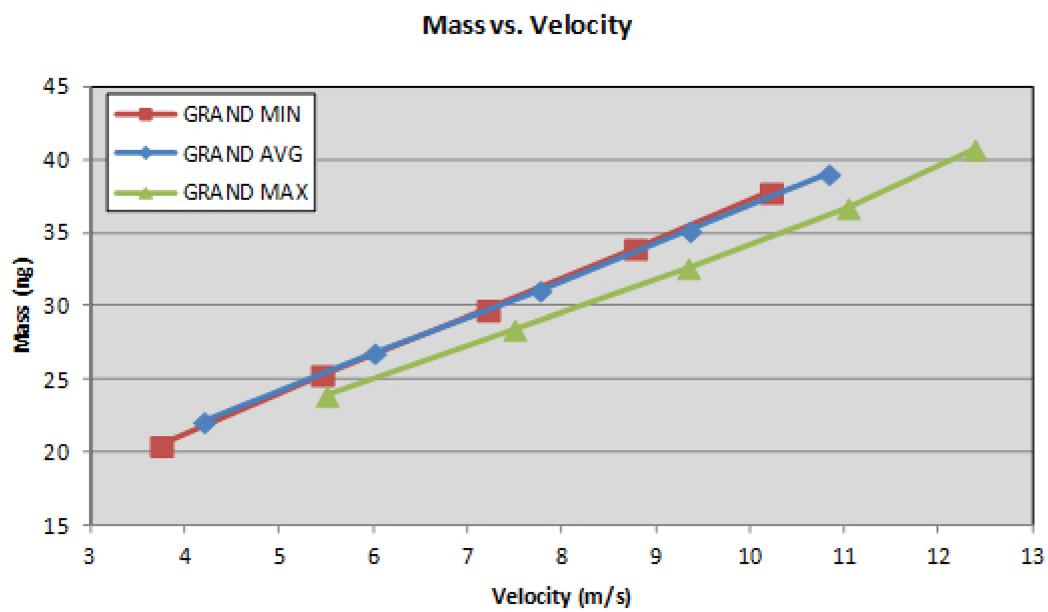


Figure C-51 SG1024/MA Mass vs Velocity

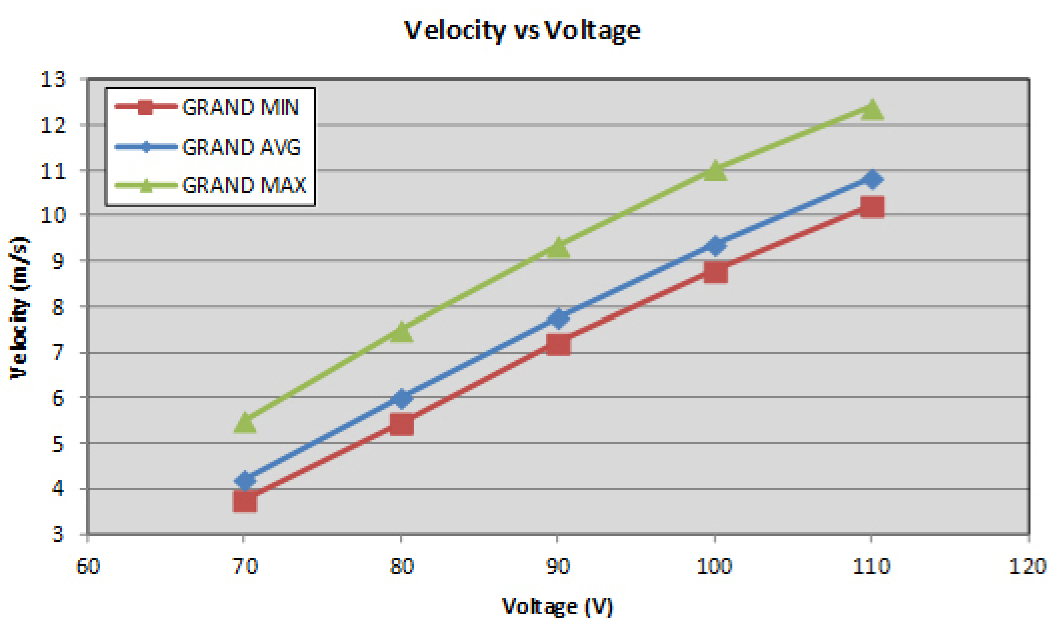


Figure C-52 SG1024/MA Velocity vs Voltage

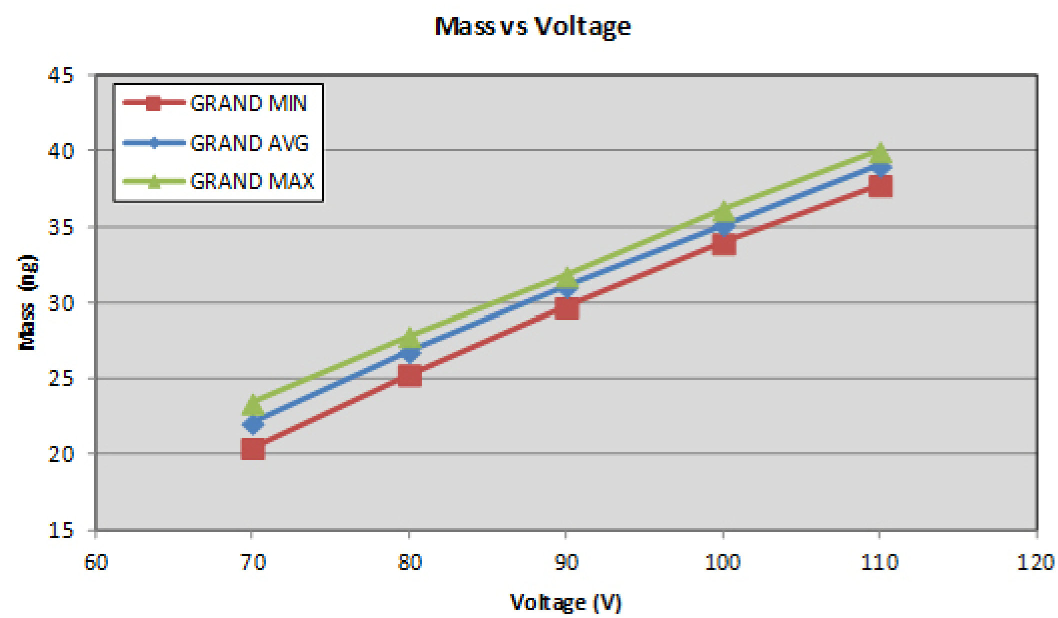


Figure C-53 SG1024/MA Mass vs Voltage

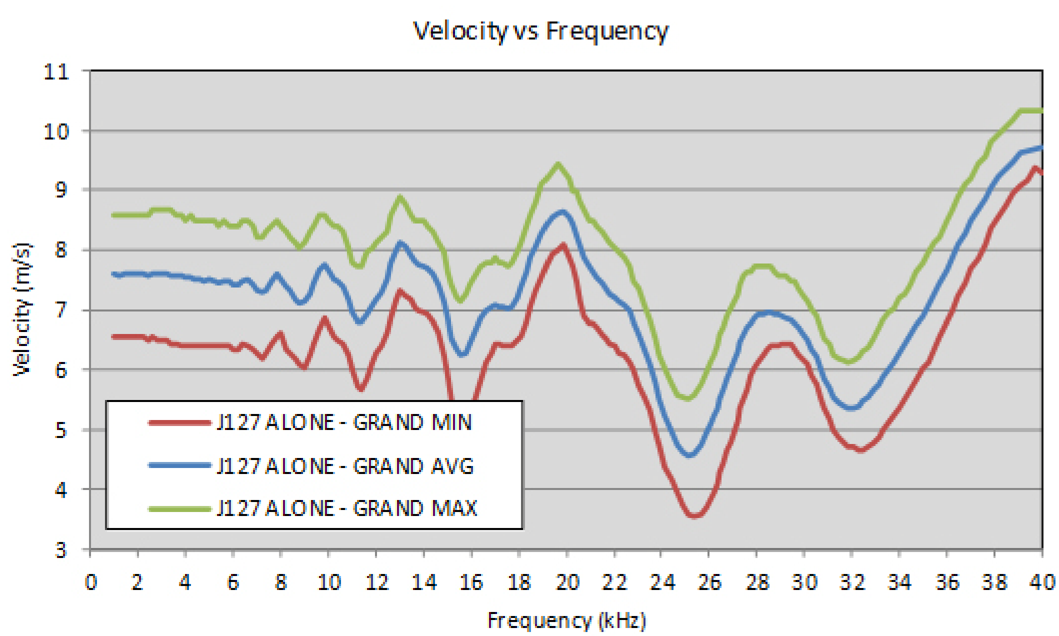


Figure C-54 SG1024/MA Velocity vs Frequency – alone

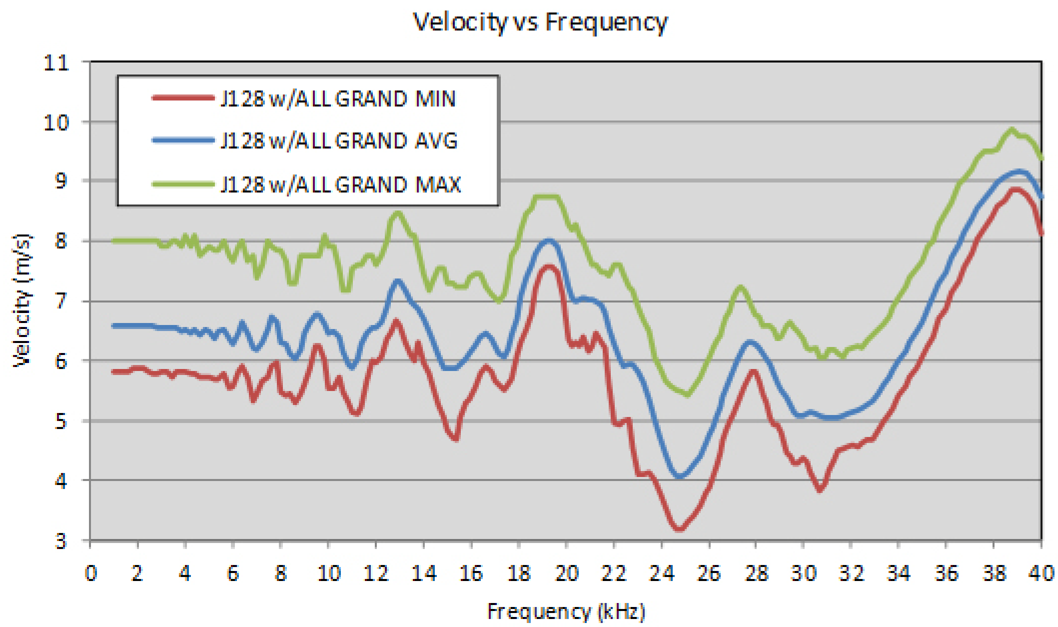


Figure C-55 SG1024/MA Velocity vs Frequency – all

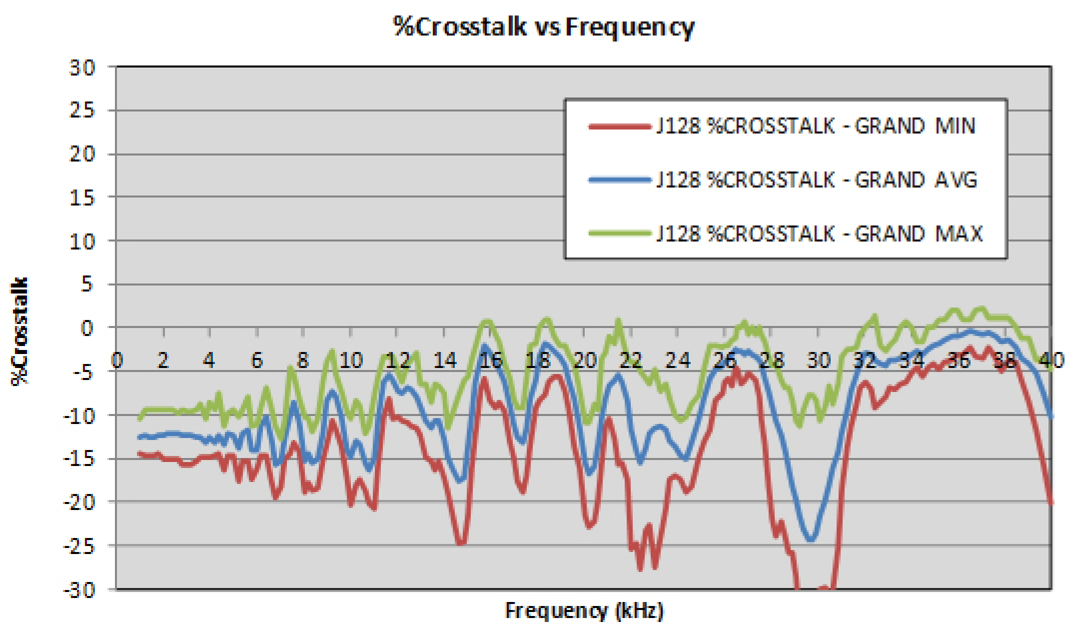


Figure C-56 SG1024/MA Percent Crosstalk vs Frequency

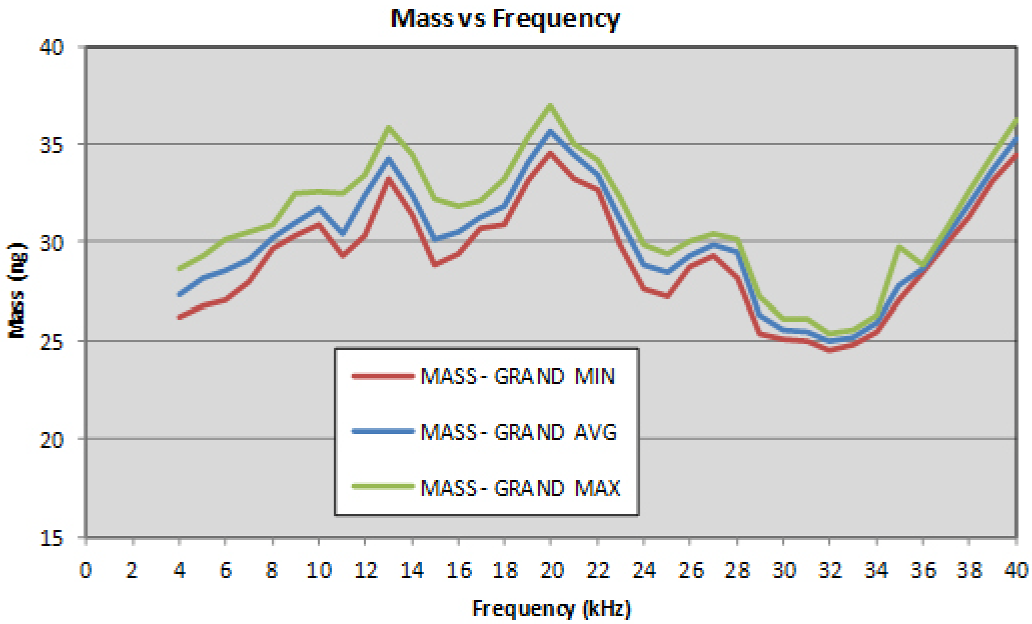


Figure C-57 SG1024/MA Mass vs Frequency

5.2 Jetting Characteristics – SG1024/MA – Multi Pulse

The two pulse performance curves shown for the SG1024/MA printhead were produced using a two pulse waveform with 30 V/µs slew rate. The drop mass was calibrated to 80 ng at 8 kHz.

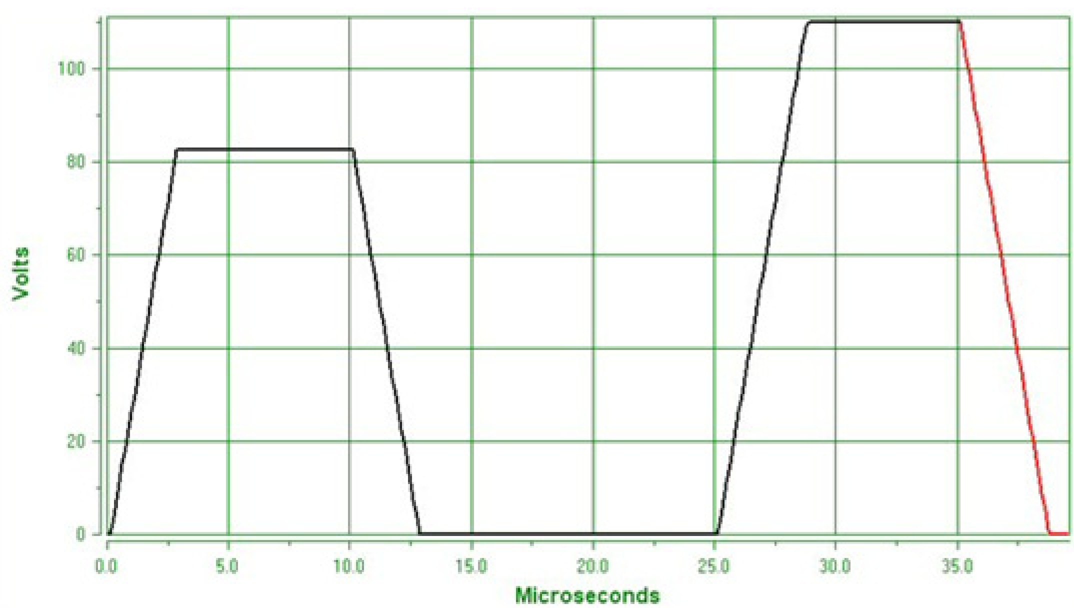


Figure C-58 Multi pulse Waveform

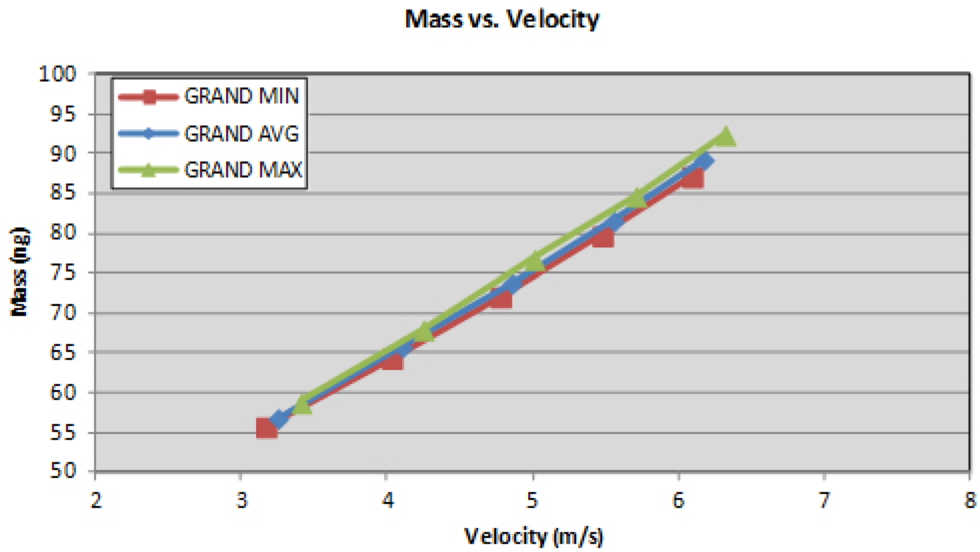


Figure C-59 SG1024/MA Mass vs Velocity

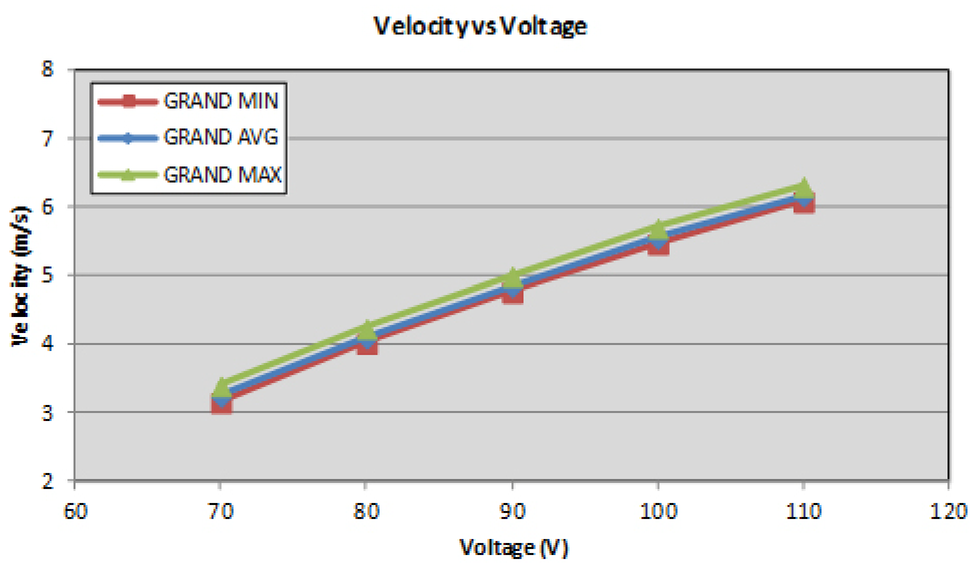


Figure C-60 SG1024/MA Velocity vs Voltage

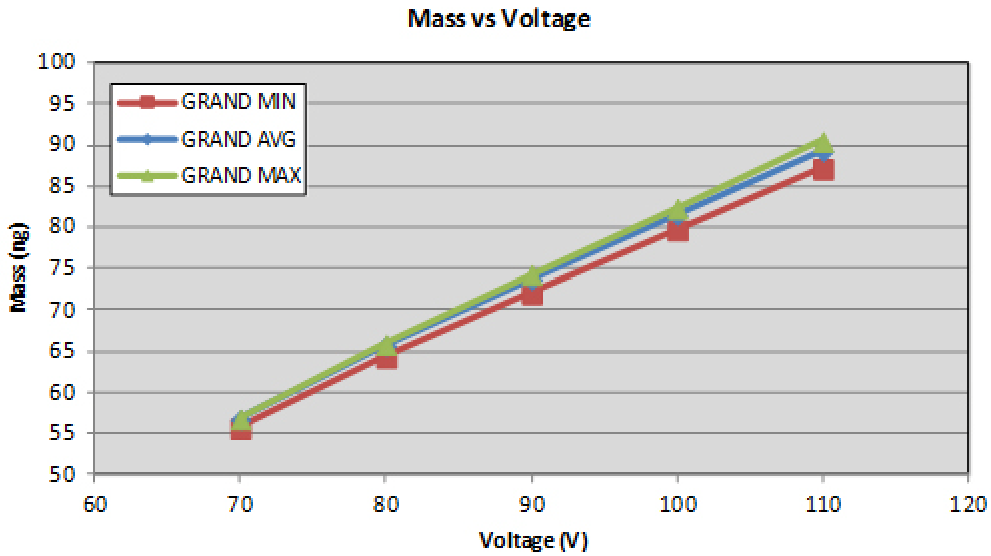


Figure C-61 SG1024/MA Mass vs Voltage

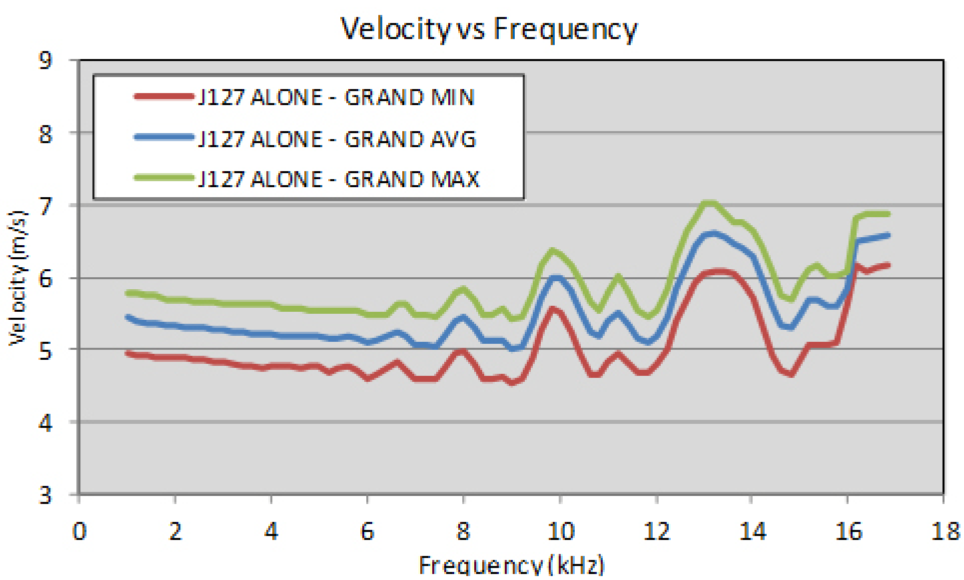


Figure C-62 SG1024/MA Velocity vs Frequency – alone

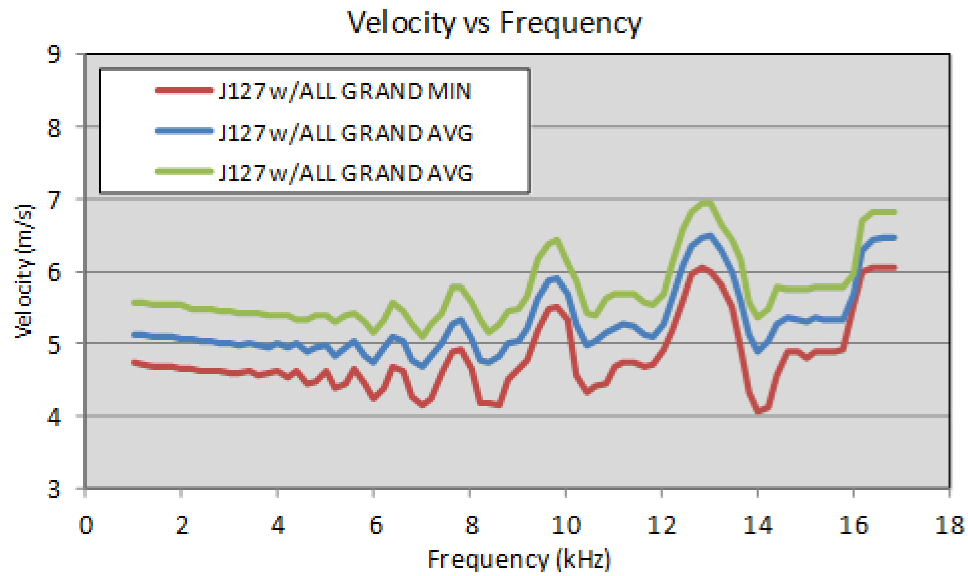


Figure C-63 SG1024/MA Velocity vs Frequency – all

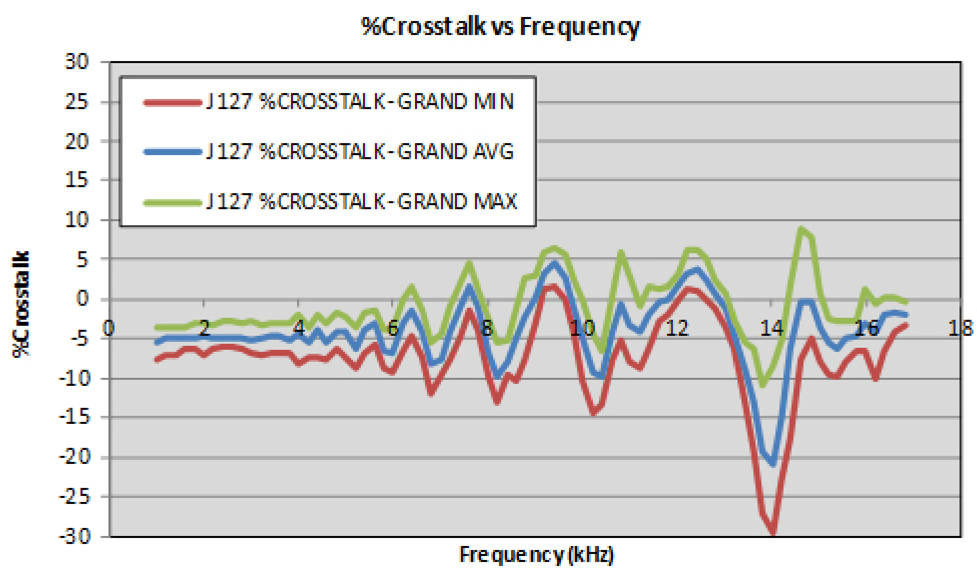


Figure C-64 SG1024/MA Percent Crosstalk vs Frequency

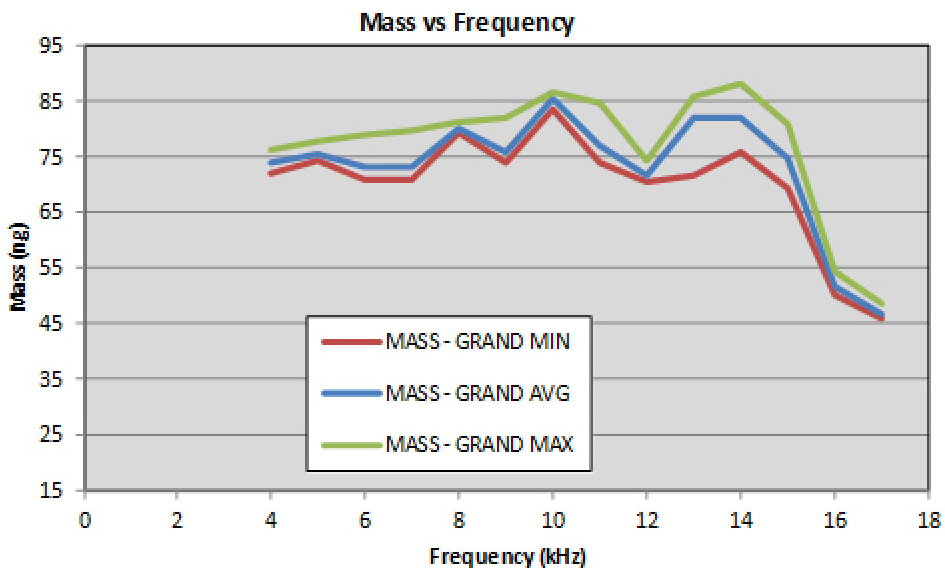


Figure C-65 SG1024/MA Mass vs Frequency

6.0 SG1024/LA-2CI Performance Data

The performance curves shown in the following sections were created using XL-30 Model Fluid heated to 33° C at the nozzle plate. The recirculation vacuum was set to 20 inches of H_20 and a large contactor (20-25 Hg) was used for degassing.

6.1 Jetting Characteristics – SG1024/LA-2CI

The single pulse performance curves shown for the SG1024/LA-2CI printhead were produced using waveform, part number 2100025788. It is a single pulse waveform with 30 V/µs slew rate. The drop mass was calibrated to 80 ng at 8 kHz.

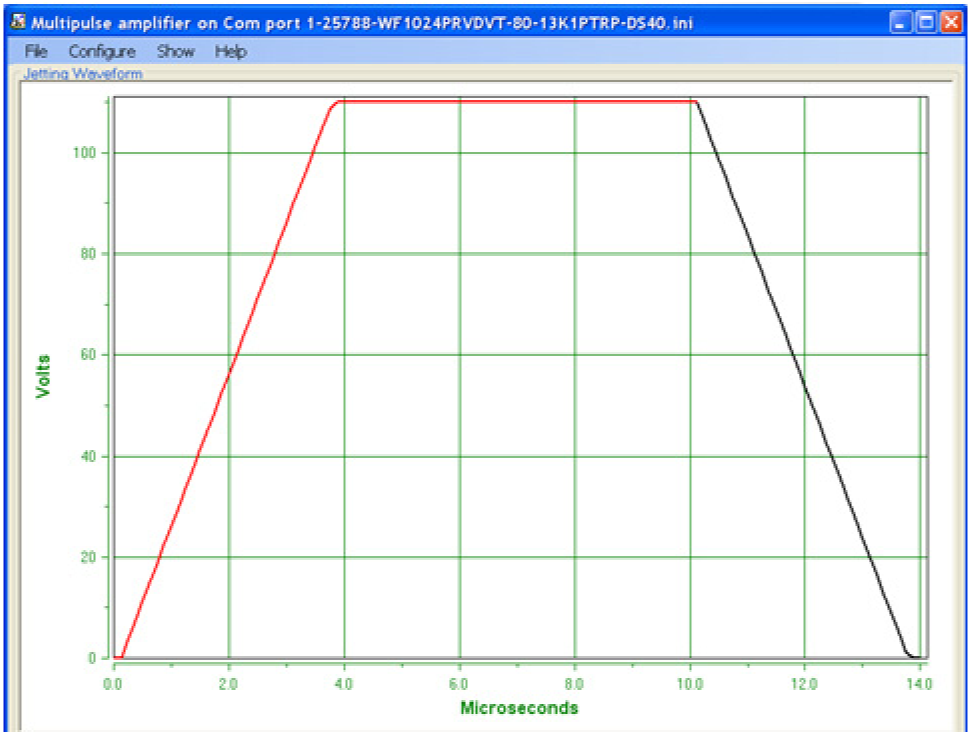


Figure C-66 Single pulse Waveform P/N 2100025788

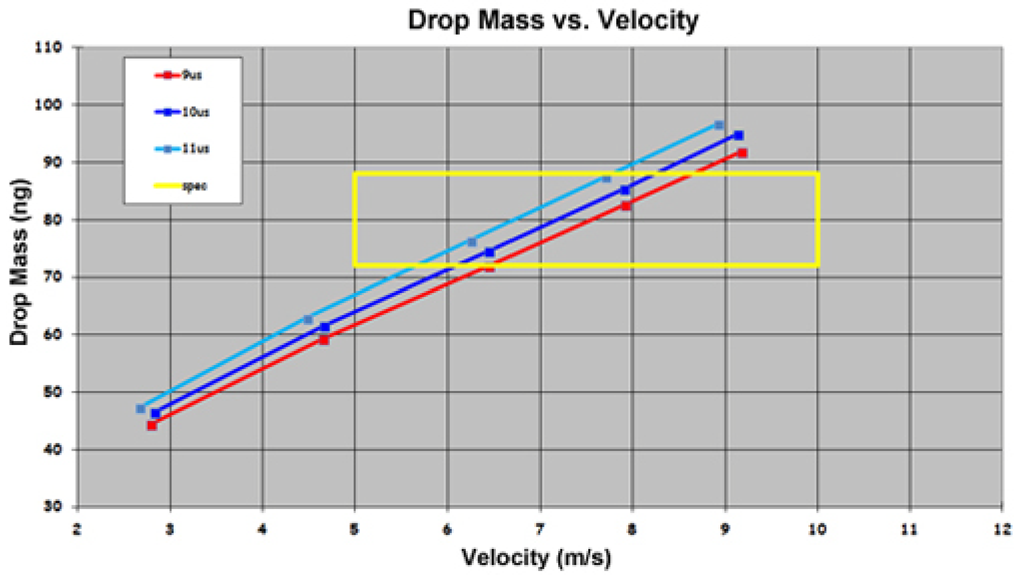


Figure C-67 SG1024/LA-2CI Mass vs Velocity

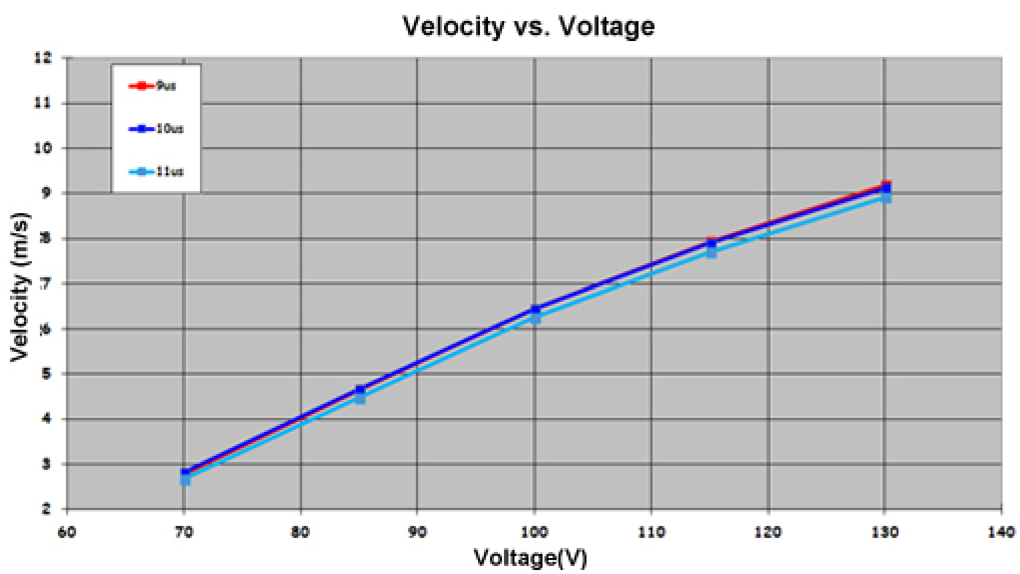


Figure C-68 SG1024/LA-2CI Velocity vs Voltage

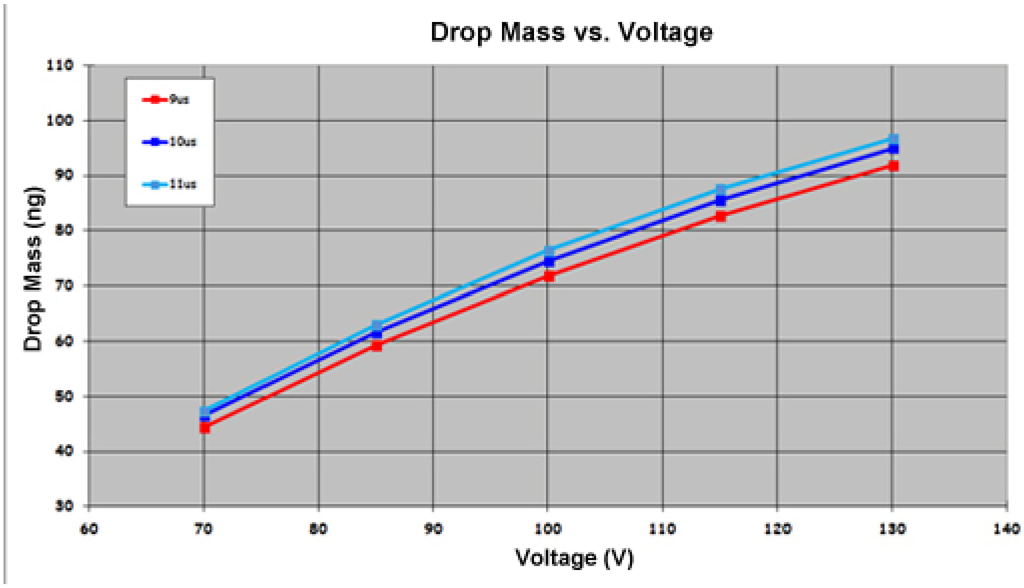


Figure C-69 SG1024/LA-2CI Mass vs Voltage

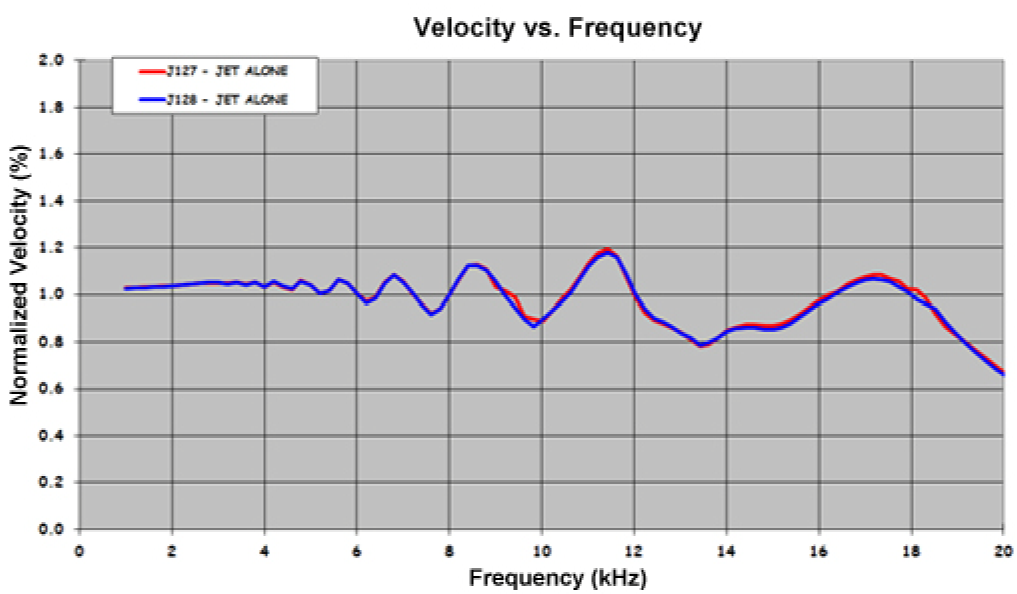


Figure C-70 SG1024/LA-2CI Velocity vs Frequency – alone

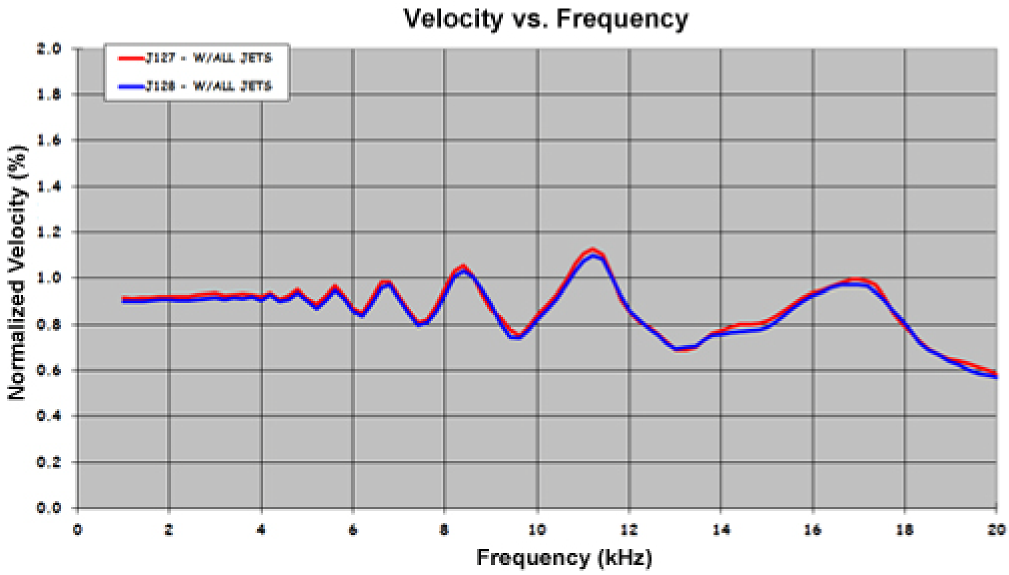


Figure C-71 SG1024/LA-2CI Velocity vs Frequency – all

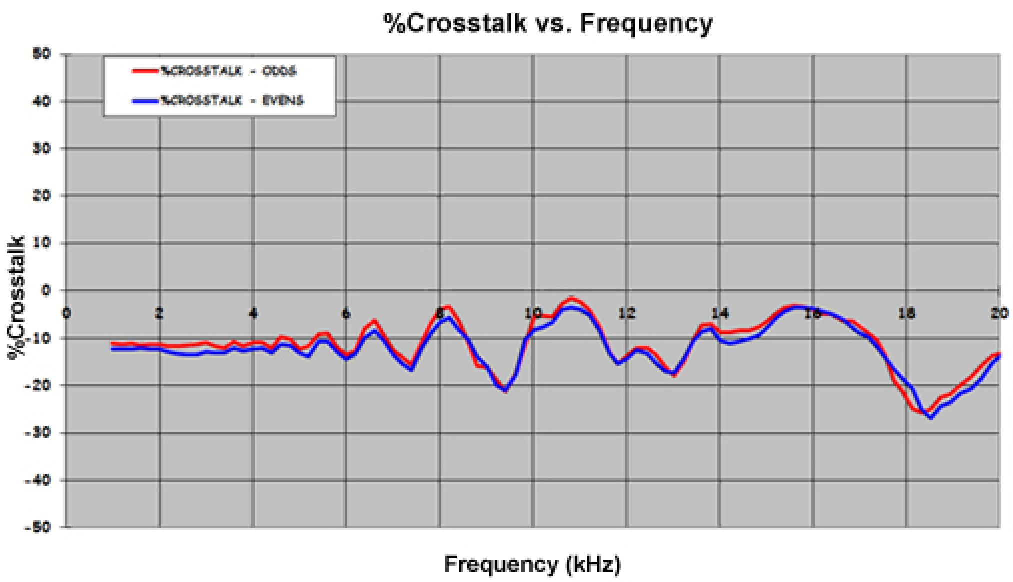


Figure C-72 SG1024/LA-2CI Percent Crosstalk vs Frequency

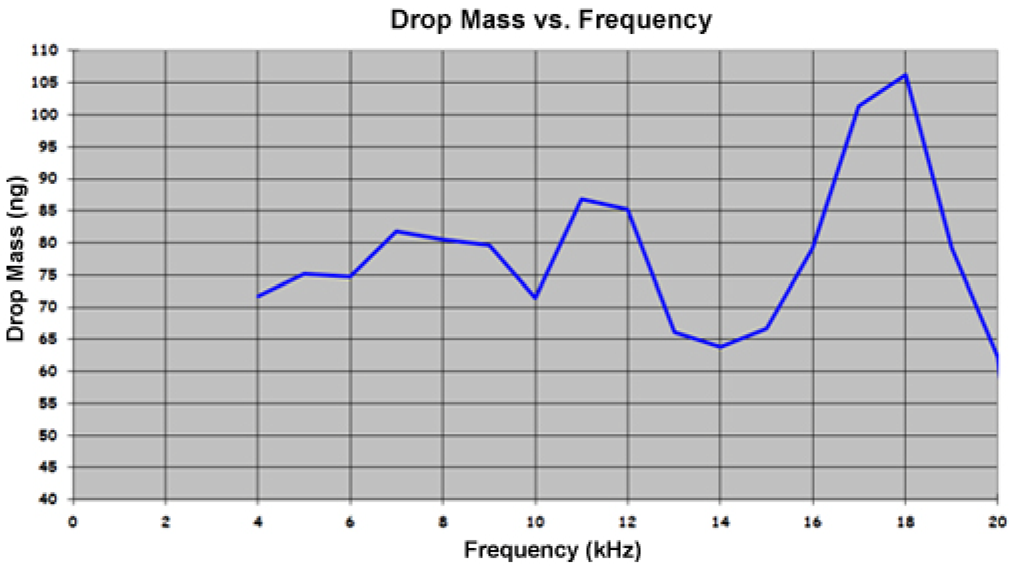


Figure C-73 SG1024/LA Mass vs Frequency

Temperature – Resistance Thermistor Table for Murata NCP15XH103F03RC

Temperature (deg.C)	Resistance (k Ohm)	Temperature (deg.C)	Resistance (k Ohm)
0	27.218	26	9.634
1	26.076	27	9.283
2	24.987	28	8.947
3	23.950	29	8.624
4	22.962	30	8.314
5	22.021	31	8.018
6	21.123	32	7.733
7	20.266	33	7.460
8	19.449	34	7.199
9	18.669	35	6.947
10	17.925	36	6.706
11	17.213	37	6.475
12	16.534	38	6.252
13	15.885	39	6.039
14	15.265	40	5.833
15	14.673	41	5.635
16	14.107	42	5.445
17	13.566	43	5.262
18	13.048	44	5.086
19	12.554	45	4.916
20	12.080	46	4.753
21	11.628	47	4.597
22	11.194	48	4.446
23	10.779	49	4.300
24	10.381	50	4.160
25	10.000	51	4.026

Temperature (deg.C)	Resistance (k Ohm)	Temperature (deg.C)	Resistance (k Ohm)
52	3.896	89	1.302
53	3.771	90	1.268
54	3.651	91	1.234
55	3.535	92	1.201
56	3.423	93	1.170
57	3.315	94	1.139
58	3.211	95	1.109
59	3.111	96	1.080
60	3.014	97	1.052
61	2.922	98	1.025
62	2.833	99	0.999
63	2.748	100	0.973
64	2.665	101	0.949
65	2.586	102	0.925
66	2.509	103	0.902
67	2.435	104	0.879
68	2.363	105	0.858
69	2.294	106	0.836
70	2.227	107	0.816
71	2.162	108	0.796
72	2.100	109	0.776
73	2.039	110	0.7580
74	1.981	111	0.739
75	1.924	112	0.721
76	1.869	113	0.704
77	1.817	114	0.687
78	1.765	115	0.671
79	1.716	116	0.655
80	1.668	117	0.640
81	1.622	118	0.625
82	1.577	119	0.610
83	1.534	120	0.596
84	1.4927	121	0.582
85	1.4521	122	0.569
86	1.412	123	0.556
87	1.374	124	0.543
88	1.338	125	0.531

Numerics

A

B

C

D

X

Y

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