TRIDENT
AN ITW COMPANY
INDUSTRIAL INKJET

256Jet-D Print Head

Application Manual

Rev. D

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Document Revision Control

REVISION	DESCRIPTION	APPROVAL	DATE
A	Production Release	*DW / ES / SL*	**6-10-08**
B	Updated Heater Control Requirements	**ES**	**06-13-08**
C	Added warning to seal back of print head from ink		**10/15/08**
D	Changed figures to show 256Jet	**ES**	**04/15/11**

Introduction

What is the purpose of this manual?
This manual provides information for the user to integrate the 256Jet-D print head in their printing applications. Given the wide range and sometime unique nature of industrial printing applications this manual will not address all possible printing applications but it will give the reader a solid overview of general practices that should apply to most printing applications when using Trident's 256Jet-D print head.

Primary specifications for the performance of the 256Jet-D print head are contained in the customer Product Specification, CS01-0407, attached as Appendix A. The current revision of this Product Specification is available from the customer login area of the Trident web site or by request from your Trident representative. If you do not have a login for Trident's website, please contact your Trident representative to request one.

This Application Manual supplements the Product Specification and provides more in-depth information for the use of the 256Jet-D print head. This Application Manual is also available from the customer login area of the Trident web site.

As updates are periodically made, please make sure you have the latest version. The electronic version of Trident manuals and specifications are controlled and updated on a regular basis by Trident and any hardcopy of these documents are uncontrolled. Before use, you should verify that your document is the latest revision by checking the website or contacting Trident.

About the 256Jet-D Printhead
The Trident 256Jet-D print head has 256 controllable channels available for jetting. The print head is designed for applications that require precise control of the jetting parameters for each channel. This print head was also designed for applications where user control of the drive parameters is required. The print head also is inert to accommodate a wide range of jetting fluids. The print head is designed to be repairable, which combined with long life offers excellent return on investment.

Trident Print head Technology - Overview

Trident inkjet technology is the piston-type impulse ink jet. There are two distinct phases of operation: fill and fire.

Referring to Figure 1, firing chamber fill occurs as a drive voltage is applied to the piezoelectric crystal. The piezo shrinks in response to the controlled voltage applied (print signal). As the piezo shrinks, ink is drawn into the firing chamber.

To fire the ink drop, the voltage is removed very quickly, which causes the piezo to return to its' original length, forcing a drop of ink out the orifice at a calibrated velocity.
This process can be repeated many thousands of times per second. One channel firing one thousand times per second is stated as a "firing frequency of 1kHz".

The figure below shows three droplets being fired from one "channel" or firing chamber.

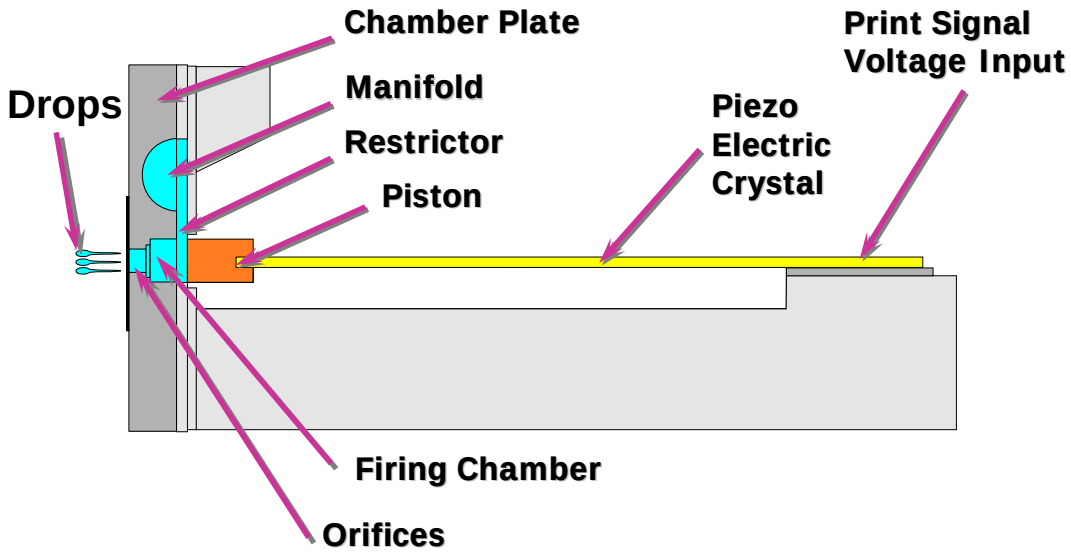


Figure 1: Firing chamber schematic
UltraJet configuration shown. Other Trident printheads are similar.

256Jet-D Integration Overview:

Mechanical, Electrical and Fluidic design

This manual is divided into three general sections:

- Mechanical
- Electrical
- Fluidic

Each section addresses the basic information needed within that discipline to successfully integrate Trident's 256Jet-D print head into the design of an OEM's Trident-based printing system.

List of Referenced Trident Documents

Current versions of the documents listed below are typically provided whenever a hard copy of this 256Jet-D Print Head Application Manual is sent to customers. These hard copies are not controlled, i.e. they will not be updated and should be considered reference copies only.

- 256Jet-D Print Head Product Specification, CS01-0407
- 256Jet-D Print Head Envelope Drawing 256-9015-01
- Trident Material Safety Data Sheet (MSDS) number 63, Trident shipping fluid

The following documents are provided to licensed Trident customers as part of refurbishment training provided by Trident:

- 256Jet-D Customer Refurbishment Procedure CS01-0426
- 256Jet-D Print Head Spare Parts Drawing 256-9016-01

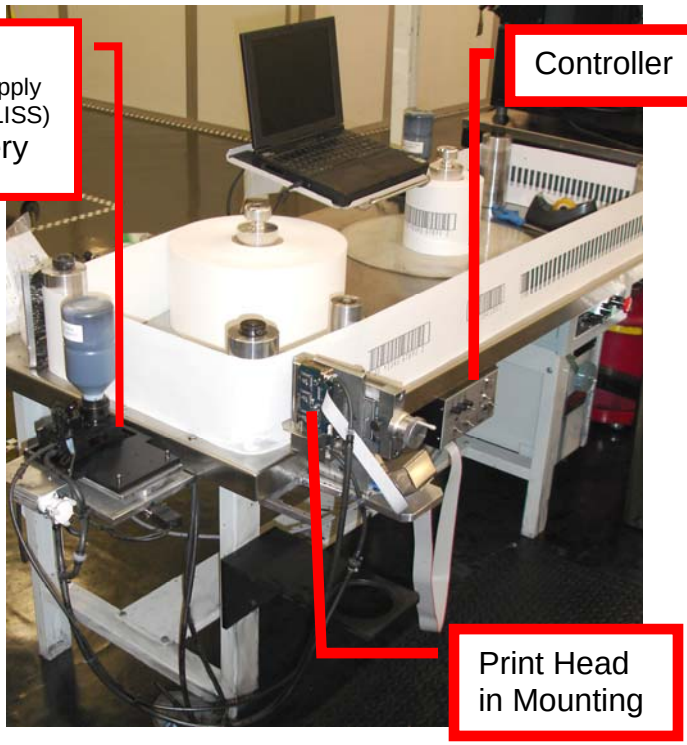
Quick Start

Before you Start …
Make sure you have the following components available:
From Trident:
- 256Jet-D Print head

OEM responsibility:
- Mounting and Hardware

- Ink Delivery Subsystem
  - o tubing
  - o ink reservoir
  - o pump or method for priming
  - o Ink or fluid to be jetted

- Print control electronics ("Controller")
  - o Controller hardware
  - o Cables
  - o Software
  - o PC (depending on controller capability)



Trident examples of these components are identified in the picture to the right. Contact Trident if you want to purchase any of these components.

Contents of the box
When the shipping box from Trident is unpacked the following will be inside:
- 256Jet-D print head
- Print Head specification sheet with rated voltages for the specific print head.

Print Head Set Up
All the steps listed below are covered in more detail later in this manual and/or in the Product Specification. This is a quick start to focus on the steps needed to get printing quickly for someone who is familiar with ink jet technology.
- Support the print head securely in a mount or fixture, oriented jetting down or sideways as required by the application. IMPORTANT: Protect ink or fluid from getting behind the print head face plate. Catastrophic damage to the print head can occur if ink or fluid gets on the transducers behind the face plate. The mounting holes are through holes to the transducer area so if ink or fluid can wick up, the holes must be sealed. See figures 9 and 10 and Appendix B, outline drawing, for location of mounting holes and screw size. Screw size is M3.

- Install Trident's Large Ink Supply Subsystem (LISS) or build an appropriate ink delivery system. The print head runs with a negative hydrostatic head pressure relative to the ink level which means that the top of the ink in the ink tank is below the level of the print head. See Figure 2 for further explanation. Dimension A is -0.25 to –0.75 inches or -6.35 to –19.05 mm for jetting horizontal.
  For jetting down, dimension A is -0.25 to -4.75 inches or -6.35 to -120.6 mm.

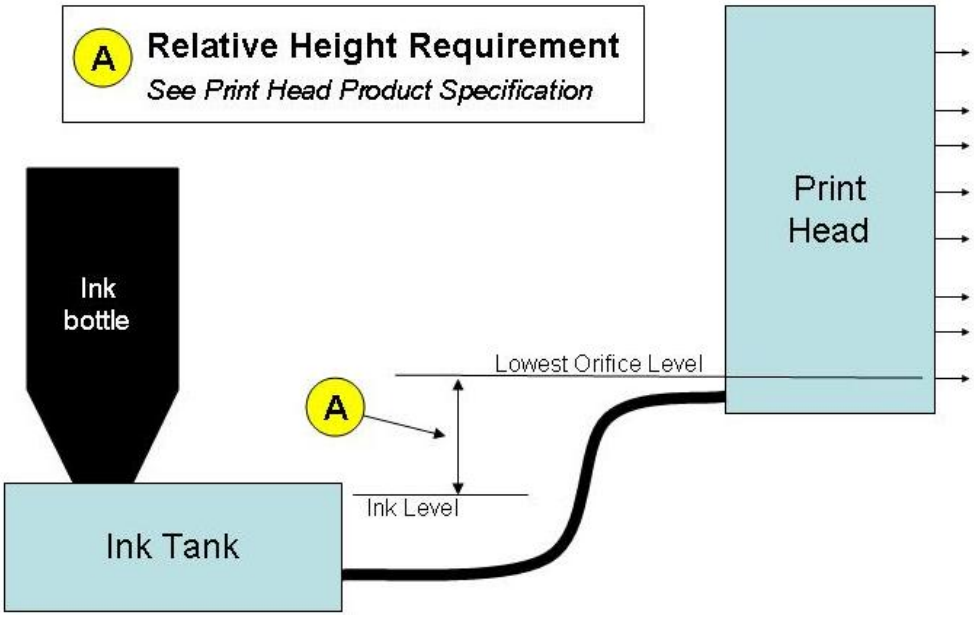


Figure 2: Relative height diagram

- Confirm compatibility of the ink to be used with the Trident print head shipping fluid which is in the print head shipped from Trident. Trident Chemistry Department is available for compatibility consultation.

  WARNING: Fluids which are not compatible can damage the print head.

- Fill completely the ink delivery system with ink.

- Connect the print head to the ink delivery system and push all the shipping fluid and air out, first from the vent, then from the orifices. Sideways orientation is most effective for this operation. See Figure 11 for photo of pushing ink through the vent and Figure 12 for pushing ink out the orifices.

- Connect driver electronics to the print head. See Figure 3 for photo of print head connected to drive cable.
  Refer to electronics section of this manual for data related to design of controller / drive electronics.

- Power on the electronics.

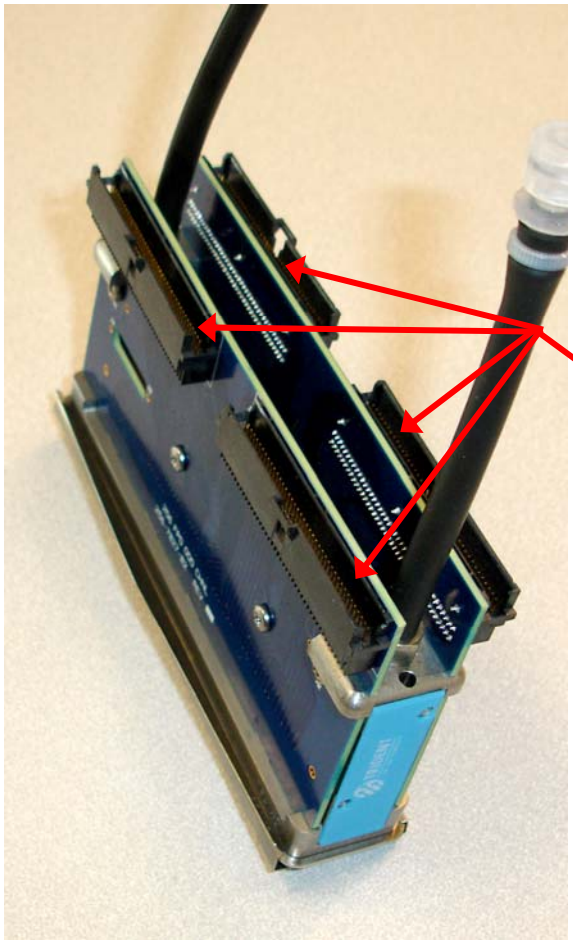


Figure 3:
Drive cable attachment
to 256Jet-D print head.

How To Print

- Load an image to print into the controller of the print head.
- Provide an encoder and print start signal to the controller as necessary.
- Activate the substrate transport

and Print !

Mechanical Integration

Mounting

Heat Sinking

If the print head will be operated at a temperature above ambient, care should be taken with mounting design to avoid "heat sinking" the print head or drawing heat out of the print head through conduction. A non-uniform temperature across the print head will result in variations in jetting performance across the print head.

Ship Cap

Mounting design should include a ship cap for the print head face to reliably seal the orifices. Sealing the orifices is required for at least three purposes:

1) to avoid leakage from the orifices when circulating ink in the print head to remove air and,
2) to prevent ink drying in the orifices during extended periods of not printing.
3) to seal the print head during shipping and handling.

It is not likely that the Trident supplied ship cap can be used when the print head is mounted since it clips to the sealing surfaces used to prevent ink from going behind the print head face and those sealing surfaces will likely be covered by the print head mounting system. This means that a ship cap will have to be designed by the OEM and integrated with the mounting design. The print head will need to have a ship cap installed at times and it is important to be able to do so without having to remove the print head from mounts. Trident suggests reviewing the function of the Trident ship cap when designing the ship cap to be used with the mounting.

See Figures 4 and 5 and Appendix B, print head outline drawing, for more information on the ship cap and print head sealing surface.

Warning: If using Trident supplied ship cap or ship cap materials, confirm compatibility with the ink to be used.

Vibration and Shock

The print head should be mounted do minimize exposure to vibration and shock, as these can cause air to be ingested into the print head and affect print quality.

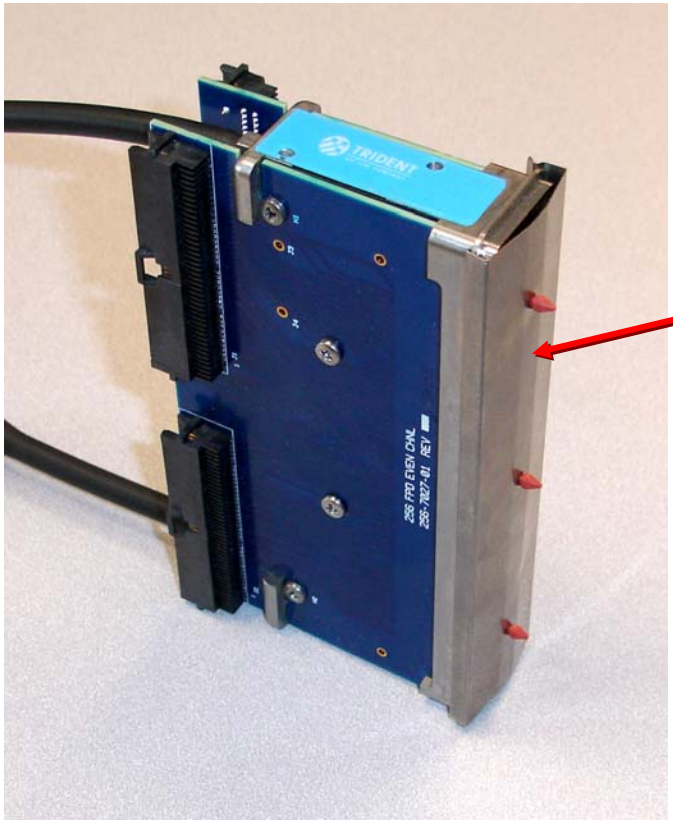


Figure 4: Trident orifice ship cap (shown installed to seal orifices)

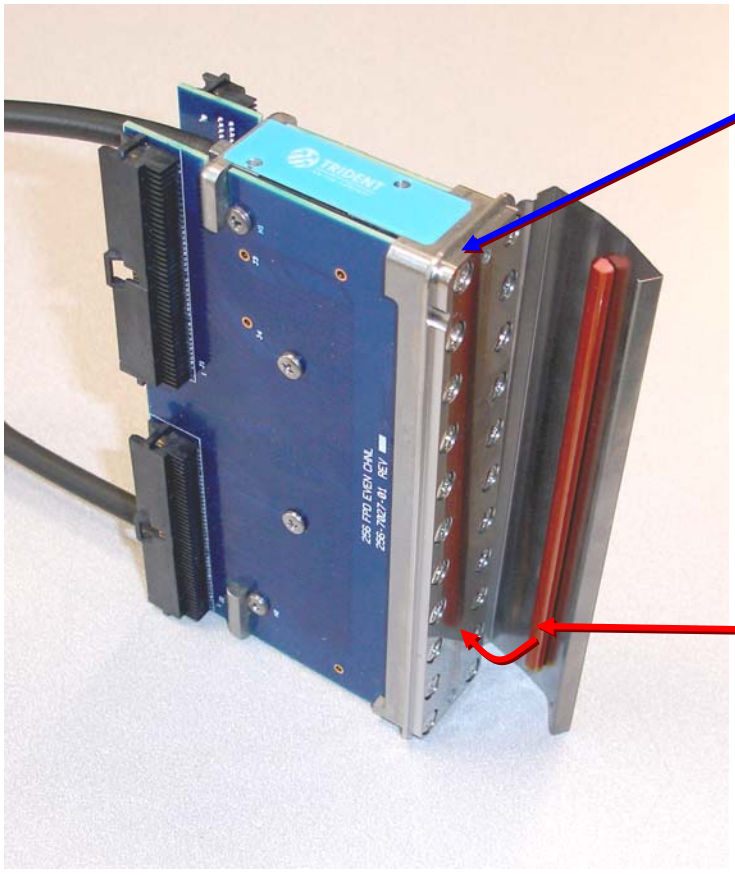


Figure 5: Trident ship cap (Unclipped to show surface of the shipcap that seals the row of orifices as well as the surfaces provided to seal the printhead to the OEM-provided case.)

Printing gap

The maximum recommended print gap is 0.100 inches (2.5 mm). Printing with a larger gap will result in poor print quality, including fuzzy print. See Figure 6 for illustration of printing gap.

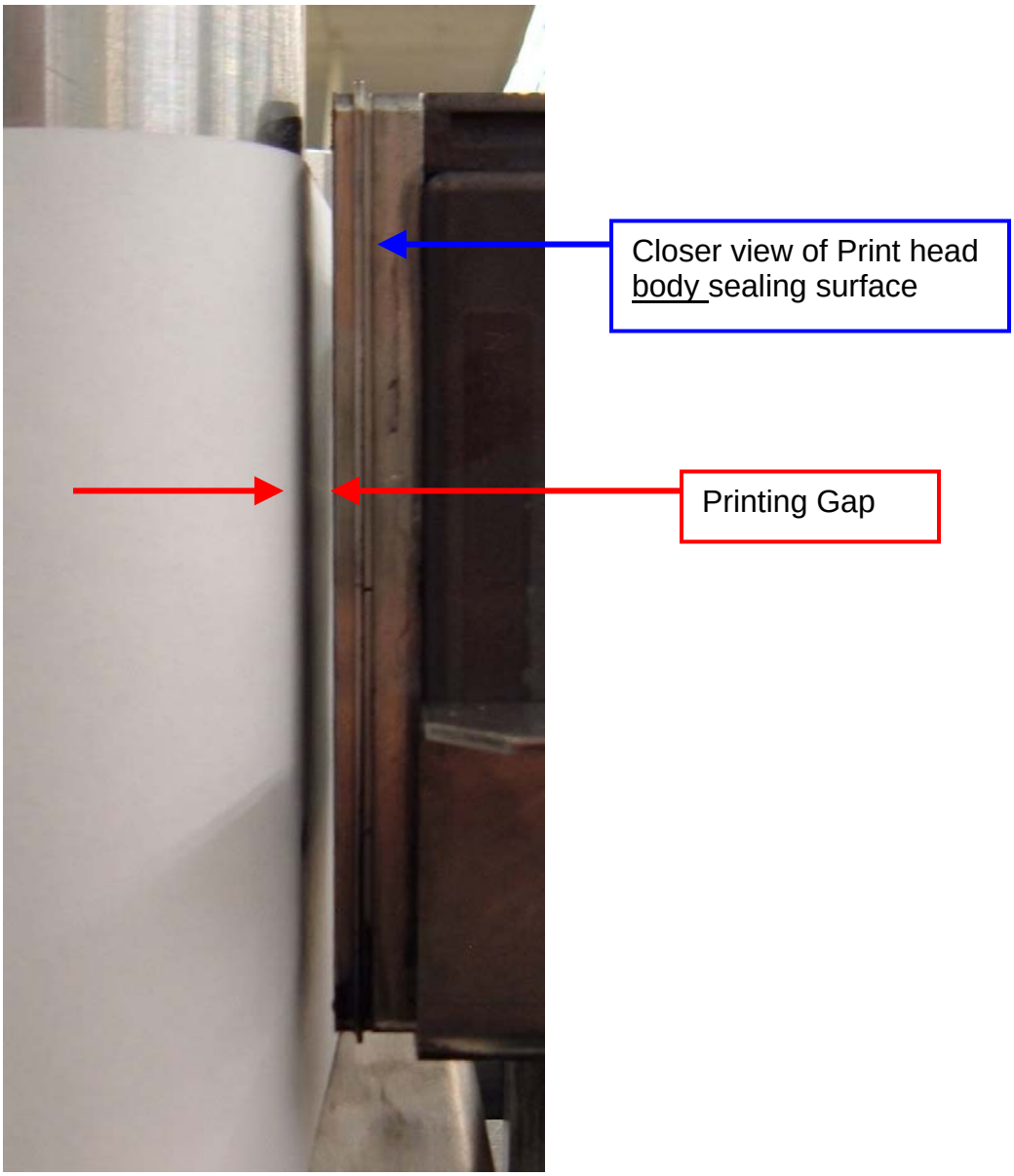


Figure 6: Illustration of printing gap

Nozzle Plate Protection

Trident inkjet technology is designed for non-contact printing. The nozzle plate may be damaged by contact with the substrate or other material. Proper substrate guiding and/or print head face guarding is required.

Print Head Shuttling

The 256Jet-D print head may be shuttled. In shuttling applications, the print head can sustain printing when subjected to the following conditions:

- 28 inches per second (43 meters per minute), 2g
- 40 inches per second (61 meters per minute), 0.2g

Care should be taken with ink system design in shuttling applications to minimize shock and vibration to the print head and ink tubes.

Good Practices

Keep inks and fluids from going behind the front print head face plate. Inks and fluids on the back part of the print head can attack materials on the outside of the print head, causing print head failure. Inks and fluids can also cause problems with the print head electronics and electrical signals. Trident recommends designing the mount to seal the print head front from the back. Refer to Figures 9 and 10. The print head has a flange just behind the front face that is used for sealing. A gasket made of material compatible with the ink or fluids being jetting is placed around the flange and an enclosure that clamps around that flange is fastened to the print head using the mounting holes of the print head.
Dimensions and location of the flange are given in the print head envelope drawing, Appendix B.

Dust and Moisture

Dust and moisture on the print head face will affect jetting performance and can lead to permanent orifice clogs. Steps should be taken to minimize dust accumulation on the print head face. Fluids compatible with the ink and approved cleaning fluids are acceptable but all other fluids should be kept away from the print head. Fluids that are not compatible can react with the ink to form hard clogs of the orifices. If fluids get into the back of the print head it can result in damage to print head components.

When wiping the print head face, always use an approved debris free clean cloth (see “wipes” section below). Never wipe a dry face, always wet it by pushing some ink out the orifices or spraying the face lightly with an approved maintenance spray. Avoid getting any fluids on the back of the print head.

Capping

The print head should typically be capped to seal the orifices when not in use for more than 4 hours. This time is dependent on the ink used. For inks that dry rapidly, the print head may need to be capped quickly. For less volatile inks, capping may be required only after a day of non-use.

Prior to installing the ship cap, be sure to wipe the ship cap pad with a clean cloth. It is also recommended to perform a small prime and wipe of the print head face to remove any debris and contaminants prior to installing the ship cap. See Figures 7 and 12.

Figure 7: 768Jet-L shown
256Jet-D similar

Example of wiping the print head during prime.
Note direction of wiping.

DO NOT RUB HARD!

DO NOT WIPE ACROSS MULTIPLE TIMES!

One initial wipe to remove most of the ink and then one or two light wipes to remove the small amount of remaining ink.

Also note the use of a Trident approved debris free wiping cloths, part number 9700-0100-01. See “Wipes” section below.

Fluidic Integration

Ink Compatibility with Trident Print Head Test Fluid

The 256Jet-D print head is shipped with Trident test fluid. The properties of this fluid are:

Surface Tension	35	dynes
Viscosity (Measured at room temp of 23°C)	6.9	cps

An MSDS for this fluid is given as Appendix C.

NOTE: Make sure the ink to be used with the print head is compatible with the Trident test fluid.

If the ink and shipping fluid is compatible, the ink may be flushed into the print head directly behind the shipping fluid.

If the ink and fluid are not compatible, a solvent compatible with both will need to be used for flushing out the Trident shipping fluid before putting the ink into the print head.

Trident Chemistry Department is available for consultation if necessary.

Ink Delivery System Design Considerations

Make sure the materials used are compatible with the ink(s) and fluid(s) to be used.

Tubing

Tubing should be kept as short as possible with no opportunity for pinching or kinks in the tubing. Specifications for tubing (size, material) used on the print head are:

Material: Proprietary viton blend
Inlet tube inside diameter: 0.188 inches
Vent tube inside diameter: 0.188 inches

Optional Large Ink Supply Subsystem (LISS)

Trident offers a ink delivery system that includes a gross filter, vent to atmosphere, ink level detection, inlet and outlet and which can accommodate 125ml or 500ml bottles. The LISS ship cap is not shown in the picture to the right. The inlet on the ink reservoir allows ink vented from the printhead to be returned to the reservoir instead of wasted.

Ink Delivery via Capillary Action

Trident print technology draws ink into the print head through capillary action and, as such, the ink delivery system must maintain the negative hydrostatic pressure to the print head. This is done by assuring that the relative position of the ink supply level and print head lowest orifice is met. See Figure 8.

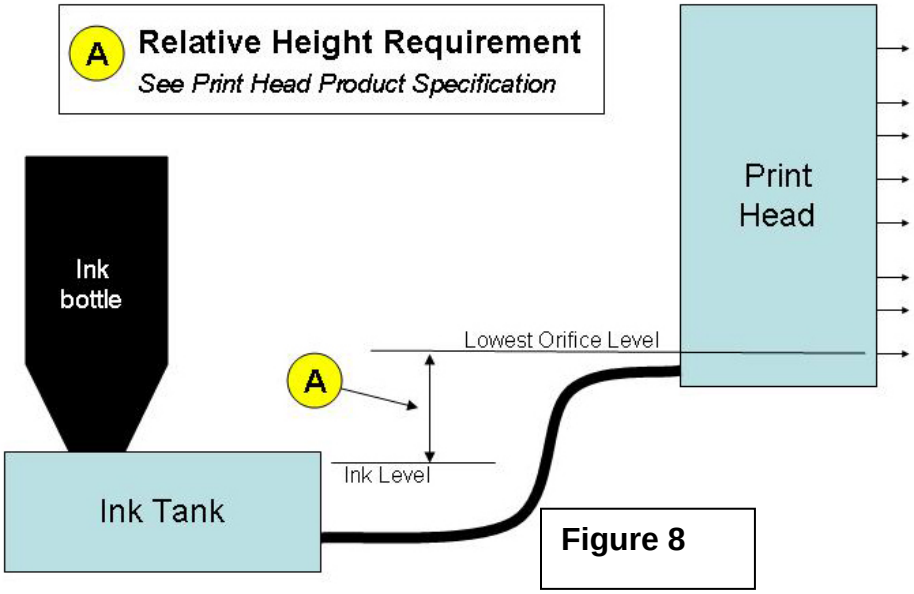


Figure 8

The specification for dimension A is:

- Jetting horizontally: -0.25 to –0.75 inches or -6.35 to –19.05 mm.
- Jetting down: -0.25 to -4.75 inches or -6.35 to -120.6 mm.

Viscosity and Surface Tension

Consider the viscosity and surface tension of the ink or jetting fluid relative to the Trident calibration ink used in the specification. The 256Jet-D print head performance defined in Appendix A, product specification is based on the specific properties of the ink used for testing and if a different ink or fluid is used it is important to match the viscosity and surface tension at the operating temperature of the print head as closely as possible.

If the ink or fluid is much lower in viscosity, using a pump may cause cavitation and air in the ink system. In this case, an ink delivery system without a pump is recommended.

Filling the Ink Delivery System

The ink delivery system, including all tubing, must be filled with ink, and all air removed, prior to connecting the print head.

Build the ink system as needed to fit into the application. If an optional compliant chamber and filter are used, connect them and ensure they are oriented so that ink enters at the low side and exits on the high side. This orientation will allow air to be removed easily.

Slowly filling the ink system is most effective since it allows the ink to push air out of the system.

- Place the print head connection end of the tube over a container to collect the ink that will flow out.
- Introduce ink into the ink tank and use air pressure or gravity (by raising the ink tank above the other components) to move the ink slowly through the system until ink with no air bubbles comes out the print head connection end. 3-5 psi (0.21 - 0.34 bar) pressure is usually enough, or 0.5 meters of height for the ink tank.
- With ink still slowly coming out the tube, connect it to the print head inlet tube.

Print Head / Ink Fill Procedure

Never run the print head empty of ink. It can be very difficult to reprime the print head after the print head has been "run dry".
Always fill the ink delivery system fully with ink prior to connecting it to the print head. See above procedure.

Note: The less air introduced into the system, the faster full printing will be achieved.

To switch from one fluid or ink to another fluid or ink:
First the fluids must be compatible. Compatible means the fluids, when mixed, will not increase in viscosity or form precipitates that clog the print head.

If possible, orient the print head on end as shown in Figure 9. This orientation is the most effective at removing air and easily priming air from the orifices. Note that the inlet is at the bottom. The downward orientation shown in Figure 10 is acceptable, but removing the air may be more difficult.

With the straight connection ink system, place the print head vent tube over the waste container and remove the luer plug on the tube. Allow ink to flow from the vent tube until no air bubbles are present. This could take 15-30 seconds. Replace the luer plug on the vent tube. See Figure 11.

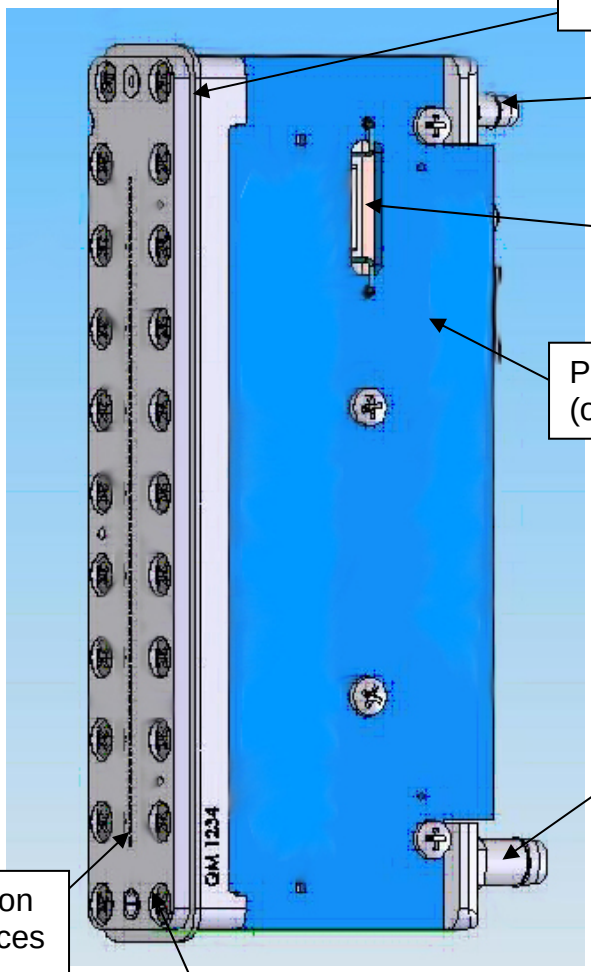


Figure 9:
Print head sideways orientation
(connectors & cables not shown)

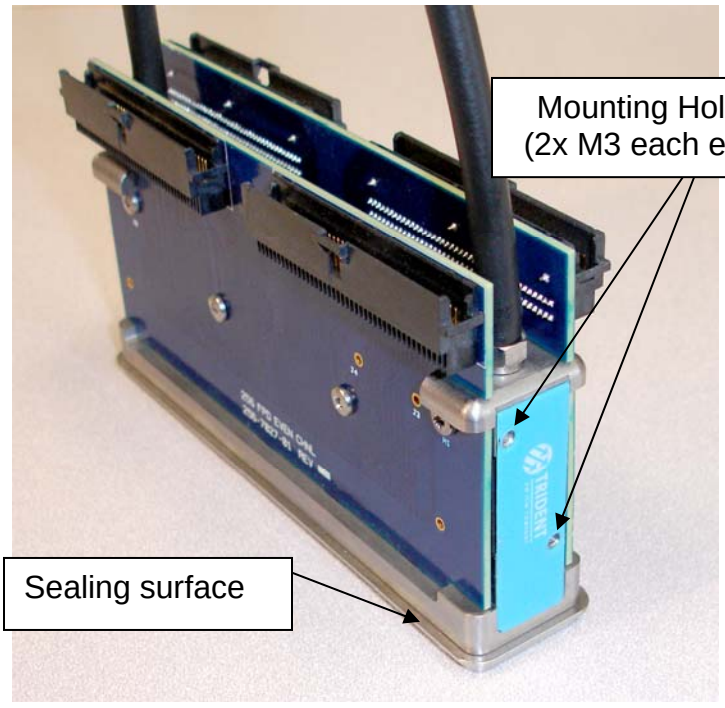


Figure 10:
Print head
jetting downward orientation

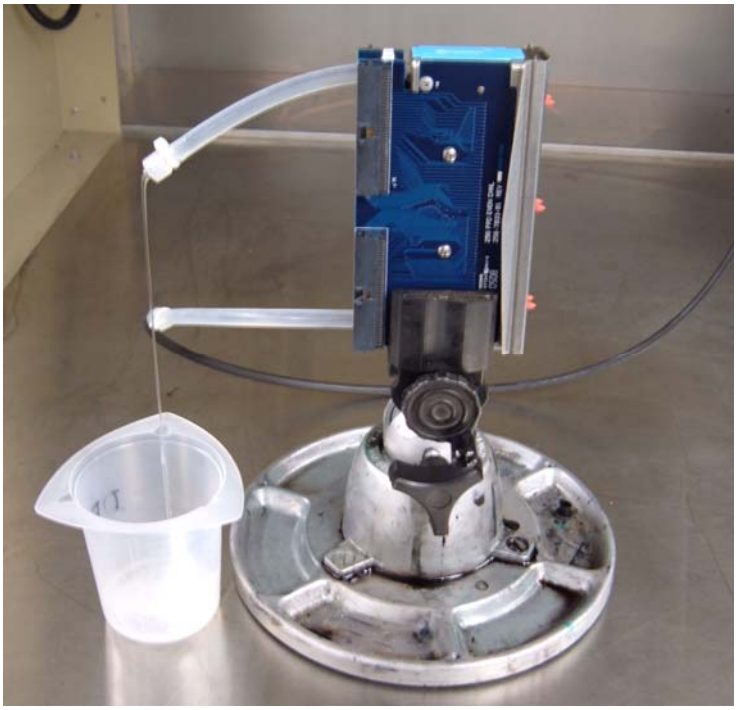


Figure 11: Print head vent purge.

The luer plug on the print head vent is removed, the ink system is pressurized, and ink flows out the vent, taking air with it.

Print Head Priming

Wipes

Trident recommends using only Trident-approved debris free clean cloths on the print head face. Other materials can push fibers into the orifices, resulting in missing orifices and noticeable defects in the printed image. An approved clean room wipe is available from Trident as part number 9700-0100-01. Contact Trident Customer Service to order these and other Trident-approved cleaning supplies.

Air or Pump Priming

Priming the print head involves using air pressure on the ink tank connected to the print head to push ink out the orifices or through the use of an inline priming pump. If there is air or debris in the orifices, priming pushes it out. Debris that cannot be pushed out by priming will require a print head to be disassembled and a thorough cleaning of the orifice plate to remove the debris. Refer to Figures 7 and 12.

Process for priming the print head

Place a debris free clean wipe on the face of the print head or place a collection pan below the face plate to catch ink that will be primed out of the orifices.

Apply air pressure to the ink supply to push ink out the orifices. Usually about 0.5 meter of positive head pressure is needed or approximately 5 psi (0.34 bar) air pressure. If a Trident inline priming pump is incorporated into the system, run the pump at 3-5 volts for priming. See Figure 12. Apply pressure for 1-3 seconds. Wipe the face of the print head to remove excess ink as shown in Figure 7.

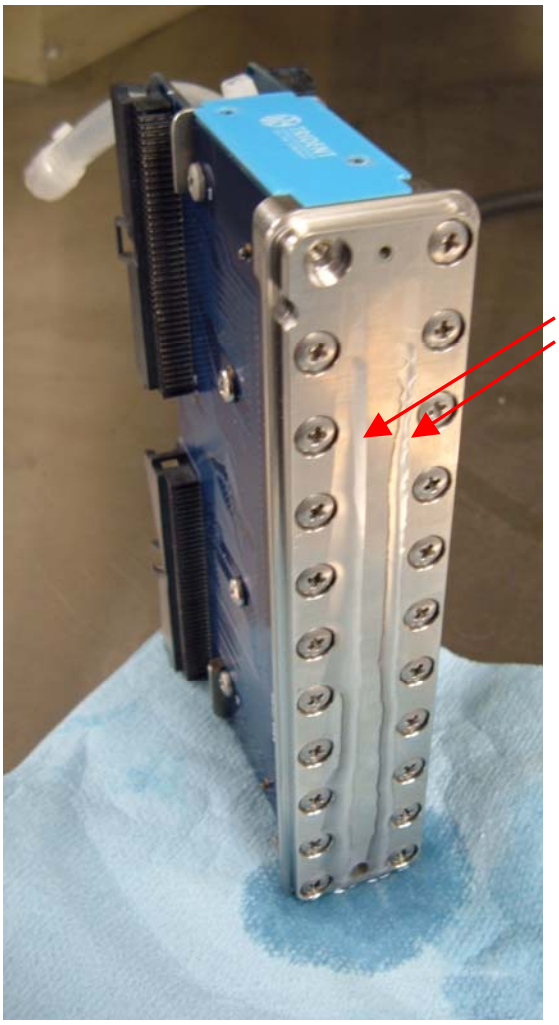


Figure 12: Print head priming.

Note ink coming out the orifices and running down the front plate.

Proper method for wiping excess ink off the face is shown in Figure 7.

Print Head Storage

Print head storage conditions are

Ambient Storage conditions	Temperature:	10 – 40 °C
	Relative Humidity:	10 – 90 %

The orifice ship cap should always be installed for storage. If the print head is left connected to an ink supply, the ink supply should be closed up also. If disconnected from an ink supply, the inlet and vent ports should be capped securely.

Note: Before storage, a print head must be full of ink or storage fluid. If left partially full of ink the properties of the fluid path can change so that the ink does not sufficiently "wet" to the print head internal surfaces. Insufficiently "wet" surfaces within the print head will make it more likely to trap air in the print head.

Evaporative inks can dry in the print head or orifices. This situation can be managed by using a non-evaporative storage solvent in the print head when storing the print head.

Electrical Integration

Electrical Specifications - Electronics

Sections shown below are taken from 256Jet-D Print head Product Specification, Trident document CS01-0407. Information provided as reference only. Please refer to latest revision of the product specification.

Connectors:
Print head PCB: Tyco 104069-3
Mating connector: Tyco 1-111196-5 plug or equivalent

Pin outs:

All are inputs unless noted.

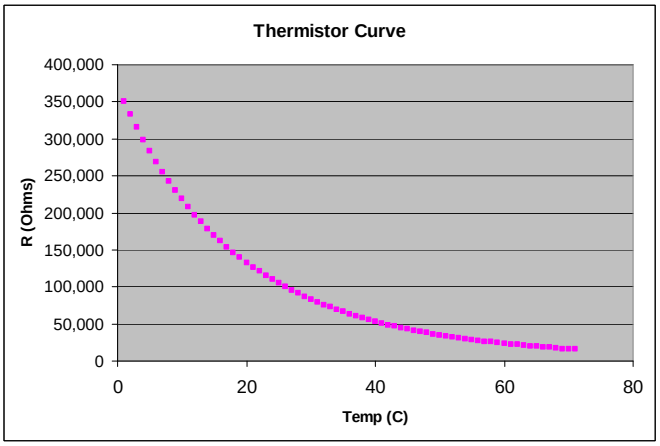
Pin	J1 (even)	J1 (odd)	J2 (even)	J2 (odd)
1	CH126	Heater+	NC	CH127
2	CH124	Heater+	NC	CH129
3	CH122	NC	NC	CH131
4	CH120	Temp1	COM_B	CH133
5	CH118	Temp2	COM_B	CH135
6	CH116	COM_A	COM_B	CH137
7	CH114	COM_A	COM_B	CH139
8	CH112	COM_A	COM_B	CH141
9	CH110	COM_A	COM_B	CH143
10	CH108	COM_A	COM_B	CH145
11	CH106	COM_A	COM_B	CH147
12	CH104	COM_A	COM_B	CH149
13	CH102	COM_A	COM_B	CH151
14	CH100	COM_A	COM_B	CH153
15	CH98	COM_A	NC	CH155
16	CH96	COM_A	CH256	CH157
17	CH94	NC	CH254	CH159
18	CH92	CH1	CH252	CH161
19	CH90	CH3	CH250	CH163
20	CH88	CH5	CH248	CH165
21	CH86	CH7	CH246	CH167
22	CH84	CH9	CH244	CH169
23	CH82	CH11	CH242	CH171
24	CH80	CH13	CH240	CH173
25	CH78	CH15	CH238	CH175
26	CH76	CH17	CH236	CH177
27	CH74	CH19	CH234	CH179
28	CH72	CH21	CH232	CH181
29	CH70	CH23	CH230	CH183
30	CH68	CH25	CH228	CH185
31	CH66	CH27	CH226	CH187
32	CH64	CH29	CH224	CH189

33	CH62	CH31	CH222	CH191
34	CH60	CH33	CH220	CH193
35	CH58	CH35	CH218	CH195
36	CH56	CH37	CH216	CH197
37	CH54	CH39	CH214	CH199
38	CH52	CH41	CH212	CH201
39	CH50	CH43	CH210	CH203
40	CH48	CH45	CH208	CH205
41	CH46	CH47	CH206	CH207
42	CH44	CH49	CH204	CH209
43	CH42	CH51	CH202	CH211
44	CH40	CH53	CH200	CH213
45	CH38	CH55	CH198	CH215
46	CH36	CH57	CH196	CH217
47	CH34	CH59	CH194	CH219
48	CH32	CH61	CH192	CH221
49	CH30	CH63	CH190	CH223
50	CH28	CH65	CH188	CH225
51	CH26	CH67	CH186	CH227
52	CH24	CH69	CH184	CH229
53	CH22	CH71	CH182	CH231
54	CH20	CH73	CH180	CH233
55	CH18	CH75	CH178	CH235
56	CH16	CH77	CH176	CH237
57	CH14	CH79	CH174	CH239
58	CH12	CH81	CH172	CH241
59	CH10	CH83	CH170	CH243
60	CH8	CH85	CH168	CH245
61	CH6	CH87	CH166	CH247
62	CH4	CH89	CH164	CH249
63	CH2	CH91	CH162	CH251
64	NC	CH93	CH160	CH253
65	COM_A	CH95	CH158	CH255
66	COM_A	CH97	CH156	NC
67	COM_A	CH99	CH154	COM_B
68	COM_A	CH101	CH152	COM_B
69	COM_A	CH103	CH150	COM_B
70	COM_A	CH105	CH148	COM_B
71	COM_A	CH107	CH146	COM_B
72	COM_A	CH109	CH144	COM_B
73	COM_A	CH111	CH142	COM_B
74	COM_A	CH113	CH140	COM_B
75	COM_A	CH115	CH138	COM_B
76	NC	CH117	CH136	COM_B
77	NC	CH119	CH134	COM_B
78	NC	CH121	CH132	NC
79	NC	CH123	CH130	Heater-
80	NC	CH125	CH128	Heater-

Heater
Both sets of pins are used for the one heater on the print head.

Temperature sensor:
Negative coefficient thermistor.

Thermistor curve:
100,000 Ohms @ 25°C
Tol. = ±5% @ 25°C



Temperature [°C]	Resistance [Ohm] .
-40	3921252.41
-35	2774564.66
-30	1988706.07
-25	1442860.78
-20	1058901.24
-15	785573.277
-10	588792.992
- 5	445601.87
0	340346.257
5	262229.446
10	203722.794
15	159521.653
20	125851.241
25	100000.00
30	80002.5468
35	64422.071
40	52199.5404
45	42548.2335
50	34879.3226

Temp. [°C]	Resistance [Ohm] .
55	28748.9194
60	23820.0865
65	19835.3748
70	16596.8198
75	13951.2679
80	11779.5372
85	9988.35826
90	8504.34377
95	7269.4478
100	6237.52723
105	5371.7226
110	4642.45213
115	4025.86733
120	3502.65769
125	3057.12117
130	2676.43769
135	2350.09889
140	2069.45833
145	1827.37528
150	1617.93137

Power Requirements

		Average	Unit
8.1	Piezo Drive Supply – per channel		
8.1.1	Voltage	100	Volts DC maximum
8.1.2	Current	60	mA per channel
8.2	Heater Power		
8.2.1	Voltage	48V	Volts DC maximum
8.2.2	Power	40	watts

Print Controlling the Print Head

Analog Control

Voltage Control

The controller must provide correct high voltage and drive pulse shape to the print head.

Digital Control

Data Clock

The Data Clock is a TTL compatible input for synchronously serial loading the print head drivers.

Trident typically controls and fires 32 or 64 channels together. All channels use the same voltage, waveform, and rise resistor. So while this discussion will show how to drive 32 channels together, the general concept can work for individual channel control.

A simple circuit of three one shots can implement the drive pulse, which then goes into the Output Enable of a HV5408. See Figures 5 and 6.

Each one-shot implements a part of the waveform. See Figures 8 and 9 for reference. For the single pulse waveform of Figure 8, only a single one-shot is necessary. For the “shark-fin” pulse of Figure 9, all three one-shots are necessary, representing primary pulse, delay, and secondary pulse.

Vpp represents the selected drive (jetting) voltage for that channel or bank depending on implementation used. See definitions below.

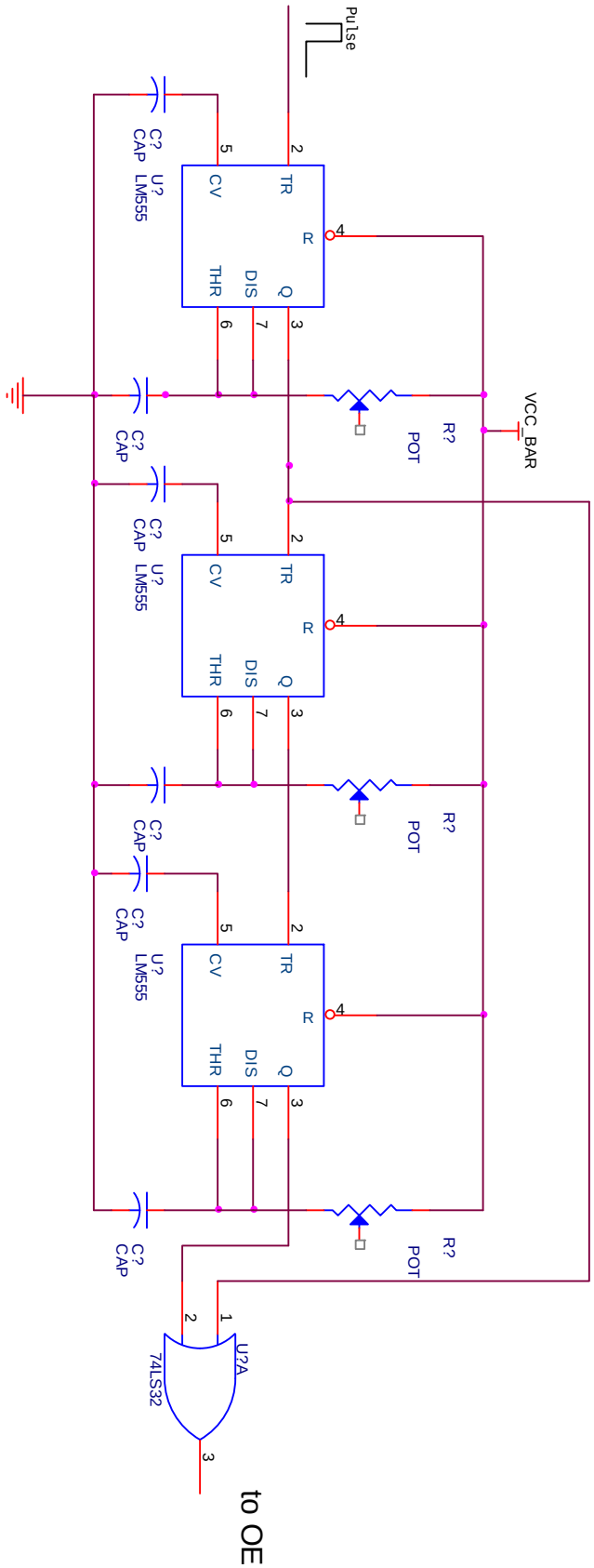


Figure 5
Digital portion of waveform shape circuit.
555's are shown configured as One Shots
to create the primary drive pulse, the off
time and then the secondary pulse.

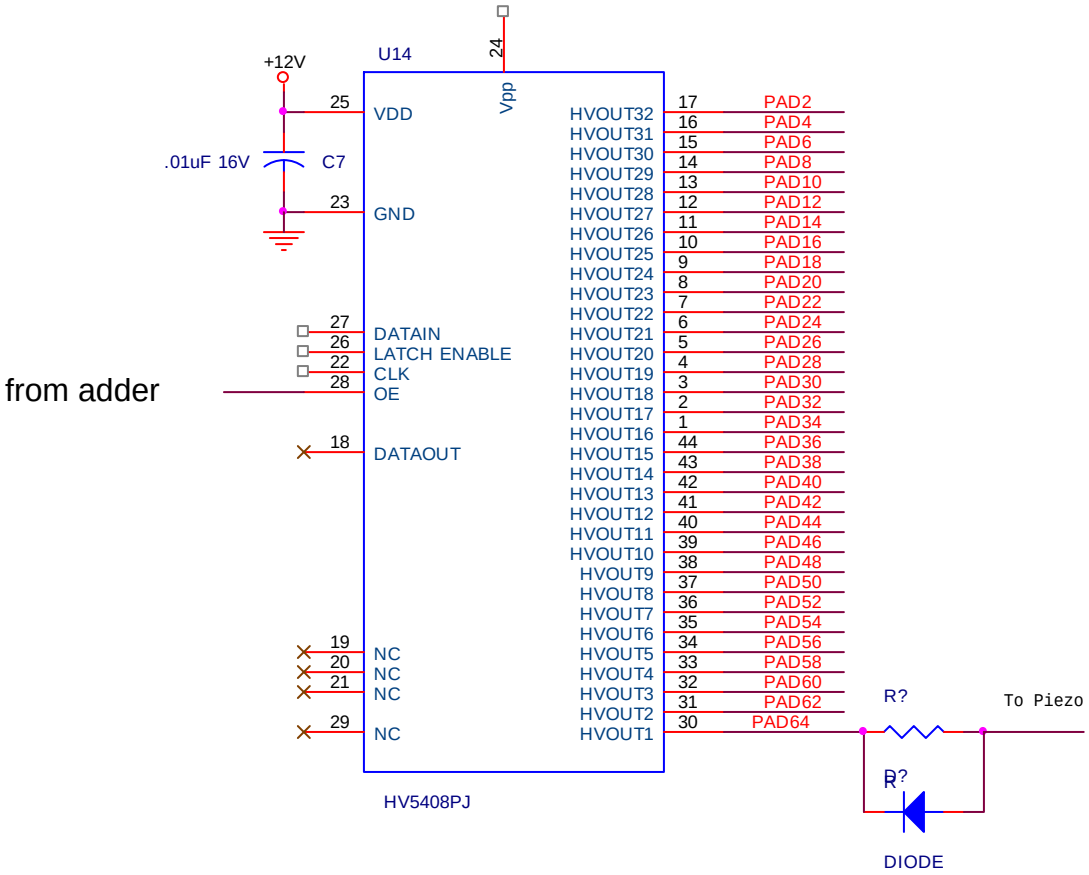


Figure 6
Converting the digital portion to analog for the piezo drive. One channel shown.

Variable definitions:

Vpp	voltage control. This is the rated voltage the channel(s) will use. From the Trident calibration sheet.
DATAIN	serially loaded data. See timing diagram below.
CLK	maximum clock rate of the device from the datasheet. In this case the 5408 operates with a 6 MHz clock maximum. 50% duty cycle is recommended.
R?	rise resistor. See discuss below and refer to Product Specification for value used during Trident calibration of the print head.
DATAOUT	allows cascade of the devices so more than, in this case, 32 channels can be driven from one serially loaded input stream.

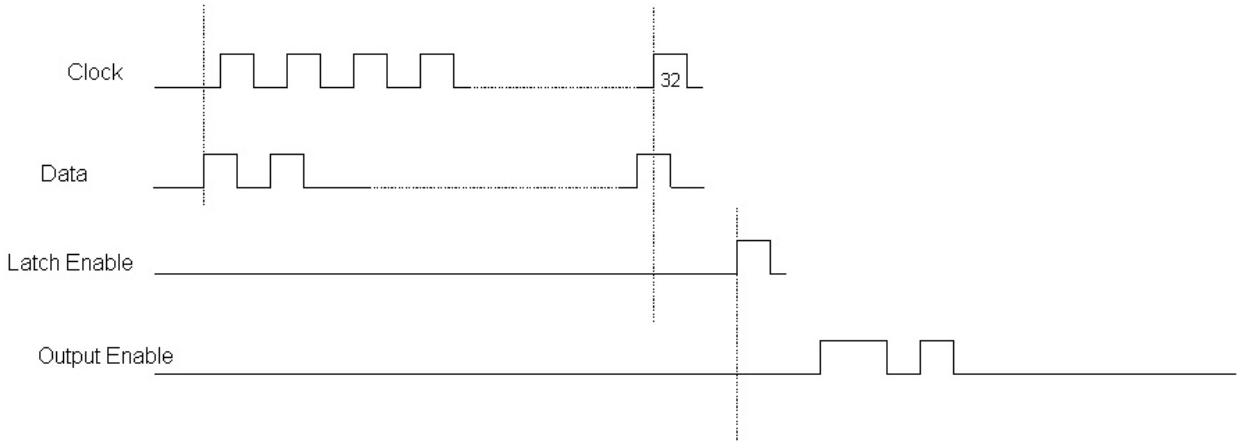


Figure 7 Sample timing diagram

A sample timing diagram is shown above. Data is loaded serially. In this example, 32 channels are loaded. For this example channels 1, 2 and 32 will print.
In actual practice, many data load possibilities exist to serve the varying needs of users.

Controllable Printing Variables
There are several variables that can be adjusted to influence jetting characteristics. The variables are:

- Rise resistor
- Main pulse width
- Delay time
- Secondary pulse width
- Drive voltage

Baseline values for these parameters are given in the Product Specification. These are the values Trident uses when calibrating the print head.

The rise resistor affects the area under the pulse curve. A lower value results in a faster rise time and better firing chamber fill.

The main pulse width, delay time and secondary pulse width affect dynamic performance. To a lesser extent it affects drop volume.

Drive voltage affects dynamic performance and drop volume.

Drive Pulse

The typical drive pulse for Trident print heads is shown in Figures 8 through 9. Note that either a “shark fin” or “standard” pulse can be used, depending on the jetting characteristics desired.
Baseline values for drive pulse parameters are given in the Product Specification. These are the values Trident uses when calibrating the print head.

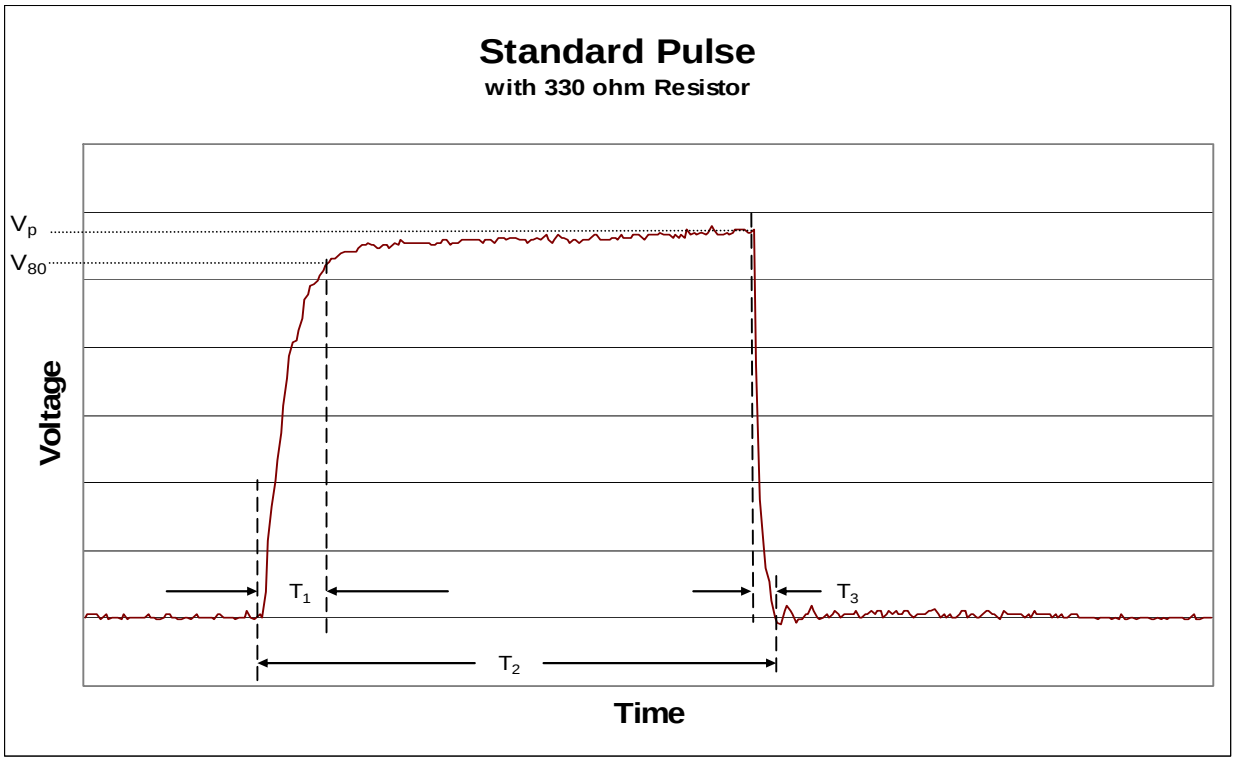


Figure 8

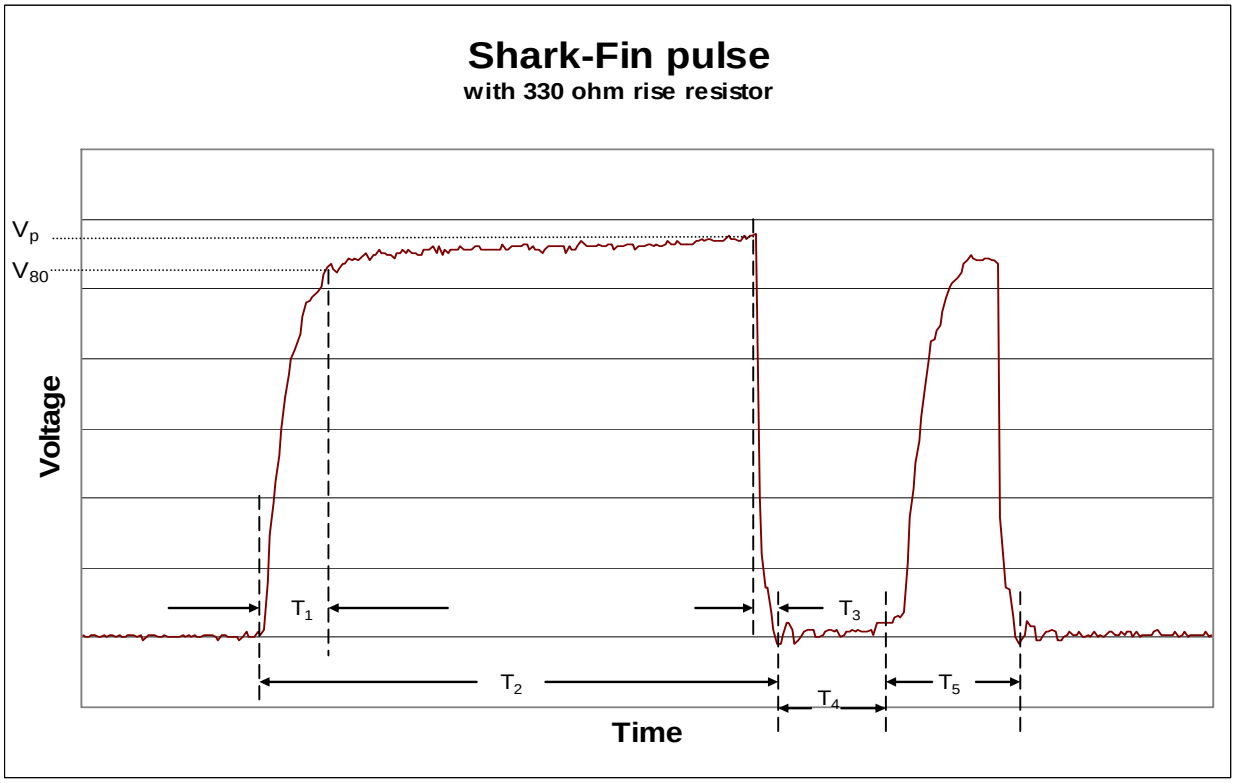


Figure 9

Parameters:
V_P = Peak (drive) voltage
V_{80} = 80% of peak (drive) voltage
T_1 = Pulse rise time
T_2 = Pulse Width
T_3 = Pulse fall time
T_4 = Delay time
T_5 = Secondary pulse width

Print Head Temperature Control

The print head temperature needs to be set so that the viscosity and surface tension of the ink or fluid will be within the range:

Surface Tension range for optimum dynamic performance	30 - 40	Dynes / cm
Viscosity range for optimum dynamic performance (Measured at print head operating temperature)	10 - 15	cps

Controlling the temperature can be done with a comparator circuit. The circuit turns on and off the heater depending on whether the thermistor resistance is above or below a reference value that corresponds to the desired temperature. Print head temperature is defined as the temperature at the face of the print head where the ink is ejected. This is where the desired properties of the ink are set by the temperature of the print head. Note that this temperature may be different from the temperature set by the thermistor as the thermistor is not at the face. It may be necessary to adjust the reference resistance to achieve the desired face temperature. For example, for 30°C the thermistor resistance is 80,002.5468 ohms. Using this value for the heater circuit reference may result in a face temperature lower than 30°C. So the reference value may need to be lowered to achieve 30°C at the face. Once the adjustment factor is determined, it should be consistent for all print heads thereafter.

Care should be taken in circuit design to avoid significant temperature overshoots and cycling. These could affect fluid properties adversely and also jetting performance. Excessive temperature overshoots on initial heat up can damage the print head.

Required Heating Procedure for Heated Print Heads

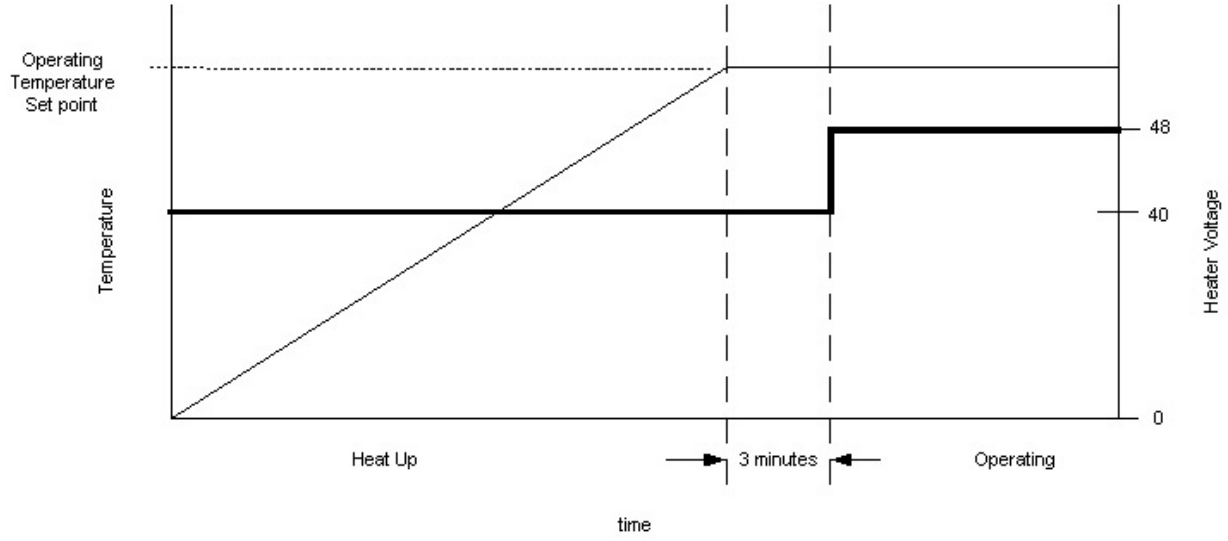
The following procedure must be followed for print heads with operating temperatures between 30°C and the maximum allowable operating temperature documented in the Product Specification. Not following this procedure can result in print head damage. Such damage will not be covered by warranty.

The initial heat up from ambient temperature to operating temperature must be done with reduced power (voltage) provided to the heater. Once stabilized operating temperature is reached, full power (voltage) can be applied for normal operation of the print head.

Initial heat up uses 40 volts applied to the heater. This can be done by reducing the input voltage or using pulse width modulation to reduce the 48 volt DC heater input voltage to 40 volts effective.

Three minutes after indication of At Temperature, full 48 volts power is applied to the heater, after which jetting can begin.

A pictorial of the scheme is shown below.



The fluid coming into the print head should be heated to the desired print head operating temperature. There is not enough thermal transfer area to heat the fluid as it passes through the print head. If the fluid is heated by the print head, there could be at least three problems:

1. There will be unacceptable temperature gradients within the print head.
2. The fluid may not reach operating temperature by the time it is at the orifices to be jetted, compromising jetting performance.
3. The duty cycle of the heater may exceed 50% trying to keep up with heating the fluid.

Duty cycle of the print head heater should not exceed 50%. If that duty cycle is exceeded in operation, raise the ambient temperature of the print head, or reduce print head operating temperature.

Subpulsing

Subpulsing is a patented Trident technology that helps keep channels vital during inactivity when using evaporative inks or fluids that might otherwise dry in the orifices and clog the print head. That is an attractive capability for certain applications. For example, in a wide format printing application which uses fast drying solvent inks, an OEM developer can implement subpulsing on channels not being used for printing to extend the time between maintenance cycles. Flat panel display or other non-ink applications can use subpulsing to keep volatile fluids active during periods of idle time.

What is subpulsing?

Subpulsing is the application of a firing signal to a chamber that is sufficient to cause a vibration within the chamber, but not enough to eject a drop from the printhead. Subpulsing is the gentle vibration of the piezo transducers to agitate the ink in the chambers so that the ink does not form a hard cap that must be broken by jetting. If a hard cap forms, the first part of the next print will be missing. Figure 10 shows an example of print with and then without subpulsing.

What happens if subpulsing is NOT used?

During periods of inactivity, evaporative inks or fluids will form a “hard cap” of dried ink or fluid at the orifice exit where they are exposed to air. If that cap is not broken or removed prior to printing again, the first part of the next print will be missing until the jetting action breaks up the cap completely. The subpulsing concept is a way to break up the cap prior to jetting.

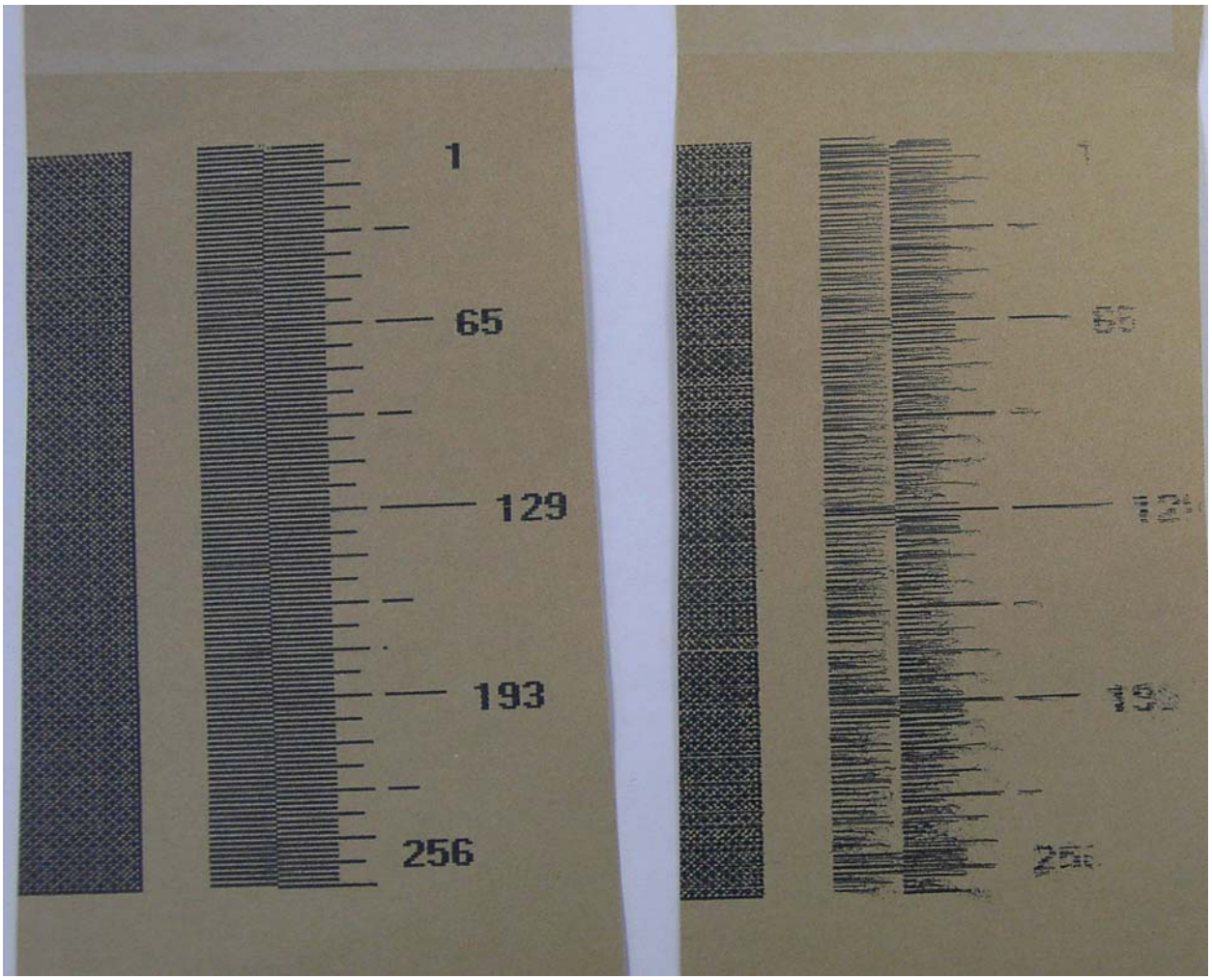


Figure 10: Print sample to show the effect of using subpulsing.
Images above were printed starting from right to left. Print on left is the first print after sitting idle with subpulsing. The print on right shows what can happen with a fast drying ink when subpulsing is not used.

Implementation of Subpulsing

There are two ways to implement subpulsing, depending on how fast the fluid evaporates. Trident-licensed OEM’s will have to test their fluids with each method to determine the most effective form of subpulsing for their application.

If the ink evaporates relatively slowly, it may be acceptable to have subpulse on continuously, subject to the general rules outlined below. But if the ink or fluid

evaporates at a rapid rate, subpulsing may have to be turned off and then restarted just prior to next printing. This method is detailed below.

For highly evaporative inks, continuous subpulsing may cause an even harder cap to form over time. To avoid this, subpulsing is turned off and a cap allowed to form. Then just prior to next printing, subpulsing is turned on to break up the cap prior to printing (refer to t_1 in Figure 11).

General Subpulsing rules

Subpulse must be off during purge and prime to enable effective priming.
Subpulse must be off during actual printing (t_2).
The subpulse is a shortened drive pulse and must have the same rise and fall shape characteristics.

Suggested parameters for subpulsing

For heads jetting down, 3.0 +/-0.5 μs pulse at 4 kHz +/-1kHz.
For heads jetting horizontal, 4 +/-.5 μs pulse at 4 kHz +/-1kHz.
After a channel fires, there must be a delay of 1.0 +/-0.5 seconds before subpulsing resumes (t_3).

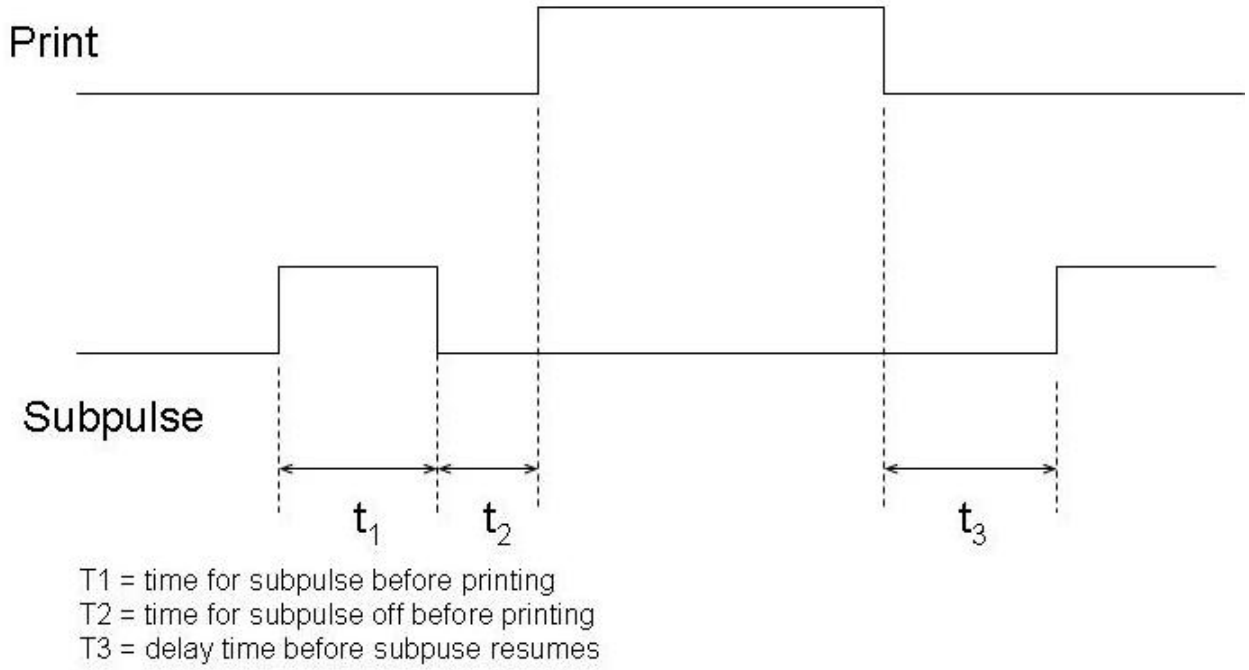


Figure 11: Suggested subpulsing timing diagram.

Optimum values for t_1, t_2 and t_3 will be determined by OEM experiments. Suggested starting values are:

t_1 = 5 seconds
t_2 = 100 microseconds
t_3 = 1 second

Refurbishment and Cleaning

The print head refurbishment procedure is available as specification CS01-0426-01, available for Trident-licensed and trained OEMs. Required equipment lists and training are provided by Trident. Contact Trident to learn more about refurbishment training.

The frequency of maintenance or cleaning is application dependent. The print head face should be kept free of dust, debris and contaminants. Avoid buildups of ink on the face also. A simple prime and wipe should be all that is needed to clear the face. Always use Trident-approved debris free clean wipes when wiping the print head face.

DO NOT RUB HARD when wiping the face! DO NOT WIPE ACROSS MULTIPLE TIMES! One initial wipe to remove most of the ink and then one or two light wipes to remove the small amount of remaining ink.

Peripherals

External Filter (optional)

Trident recommends an external filter installed just prior to the printhead inlet to minimize contamination from entering the print head. An optional external filter is available to supplement the last chance filter in the print head. It should be mounted as close a possible to the print head.

External Filter

A filter placed at the inlet of the print head is strongly recommended. Recommended size is 10 micron nominal and 25 micron absolute with no greater than 1.0 inch (25 mm) of water pressure drop across. The filter should have a large surface area to allow for maximum time between replacement. Optional External Filter components offered by Trident come in two varieties

1. PixelJet “Bullet” Filter is an inline 10 micron filter that was used for some of the testing done in the development of this specification. This filter may not be suitable for high throughput applications. The part number for this filter is 9064-5049-02 (Qty.25).

2. HTF - High Throughput Filter Assembly is currently under development at Trident. Please contact your Trident representative or Customer Service for more information about this filter.

Reference

Troubleshooting and Common Faults

Contact your Trident Application Engineering representative for assistance troubleshooting any problems that may arise.

Glossary

Refer to the Resource Center portion of Trident's web site, www.trident-itw.com for additional inkjet terms.

Term:	Definition:
CPOP	Chamber Plate/Orifice Plate, the front face plate on the print head which contains the orifice nozzles.
dpi	dots per inch resolution
Pixel	A set of drops of ink jetted onto the substrate at the same time. For example, the 256Jet-D fires 3 drops from each chamber to create a pixel that is 3 dots tall by 1 dot wide.
Substrate	The material being printed upon.
Capillary Action	Capillary action is the ability of a substance or tube to draw liquid upwards against the force of gravity. It occurs when the adhesive intermolecular forces between the liquid and a solid are stronger than the cohesive intermolecular forces within the liquid. This is similar to the effect that causes porous materials to soak up liquids.
Crosstalk	Crosstalk is the effect on drop velocity of one channel when firing adjacent channel. For example, if channel 10 is jetting at specified velocity, and then channel 12 adjacent to it is turned on, crosstalk is the change in channel 10 velocity. To minimize the effect on visual print quality, crosstalk must be minimized.

Trademarks

Disclaimers & Legal Notices

Contact Trident for updated information. All information provided is for reference and users of Trident technology should be aware of any potential safety or health precautions as indicated in this and other Trident documents. Take reasonable care when working with Trident products.

Appendix A:

256Jet-D Print Head Product Specification, CS01-0407

Warning:
Reference version only.
Confirm latest revision before use.

Appendix B:

256Jet-D Print Head
Envelope Drawing 256-9015-01

Warning:
Confirm latest revision before use.

This page is left blank in Word Document so that the page numbering would be correct when the actual drawing is added in PDF version.

Appendix C:

Trident Material Safety Data Sheet (MSDS) number 63, Trident test fluid

Warning:
Confirm latest revision before use.