

TSUBA

Test System Requirement Specification

Small Volume Ink system

Revision: Preliminary Version: 1

Document Number: Doc-XXXXXXX

This document contains pages.

**Modification Record**

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| --- | --- | --- | --- | --- |
| Version | Date | Author | Changes (including Change Management reference) | Approval by |
| 1 | 24/11/2015 | J Holmes | Preliminary release | none |
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# Introduction

Marking Materials requires an ink system capable of delivering ink to printing heads at a variety of pressures and flow rates, while maintaining composition in terms of aeration, temperature and filtration. It is essential that this ink system is capable of allowing different inks to be presented to a printing system without contamination of previous inks while at the same time requiring the minimum amount of ink. The system should be capable of priming and flushing the printing head in the minimum time. The system must provide all diagnostic metrics that can be gleamed; pressure, pressure ripple, flow rate.

The purpose of such an ink system is;

1. To allow developmental inks to be introduced to a system and be printed in a system that is as close as possible to the intended final target system without requiring large volumes of fluid to be prepared, or requiring a long time to prime the system.
2. To assess the flow of our fluids through the printing heads and provide metrics with regards to flow rates and print rates.
3. To allow the assessment of long term flowing of ink through printing heads without tying up expensive full systems.

# Requirements

|  |  |
| --- | --- |
| 0 | The system shall provide an ink system to deliver inks to a DOD printing head at a variety of pressures and temperatures, maintaining composition, providing diagnostic data and being efficient to implement for the development of new inks. |
| 1.0 | The system shall deliver inks to a DOD printing system at a variety of pressures and flow rates. |
| 1.1 | An input vessel shall be capable of providing two pressure regimes, -5kPa to -3kPa or +50kPa |
| 1.2 | An output vessel shall be capable of three pressure regimes; -5kPA - -3kPa, -10 - -30 kPa and <-50kPa. |
| 1.3 | The system shall monitor levels in each vessel and provide a return flow from the output vessel to the input vessel. |
| 1.4 | The system shall provide a prime routine allowing a positive pressure to be provided to the head while flowing ink. |
| 1.5 | The system shall provide a clean routine where as much ink as possible is removed from the system as possible before flushing fluid is pushed around the system. |
| 1.6 | The fluid connection to the printing head shall be presented as (6 OD x 4 ID)mm PTFE pipe. |
| 2.0 | The system shall provide conditioned inks in terms of aeration, temperature and filtration. |
| 2.1 | Heating shall be provided to feed and return tanks, it shall heat to a maximum of 50ºC |
| 2.2 | Filtration shall be provided with in line filters, provision shall be made for connecting a capsule filter between the outlet of the return pump of the feed tank. |
| 2.3 | Provision shall be made for connecting a lung between the outlet of the return pump and the feed tank. It is assumed however, that this shall not be the normal operation as the small volume of ink presented to the system should already be degassed. The lung is difficult to clean and takes up a large volume (~150ml). |
| 2.4 | An option shall be provided for introducing ink to the system through the return pump so that it can be filtered and degassed as it enters the system. |
| 3.0 | The system shall be presented upon a frame such that a printing head shall be able to be integrated with a print driver, ink catcher with scales, linear slides and to a camera system. |
| 3.1 | The feed reservoir and collection reservoir shall be mounted on a frame that allows mounting of a printing head in close proximity to their connecting ports. |
| 3.2 | An extracted ink container shall be mountable under the printing head, this shall be able to be placed upon scales to measure the mass of printed ink. |
| 3.3 | It shall be possible to mount a camera system beneath the printing head |
|  |  |
|  |  |

# Specification

## Environment

The system will be operated in a normal laboratory, and will not be expected to operate at extremes. It is assumed that chemical handling facilities and extraction are available that are adequate for the printing system.

## Physical Components

A proposed schematic is shown in Figure 1

P

P

Unit under test

pump

valve

heater

restrictor

level sensor

Ink in?

Ink conditioning

stirrer

Figure 1- Schematic of proposed hydraulic system

Tubing- shall be made from 4x 6mm pipes initially PTFE shall be used but the option of using black nylon tubing that is used by Graphtech is also possible.

Fittings – all fittings will be made using the John Guest style of fittings were possible, bulkhead mounted 19mm feedthroughs into the chambers and stainless steel conversion to change pipe size where needed for the diaphragm pumps.

Diaphragm Pumps: KNF PML7433-NF30, from the standard i-Tech shall be used as they use analogue output to control them.

Pressure vessels: stainless steel vessels for the main sections and bespoke lids that have three feed throughs in each and the level sensor. This will also capture the sealing o-rings and have two clips to pull down the lid onto the vessel.

Level sensors – these shall be A series standard capacitive level sensors with a circuit constructed to read back an analogue signal.

Valves:- A series / i-Tech valves mounted on an Ertalite block.

Restrictors – Initially use needle valves but will replace with machined blocks of Ertalite when dimensions known.

Filter and degassing to be decided if it is required.

Agitation – it is not clear that this is needed

Heater – a metal tube section with A series print head heaters attached with thermistor.

Elecronics

## Electronic Interface

The following electronic interfaces are required;

|  |  |  |
| --- | --- | --- |
| Type | range | Description |
| AI | 1-5 | Pressure 1 Input |
| AI | 1-5 | Pressure 2 Input |
| AI | 1-5 | Temperature 1 Input |
| AI | 1-5 | Temperature 2 Input |
| AI | ? | Level Sensor 1 |
| AI | ? | Level Sensor 2 |
| AO | 0-5 | Pump 1 |
| AO | 0-5 | Pump 2 |
| AO | 0-5 | Pump 3 |
| DO | TTL | PWM heater output 1 |
| DO | TTL | PWM heater output 2 |
| DO | TTL | Enable heater 1 |
| DO | TTL | Enable heater 2 |
| DO | TTL | Valve 1 |
| DO | TTL | Valve 2 |
| DO | TTL | Valve 3 |
| DO | TTL | Valve 4 |
| DO | TTL | Valve 5 |
| DI | TTL | Heater 1 on? |
| DI | TTL | Heater 2 on? |
|  |  |  |

In this it is assumed that the capacitance measurement performed on the level sensors will result in an analogue output, it may however result equally in a frequency measurement.

There are two routes forward for the hardware, either cDAQ or X-series. The cDAQ modular route below allows more flexibility as the project progresses, but is more expensive. The X series DAQ would allow for an OEM card to be used in the final solution.

Table 1 - National instruments hardware cDAQ option

|  |  |  |  |
| --- | --- | --- | --- |
|  | Part no | Description | Cost |
| cDAQ-9174 | 781157-01 | CompactDAQ 4-Slot USB Chassis | 662 |
|  | 763064-01 | Power Cord for AC/DC Adapter, United Kingdom 240VAC | 7 |
|  | 780702-01 | 2-Position Screw Terminal Kit for Power Supply Connection, Qty 4 | 8 |
|  | 779019-01 | NI 9912 DIN Rail Kit for 4-slot Chassis | 24 |
|  | 780534-01 | USB Cable with Locking Screw (2m) - | 25 |
| NI-9263 | 779012-01 | ±10 V, Analog Output, 100 kS/s, 4 Ch Module | 323 |
|  | 781081-01 | 25-Pin D-SUB to screw terminal block (X2) | 94 |
|  | 190654-01 | 10-Pos combicon to 25-pin D-SUB (1m) - | 39 |
| NI-9201 | 779372-01 | ±10 V, Analog Input, 500 kS/s, 8 Ch Module | 323 |
|  | 192568-01 | Shielded female to male, 1m | 24 |
| NI-9403 | 779787-01 | 5 V/TTL, Bidirectional Digital I/O, 32 Ch Module | 313 |
|  | 778676-01 | DIN-Rail 37-Pin, horizontal mount, spring terminal | 40 |
|  | 778621-01 | Shielded female to male, 1m | 26 |
| NI 9977 | 196917-01 | C Series Filler Module for Empty Slot - | 24 |
| **Total** |  |  | **1932** |

Table 2 - National instruments hardware x-series DAQ option

|  |  |  |  |
| --- | --- | --- | --- |
|  | Part no | Description | Cost |
| USB-6343 | 781439-01 | X Series DAQ: 32 AI Channels (16 BNC), 500 kS/s | 1364 |
|  | 763064-01 | Power Cord, United Kingdom 240VAC | 7 |
|  | 781515-01 | USB X Series Mounting Kit with DIN-RAIL clip | 93 |
|  | 780534-01 | USB Cable with Locking Screw, 2 m | 25 |
|  | 781661-01 | USB X Series LID with Thumbscrew Fasteners | 26 |
|  | 780702-01 | 2-Position Screw Terminal Kit for Power Supply Connection, Qty 4 | 8 |
| **Total** |  |  | **1523** |

# Safety

## Method

## Safety Scenarios

# Cost

# Appendices