Analysis of solderability test methods: predicition model generation for through-hole components

Bobby Woods

Analysis of Solderability Test Methods: Prediction Model Generation for Through-Hole Components

Author: Bobby Woods

0010057

A Thesis Submitted for the Degree of

Doctor of Philosophy

To

The College of Engineering,

Department of Design and Manufacturing Technology,

University of Limerick,

Ireland.

Research Supervisor - Dr Christy Gillick

Submission

March 2013

Declaration

I declare that this thesis has not already been accepted in substance for any degree and is not currently submitted in candidature for any other degree.

…………………………. ……………………………...

(Bobby Woods) (Dr. Christy Gillick)

Date:……………………. Date:……………………

Statement

I affirm that the substance of this degree is currently the result of my own investigation and that due reference and acknowledgement is made where necessary to the work of other researchers.

…………………………. ……………………………...

(Bobby Woods) (Dr Christy Gillick)

Date:……………………. Date:……………………

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Appendices

Appendix 1 Quality Problem Report from Component Supplier

Customer Complaint Report

F120617777- Final Report

CUSTOMER INFORMATION	
Customer Name:	KOSTAL IRELAND GMBH
Customer Contact:	Paddy Stack
Final Customer:	
Indirect customer:	
Customer Complaint Reference:	10004582
Customer Part Number:	66610000140311
Customer Module Name:	
Origin of the defect:	MANUFACTURING
Quantity Returned:	2000 Reel
Failure Description (Title):	re-occurance of tarnished or corroded leads. This issue was seen in 2009 on the ULQ2003Y
Report Prepared Date:	March 2nd, 2012

APPROVAL LIST		
Name	***Function***	***Organization Location***
Jean marc BUGNARD	AMS Quality and Reliability Manager	APM-Grenoble
Asmae ELOUFIR	QA DIRECTOR	PTM-Bouskoura 2000
Abdellatif khalfaoui	SOSA Operation Manager	PTM-Bouskoura 2000

DISTRIBUTION LIST		
Name	***Function***	***Organization Location***
Xavier ROCHETTE	AMS Quality Assurance	AMS-Grenoble
Marie-Therese DUROYAUME	AMS Quality Assurance	AMS-Grenoble
Marie-Sophie THIBAULT	AMS Quality Assurance	AMS-Grenoble
Severine TRELLU	Field Quality Service	EUR-Munich
Massira MAZROUI	BSK Quality Assurance	PTM-Bouskoura 2000
Jean-Marc BUGNARD	AMS Quality Assurance	AMS-Grenoble
Mary ZENGLEIN	Field Quality Service	eur-Munich
Franck JACQUIN	AMS Quality Assurance	AMS-Grenoble
Rolf-A ZENGLEIN	Field Quality Service	eur-Munich
Hardy ANDERS	Field Quality Service	EUR-Munich
Asmae ELOUFIR	QA DIRECTOR	PTM-Bouskoura 2000
Abdellatif khalfaoui	SOSA Operation Manager	PTM-Bouskoura 2000

Complaint ref: F120617777-

Customer: KOSTAL IRELAND GMBH

Commercial Product: LM2901YDT

DETAIL INFORMATION	
STMicroelectronics Complaint Information	
Customer Complaint date:	February 10, 2012
Complaint Creation date:	February 10, 2012
Complaint Open date:	February 24, 2012
Part(s) Reception date:	February 24, 2012
Complaint Creator:	Severine TRELLU, -Munich
Complaint Manager:	Marie-Therese DUROYAUME, -Grenoble
Device Information	
STMicroelectronics Commercial Product:	LM2901YDT
Finished Good:	LM2901YDT$DLF
Raw line:	FDK7*0339BL6
Package:	SO14
Wafer fab. Process:	PRO450S-A
Wafer Fab:	AM6F_AMK 6"
Electrical Wafer Sort Plant:	APEE_ASIA PAC SINGAPORE EWS
Assembly fab:	BO2A_ST BOUSKOURA 2 - MOROCCO
Test plant:	BO2A_ST BOUSKOURA 2 - MOROCCO

ANALYSIS SUMMARY:

Sample	*Qty*	*Customer Sample*	*Dominant Defect*
1	1		Defect code 1: NOT CONFIRMED Defect code 2: NOT CONFIRMED Defect code 3: NOT CONFIRMED

Complaint ref: **F120617777-**

Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

8D1 8D00027517

8D1 D1: Team

	Name	Function - Organization (Location - COUNTRY)
Team Leader	Massira MAZROUI	-PTM-Bouskoura 2000
Team Members	Brahim ZINE	-PTM-Bouskoura 2000
	Jean-Marc BUGNARD	-AMS-Grenoble
	Marie-Sophie THIBAULT	-AMS-Grenoble
	Marie-Therese DUROYAUME	-AMS-Grenoble
	Meriem EL ASMAI	-PTM-Bouskoura 2000
	Mohammed KAIDI	-PTM-Bouskoura 2000
	Salah eddine EL MOUKRI	-PTM-Bouskoura 2000
	Sandra FASSETTA	-AMS-Grenoble
	Xavier ROCHETTE	-AMS-Grenoble

8D1 D2: Problem Description

8D1 1. Customer Symptom Description

Symptom Description	Symptom Details
re-occurance of tarnished or corroded leads. This issue was seen in 2009 on the ULQ2003Y	reel with 2000 parts. see pictures

8D1 2. Verification of the Problem

Problem Description	Kostal sent to ST one virgin unit, one piece on the board and 2000 pieces on the reel
Complementary Information	

Problem Description	IS	IS NOT	Complementary Information
Who is affected ?	Kostal	others customer	--
What is the problem?	Discoloration on the leads	other defects	--
When does it happen?	Feb 10 th, 2012	any other date	--
Where is the problem discovered?	Manufacturing	at previous stage	--
Why is it a problem ?	Detected by customer	Detected by ST	--
How does the problem happen?	See 4D	See 4D	--
How big is the problem ?	1 unit, 2000 pieces on the reel, 1 pieces on the board	other lots	--

Complaint ref: **F120617777-**

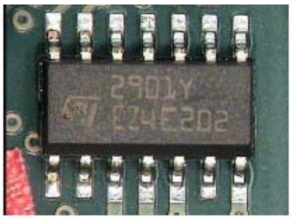
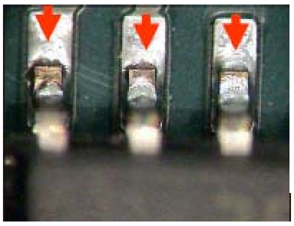
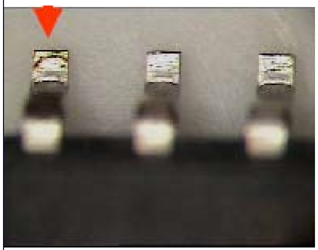
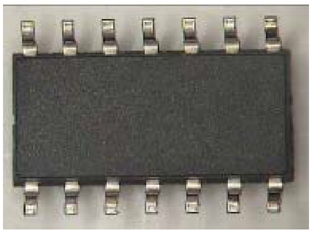
Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

Physical Analysis

We received:

1- One unit on the board
2- one virgin unit
3- 2000 pieces on the reel: the reel will be submitted to visual screening , we found 3 pieces with discolored leads

Below the result of our physical analysis

Step	Findings
External & Xray Visual Inspection	**Unit on the board** : Result of Visual inspection :discolored leads 1,2,3,12 et 14 (Picture1&2)  Picture1 Picture2 **Virgin Unit :** Result of Visual inspection: 1- Front view: discolored lead 1 et 14 (picture2) **2-** Back view: non visual defect on back side (picture4)  **Picture 3** **Picture4** **The 3 unit from the reel (with discolored problem):**Result of Visual inspection: The tree unit have the same defect 1- Front view: Discolored leads 1-2-3-13&14 observed on 3 units 2- Back view: Discolored leads 1&14 observed on 3 units  Front View Back view

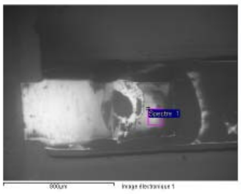
Complaint ref: **F120617777-**

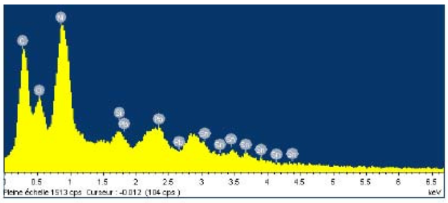
Customer: **KOSTAL IRELAND GMBH**

Commercial Product: **LM2901YDT**

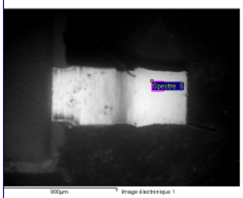
EDX analysis

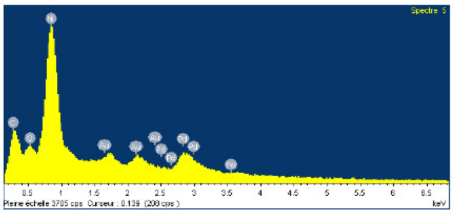
Unit on the board: result of EDX analysis--> Presence of C,Ni and small qty of Pb&Sn.



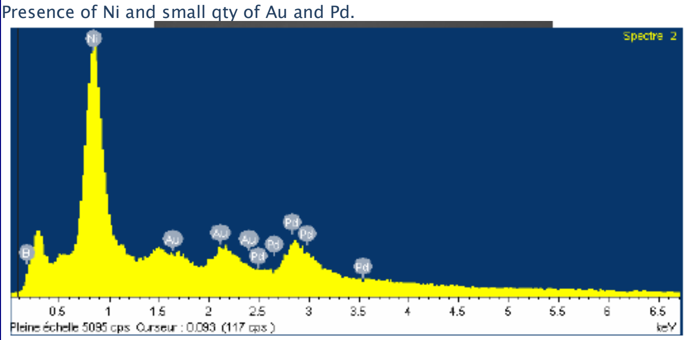


Virgin Unit result of EDX analysis---> Presence of Ni and small qty of Au and Pd.

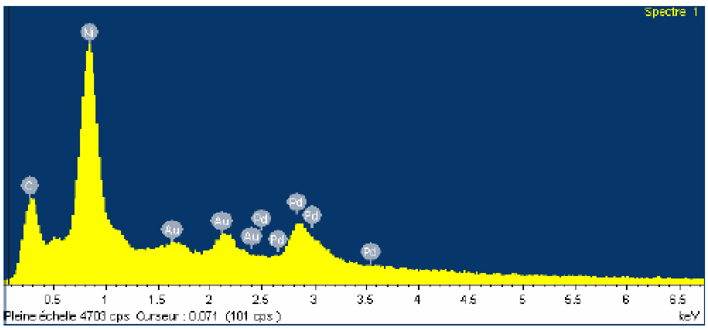




The 3 unit from the reel (with discolored problem) result of EDX analysis--->
Presence of Ni and small qty of Au and Pd.



1 good unit from the reel of EDX analysis---> Presence of Ni and small qty of Au and Pd.

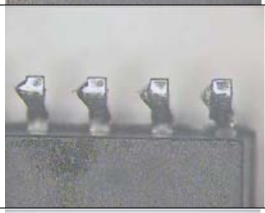
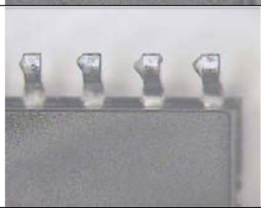
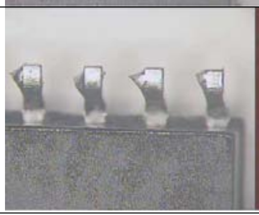


Complaint ref: **F120617777-**

Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

Solderability tests:

The solderability tests have been done on the received virgin, see result here below:

		Result
Solderability on discolored unit @T= 8H TH (8 5 ° c;8 5% RH) (SnAg)		No visual defect
Solderability on discolored unit @T= 8H TH (8 5 ° c;8 5% RH) (SnPb)		No visual defect
Solderability on good unit @T= 8H TH (8 5 ° c;8 5% RH) (SnAg)		No visual defect
Solderability on good unit @T= 8H TH (8 5 ° c;8 5% RH) (SnPb)		No visual defect

HTS: High Temperature Storage;
TH: Temperature Humidity; RH: Relative Humidity

Solderability check conclusion:

-The received units (discolored & good units) are good on solderability tests.

Verification of plating thickness:

Even if there is no defect, only a cosmetic aspect, this case was addressed to the lead frame supplier, in other to have more information about the plating thickness for the involved frame lot, below the data :

Complaint ref: **F120617777–**

Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

MHT Mitsui High-tec (Malaysia) Sdn. Bhd.

MA-QCS-111/6 REV. B

REPORT NO.	12-1

CERTIFICATE OF CONFORMANCE

CUSTOMER	STMicroelectronics Casablanca
PART NO.	14LD SOP MATRIX 0.094 X 0.125 OPTION D (5FT76380) Ni / Pd / Au (THIN Pd)
DRAWING NO.	0102955 REV. L
INVOICE NO.	CI11 - 10 - 148
QUANTITY	960,000 PCS
SHIPMENT LOT NO.	M111001

ITEMS	SAMPLE SIZE	AQL	AC / RE	MEASUREMENT SPEC	MIN.	MAX .	ACC / REJ
VISUAL BEFORE BAKE	315 F	2.5	0 / 1				Acc
VISUAL AFTER BAKE	2F		0 / 1				Acc
PEELING TEST	1F		0 / 1				Acc
SOLDERBILITY TEST	1F		0 / 1				Acc
FRAME PITCH	3F		0 / 1	188.950 - 189.050	188.979	189.005	Acc
COINED LEAD WIDTH	3F		0 / 1	Min. 80 %	97	98	Acc
MISMATCH	3F		0 / 1	Max. 0.050	0.012	0.017	Acc
HORIZONTAL BURR	3F		0 / 1	Max. 0.050	0.011	0.015	Acc
BOW / COIL SET	3F		0 / 1	Max. 0.500	0.209	0.249	Acc
LEAD TWIST	3F		0 / 1	Max. 3^0	0.74	0.98	Acc
LEAD TILT	3F		0 / 1	-0.017 / + 0.010	0.003	0.005	Acc
PAD FLATNESS	3F		0 / 1	MAX. 0.010	0.002	0.004	Acc
LEAD TIP PLANARITY	3F		0 / 1	+ 0.060 ~ -0.040	0.007	-0.015	Acc
1	3F		0 / 1	57.608 - 57.708	57.657	57.669	Acc
2	3F		0 / 1	56.363 - 56.413	56.379	56.398	Acc
3	3F		0 / 1	8.939 - 8.979	8.952	8.954	Acc
4	3F		0 / 1	6.809 - 6.849	6.821	6.824	Acc
5	3F		0 / 1	18.239 - 18.279	18.251	18.252	Acc
6	3F		0 / 1	16.109 - 16.149	16.120	16.122	Acc
7	3F		0 / 1	27.539 - 27.579	27.550	27.551	Acc
8	3F		0 / 1	25.409 - 25.449	25.420	25.421	Acc
9	3F		0 / 1	36.839 - 36.879	36.849	36.856	Acc
10	3F		0 / 1	34.709 - 34.749	34.718	34.723	Acc
11	3F		0 / 1	46.139 - 46.179	46.149	46.155	Acc
12	3F		0 / 1	44.009 - 44.049	44.019	44.022	Acc
13	3F		0 / 1	55.098 - 55.138	55.103	55.110	Acc
14	3F		0 / 1	4.235 - 4.285	4.258	4.262	Acc

The plating thickness is within spec for this lot.

Conclusion:

1 -The received units shows yellow color on virgin units and also on unit on the board
2 -The received virgin units pass our solderability tests.

According to analysis above for the received units, customer claim is not recognised as defect from ST spec According to ST specification "0033485"

C5: Discoloration, contamination and blackening on metal finishing.
Any blackening visible on the solderable area.
Any contamination or **discoloration that leads to solderability failure**

So, the discoloration is accepted as did not affect the solderability test and confirmed as cosmetic issue .
However ST will continue investigation with supplier to understand the origin of this yellow aspect and the report will be updated when the phenomena of discoloration will fixed.

The plant production line is aware about the customer dissatisfaction and we informed all relevant people. See 3D.

Complaint ref: **F120617777-**

Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

Traceability check

According to information (date code & sales type) received from customer, below the lots shipped to Kostal , no anomalies have been detected on those lots.

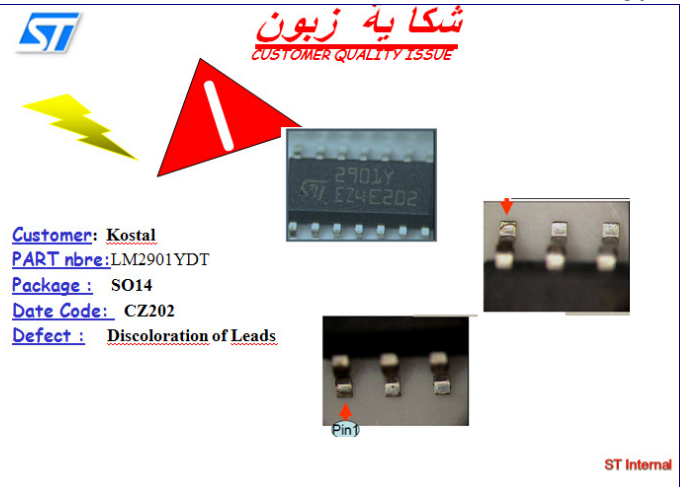
CUSTOMERNAME	CUSTOMERCODE	PRODUCTCODE	QANR	LOTNR	RAWLINE	DATECODE
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03MDB0008	CZ20204EZ7	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03MDB0009	CZ20204EZ7	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0002	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0003	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0004	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0005	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0006	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0007	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0008	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0009	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03LTG0010	CZ20204EZD	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0003	CZ20204EZG	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0004	CZ20204EZG	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0005	CZ20204EZG	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0006	CZ20204EZG	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0007	CZ20204EZG	FDK7 0339BL6	C1202
KOSTAL IRELAND	40039210	LM2901YDT$DLF	T2Z03M0E0008	CZ20204EZG	FDK7 0339BL6	C1202

8D1 D3: Containment action(s)

Title	All the concerned people have been informed about the claim
Description	All the concerned people have been informed about this issue. Picture of the defect has been displayed on the line.

Complaint ref: **F120617777-**

Customer: **KOSTAL IRELAND GMBH** Commercial Product: **LM2901YDT**

	
Action Owner	Meriem EL ASMAI
Due date	February 27, 2012
Implementation Date	February 27, 2012

Title	**To check warehouse and Tailend store**
Description	To check warehouse and Tailend store to quarantine parts with the same Date-Code. Results: one lot found on production, this lot is put it on the hold for visual screening
Action Owner	Meriem El Asmai/Kaidi
Due date	February 27, 2012
Implementation Date	February 28, 2012
Implementation Comment	Done
Effectiveness review date	
Effectiveness result	

8D1 D4: Root Cause(s) – NOT APPLICABLE

8D1 D5 & D6: Permanent Corrective Action(s) – NOT APPLICABLE

8D1 D7: Preventive Action(s) – NOT APPLICABLE

8D1 D8: Congratulate the team /Conclusions

Completed : March 2nd, 2012

Appendix 2 Dip and Look Results

Appendix 2.1 Dip and Look: Wave soldering in a Pb process, components

Run	Solder Temperature (°C)	Immersion Depth (mm)	Dwell time (sec.)	Response: Wettability (%)
1	240	1.4	6	95
2	245	0.8	6	95
3	235	0.1	6	95
4	235	0.8	5	95
5	235	0.8	4	95
6	235	1.4	6	95
7	235	0.1	5	95
8	240	0.1	5	95
9	240	1.4	4	95
10	240	1.4	5	95
11	245	0.1	5	95
12	235	1.4	5	95
13	245	1.4	4	95
14	240	0.1	6	95
15	245	0.1	6	95
16	240	0.8	4	95
17	245	0.8	4	95
18	245	1.4	5	95
19	235	0.1	4	95
20	245	0.1	4	95
21	235	0.8	6	95
22	235	1.4	4	95
23	240	0.8	6	95
24	240	0.1	4	95
25	245	1.4	6	95
26	240	0.8	5	95
27	245	0.8	5	95

Appendix 2.2 Dip and Look: Wave soldering in a Pb-Free process, components

Run	Solder Temperature (°C)	Immersion Depth (mm)	Dwell time (sec.)	Response: Wettability (%)
1	240	1.4	4	95
2	260	0.8	6	95
3	250	0.1	5	95
4	260	1.4	4	95
5	250	0.8	5	95
6	250	0.1	6	95
7	250	0.8	4	95
8	240	0.8	6	95
9	260	0.1	4	95
10	260	1.4	6	95
11	250	1.4	4	95
12	240	1.4	6	95
13	240	0.8	5	95
14	240	0.1	5	95
15	260	0.1	6	95
16	240	0.1	4	95
17	240	0.1	6	95
18	260	0.8	5	95
19	250	0.8	6	95
20	260	0.1	5	95
21	260	1.4	5	95
22	240	0.8	4	95
23	250	0.1	4	95
24	250	1.4	6	95
25	240	1.4	5	95
26	260	0.8	4	95
27	240	1.4	5	95

Appendix 2.3 Dip and Look: Reflow soldering in a Pb-free process, Components

Run	Solder Temperature (^oC)	Immersion Depth (mm)	Dwell Time (sec.)	Response: Wettability (%)
1	250	1.4	4	95
2	245	1.4	4	95
3	250	0.8	4	95
4	240	1.4	4	95
5	245	0.1	5	95
6	250	1.4	5	95
7	240	0.1	5	95
8	245	0.1	4	95
9	240	0.8	5	95
10	245	0.8	6	95
11	250	0.1	4	95
12	240	0.8	4	95
13	250	0.8	5	95
14	240	0.1	6	95
15	250	0.8	6	95
16	245	0.1	6	95
17	245	0.8	5	95
18	245	1.4	5	95
19	240	0.8	6	95
20	240	1.4	6	95
21	245	1.4	6	95
22	240	1.4	5	95
23	250	1.4	6	95
24	245	0.8	4	95
25	250	0.1	5	95
26	250	0.1	6	95
27	240	0.1	4	95

Appendix 2.4 Dip and Look: Reflow soldering in a Pb process, Components

Run	Solder Temperature (^{o}C)	Immersion Depth (mm)	Dwell Time (sec.)	Response: Wettability (%)
1	210	0.8	6	95
2	215	0.1	6	95
3	210	0.8	4	95
4	220	0.1	6	95
5	220	0.8	6	95
6	220	0.1	4	95
7	220	1.4	5	95
8	215	0.8	5	95
9	215	1.4	4	95
10	210	1.4	6	95
11	210	0.1	5	95
12	220	0.8	4	95
13	215	1.4	5	95
14	215	0.8	6	95
15	210	1.4	5	95
16	215	0.1	5	95
17	210	1.4	4	95
18	215	1.4	6	95
19	215	0.1	4	95
20	220	1.4	6	95
21	215	0.8	4	95
22	210	0.1	6	95
23	220	0.1	5	95
24	220	1.4	4	95
25	220	0.8	5	95
26	210	0.1	4	95
27	210	0.8	5	95

Appendix 2.5 Dip and Look: Wave soldering in a Pb-Free process, PCB's

Run	Solder Temperature (°C)	Immersion Depth (%)	Dwell Time (sec.)	Response: Wettability (%)
1	250	50	4	95
2	250	25	6	95
3	250	75	5	95
4	255	25	4	95
5	255	75	5	95
6	255	50	6	95
7	250	75	4	95
8	250	25	6	95
9	260	75	4	95
10	255	75	6	95
11	255	50	4	95
12	250	25	6	95
13	260	75	5	95
14	260	25	5	95
15	255	25	6	95
16	260	50	4	95
17	260	25	6	95
18	255	75	5	95
19	250	50	6	95
20	260	25	5	95
21	250	50	5	95
22	260	75	4	95
23	255	25	4	95
24	260	50	6	95
25	255	50	5	95
26	260	50	4	95
27	250	75	5	95

Appendix 2.6 Dip and Look: Wave soldering in a Pb process, PCB's

Run	Solder Temperature (°C)	Immersion Depth (mm)	Dwell Time (sec.)	Response: Wettability (%)
1	230	50	4	95
2	235	25	6	95
3	240	75	5	95
4	230	25	4	95
5	240	75	5	95
6	240	50	6	95
7	235	75	4	95
8	230	25	6	95
9	240	75	4	95
10	240	75	6	95
11	235	50	4	95
12	235	25	6	95
13	230	75	5	95
14	230	25	5	95
15	230	25	6	95
16	240	50	4	95
17	230	25	6	95
18	235	75	5	95
19	240	50	6	95
20	240	25	5	95
21	235	50	5	95
22	235	75	4	95
23	230	25	4	95
24	235	50	6	95
25	240	50	5	95
26	230	50	4	95
27	235	75	5	95

Appendix 3 Calibration Certificate for Wetting Balance Machine

MUST SYSTEM II+
CERTIFICATE OF CALIBRATION

Issued by:

Gen3 Systems Limited
Unit B2 Armstrong Mall
Southwood Summit Centre
Farnborough, Hants, GU14 0NR

Tel: 01252 521500
Fax: 01252 521112

Approved Signatory:

Approved by .... B Wardhaugh

Calibration Engineer......................... G Dickson

Date: 13th September 2012

Next Calibration Due: 12th September 2013

Customer: Kostal Ireland GmbH
Mountmahon
Abbeyfeale
Limerick
Ireland

Serial No: 3050

Certificate No: MU415

Force Measurement Calibration

Range mN	Deviation %	IEC 68-2-54
1	-3.2	<5%
5	-3.1	<5%
100	-4.8	<5%
500	-2.3	<5%

Temperature Calibration

	Expected	Actual	Deviation	IEC68-2-54
Globule 1	235.0°C	236.4	1.4	±3°C
Globule 2	235.0°C	235.8	0.8	±3°C
Globule 3	235.0°C	N/A	N/A	±3°C
Globule 4	235.0°C	N/A	N/A	±3°C
Bath 1	235.0°C	236.2	1.2	±3°C
Lead-Free				
Globule 1	255.0°C	256.3	1.3	±3°C
Globule 2	255.0°C	254	-1.0	±3°C
Globule 3	255.0°C	253.7	-1.3	±3°C
Globule 4	255.0°C	255.4	0.4	±3°C
Bath 1	255.0°C	255.5	0.5	±3°C

Instrumentation:

This is to certify that the test equipment used in the calibration of the above instrument has been tested and calibrated against test equipment and standards referenced to comply with ISO10012-1 and are traceable to National or International Standards.

Form: G3F02/3

ENGINEERING RELIABILITY IN ELECTRONICS

GEN3 SYSTEMS

Appendix 4 Wetting Balance Machine Capability Results

No.	Ta Results - with vibrations		Tb Results - with vibrations		Ta Results - with no vibrations		Tb Results - with no vibrations	
1	0.516	0.486	0.546	0.510	0.513	0.576	0.534	0.606
2	0.528	0.501	0.549	0.528	0.516	0.522	0.537	0.552
3	0.540	0.498	0.567	0.522	0.495	0.540	0.516	0.588
4	0.453	0.498	0.474	0.522	0.534	0.507	0.555	0.534
5	0.465	0.507	0.486	0.531	0.492	0.570	0.513	0.603
6	0.483	0.525	0.507	0.549	0.486	0.498	0.507	0.525
7	0.477	0.486	0.498	0.510	0.495	0.468	0.516	0.492
8	0.456	0.474	0.477	0.498	0.459	0.474	0.477	0.498
9	0.483	0.519	0.507	0.540	0.465	0.468	0.486	0.489
10	0.498	0.501	0.528	0.525	0.480	0.561	0.504	0.585
11	0.492	0.522	0.516	0.546	0.528	0.522	0.549	0.549
12	0.537	0.513	0.561	0.543	0.492	0.522	0.516	0.552
13	0.504	0.540	0.528	0.567	0.477	0.468	0.501	0.492
14	0.495	0.576	0.519	0.606	0.540	0.453	0.564	0.480
15	0.504	0.495	0.528	0.519	0.513	0.495	0.537	0.522
16	0.522	0.468	0.549	0.504	0.543	0.507	0.567	0.540
17	0.507	0.492	0.528	0.516	0.507	0.495	0.531	0.522
18	0.480	0.492	0.501	0.519	0.492	0.549	0.516	0.579
19	0.501	0.486	0.525	0.513	0.498	0.477	0.522	0.501
20	0.513	0.531	0.540	0.558	0.516	0.462	0.540	0.489
21	0.477	0.474	0.498	0.495	0.498	0.453	0.522	0.477
22	0.549	0.465	0.573	0.489	0.531	0.492	0.561	0.519
23	0.477	0.498	0.501	0.522	0.510	0.474	0.537	0.501
24	0.471	0.456	0.495	0.477	0.543	0.489	0.570	0.516
25	0.543	0.459	0.570	0.483	0.570	0.531	0.600	0.561

Appendix 5 Wetting Balance Test Screening DoE Arrays

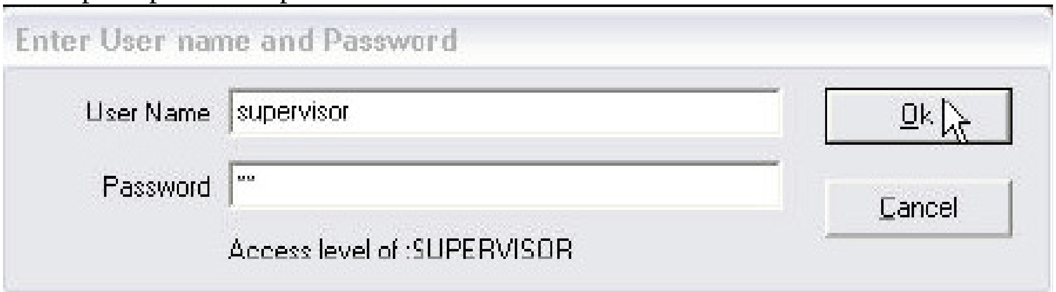
StdOrder	RunOrder	CenterPt	Blocks	Solder Temperature	Immersion Speed	Immersion Depth	Dwell Time	Removal Speed
4	1	1	1	260	25	2	10	5
18	2	1	1	260	5	2	5	5
6	3	1	1	260	5	5	5	25
23	4	1	1	240	25	5	5	5
16	5	1	1	260	25	5	10	25
12	6	1	1	260	25	2	10	5
2	7	1	1	260	5	2	5	5
10	8	1	1	260	5	2	5	5
11	9	1	1	240	25	2	5	25
24	10	1	1	260	25	5	10	25
22	11	1	1	260	5	5	5	25
19	12	1	1	240	25	2	5	25
15	13	1	1	240	25	5	5	5
17	14	1	1	240	5	2	10	25
3	15	1	1	240	25	2	5	25
1	16	1	1	240	5	2	10	25
14	17	1	1	260	5	5	5	25
13	18	1	1	240	5	5	10	5
5	19	1	1	240	5	5	10	5
21	20	1	1	240	5	5	10	5
9	21	1	1	240	5	2	10	25
7	22	1	1	240	25	5	5	5
20	23	1	1	260	25	2	10	5
8	24	1	1	260	25	5	10	25

Appendix 6 Wetting Balance Test Procedure

Points 1 to 16 describe the procedure used for the trial to set-up the MUST II wetting balance machine to test a component.

1. Log - On

Click the MUST SYSTEM 3 shortcut on the Desktop to start the program. Click the "Log On" button. The initial password for access at Supervisor level is: 'sp'. Type this when prompted for a password.



2. Initialisation

Following directly on from point 1 above – ensure that the MUST System 3 unit is switched on and connected to the PC.

• Click on the "Connect" icon.

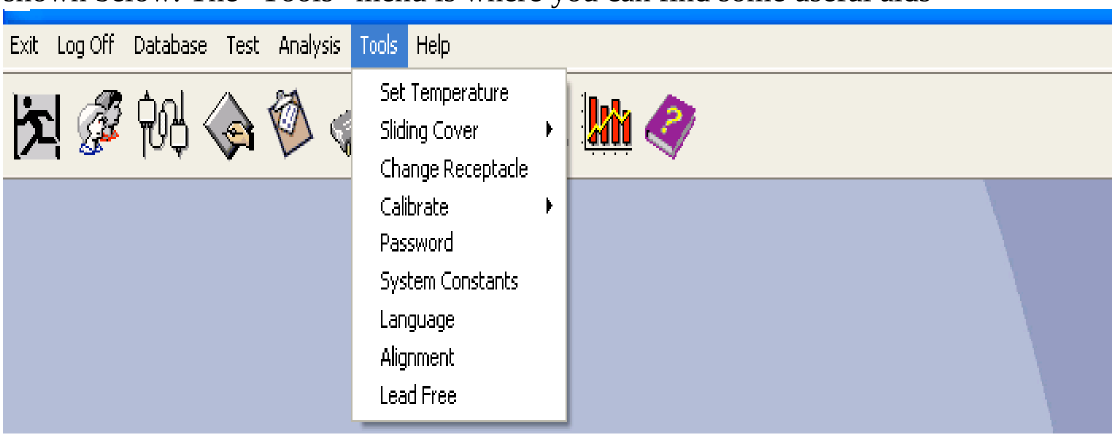
• System Initialisation window will appear with progress bar at bottom of window.

3. Main Menu

Once logged on and connected to the machine you are presented with the main menu. Here you can begin to create and manage component parameters, create and manage test parameters perform wetting test and export test result as data file etc. [41]

4. Tool Menu

The main menu is easy to navigate with icons representing in the toolbar which is shown below. The "Tools" menu is where you can find some useful aids



i. Set Temperature

Sets the temperature and turns the heater to the receptacle on.

ii. Sliding Cover

Opens and closes the sliding cover door.

iii. Change Receptacle

Changes the receptacle after test, will only allow the receptacle to be ejected after temperature has cooled to below 70°C.

iv. Calibrate

Calibrates the machines temperatures and forces

v. Password

Sets access levels, usernames and passwords.

vii. Language

Set's the software language.

viii. Alignment

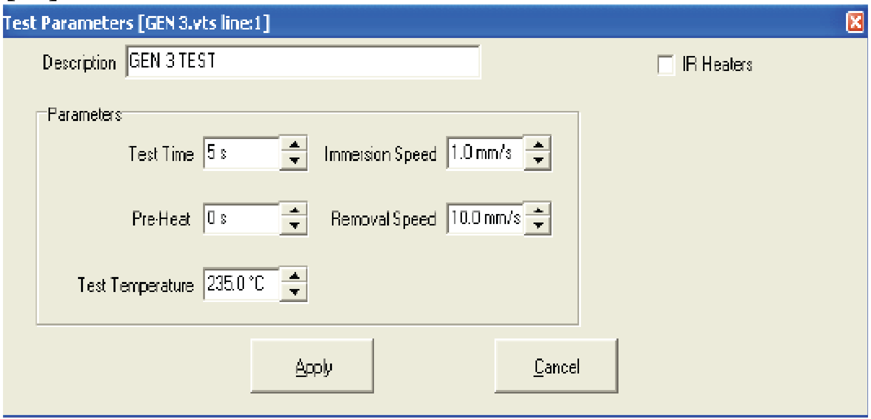
Sets the alignment of the receptacle to the component

ix. Lead Free

Check this to set the machine to run lead free receptacles and lead free test parameters.

5. Creating New Test Parameters

From the main menu click the Manage Test Parameters icon to open the Test Parameters sheet. Then select "New" from the File dropdown menu. Click the Add New Test Parameter icon in the test parameter sheet window. Click "Yes" to save changes. You will be shown the Test Parameter Database with some default test parameters. Give your test parameter and new name and click "Save". The window will change asking you to load the Test Parameter. Locate and highlight your saved parameter and click "Open". In the new window, fill in the field you require and click "Apply". [41]



A new Test Parameter has been created and the Parameter will be shown in the Test parameter sheet. Click "Exit" icon when done.

6. Managing Test Parameters

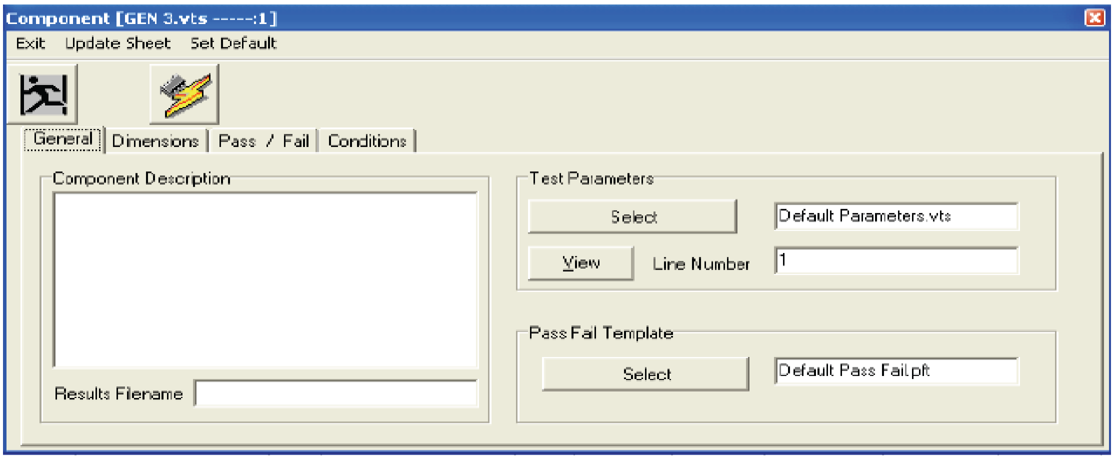
From the main menu, click the Manage Test Parameter icon to open the test parameter sheet. From the test parameter sheet, click "open" icon. The load test parameter selection window will now be displayed. Highlight the saved parameter to edit and click "open". The parameter stored in the parameter file will be displayed in the parameter sheet. In this window, highlight the parameter and select the "Edit Test Parameter" icon Modify the field and when done click "Apply".

7. Creating New Pass/Fail Templates

Highlight any template and click "Open". Pass/Fail template will be shown. Edit as required, then select "File" and from the drop down menu click "Save as", click "yes" to save changes and give the template a new name. Click "Save".

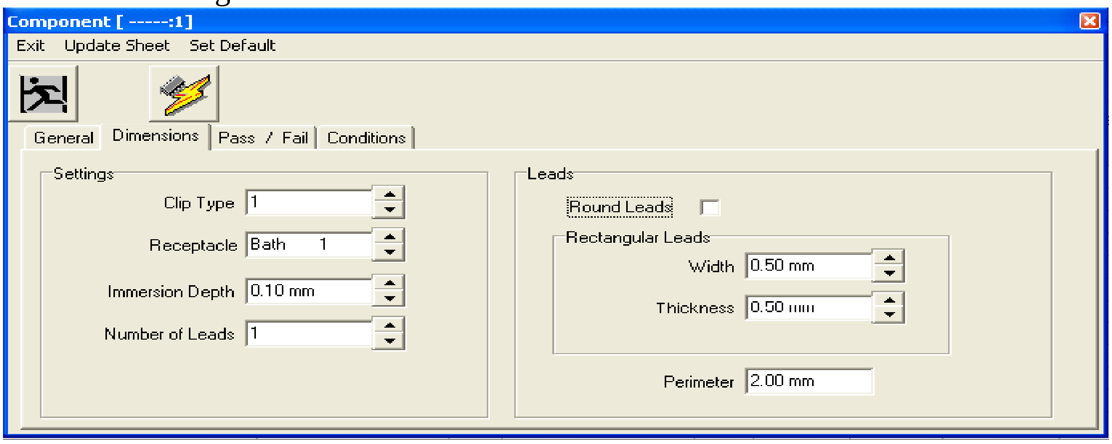
8. Creating New Components

From the main menu, click the Manage Components icon to open the component sheet. From the component sheet, select "New" from the file dropdown menu. An instruction window will appear, prompting for a file name, click "Ok". The component library window will be shown. Assign a new name to the component file then click "Save". From the saved component sheet, click "Add new component" icon. Select the General tab and enter the component description and the results filename.

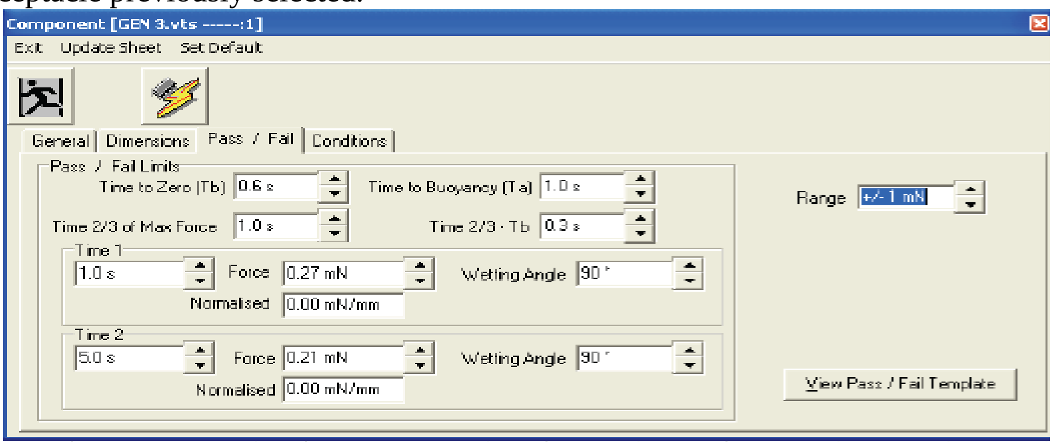


Click “Select” button under test parameter section, then highlight a test parameter and click “Open”. The test parameter sheet will be opened. Highlight the test parameter to be used and click the select test parameter icon. The number on the left will changed to <--> to signify the parameter has been selected. Click “Exit” to be taken back to the component setup box. Click “select” button under Pass/Fail template section to open a pass/fail template.

Highlight the desired Pass/Fail template and click “Open”. Modify the fields if necessary, and then click “Yes” on the prompted window. Click “dimension” tab and fill in the fields. Note: different setting required when using Bath with round leads, Bath with rectangular lead and Globule test method.



Click “Pass/Fail” tab. Fill the different options which are depending on the type of receptacle previously selected.



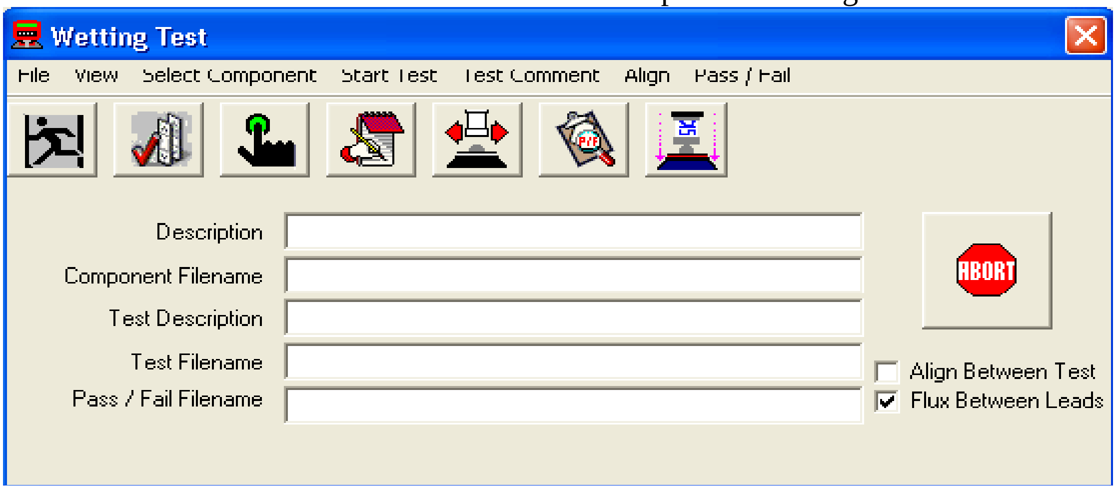
Fill in the material to be used in the test for that particular component. Ignore the position information which is aligned again. Different options will be available depending on the type of receptacle that been selected. To calculate the surface tension, see the section titled how to calculate surface tension. When all fields have been entered, do click "update" icon to update the new component. Note: click that icon every time when you do some changes. When done, click "Exit" icon and click "Yes" to save changes.

9. Editing Components

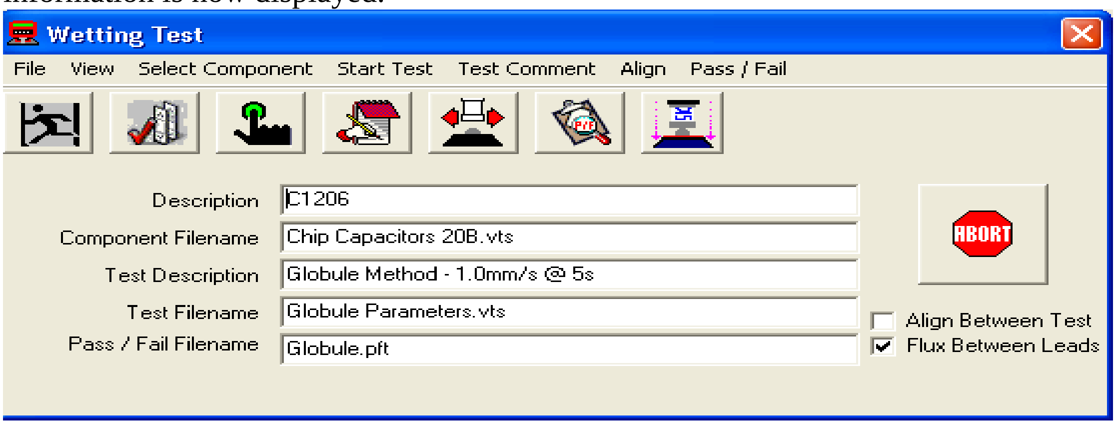
From the main menu, click "Manage Components" icon to open the component sheet. In the component sheet window, from the file dropdown menu or the icon, select "Open". In the load component window, highlight the required file to edit and click "open". In the component sheet highlight the component parameter to edit and click the edit component icon. Edit the component field and when done click "Update" icon, exit and save changes.

10. General Testing

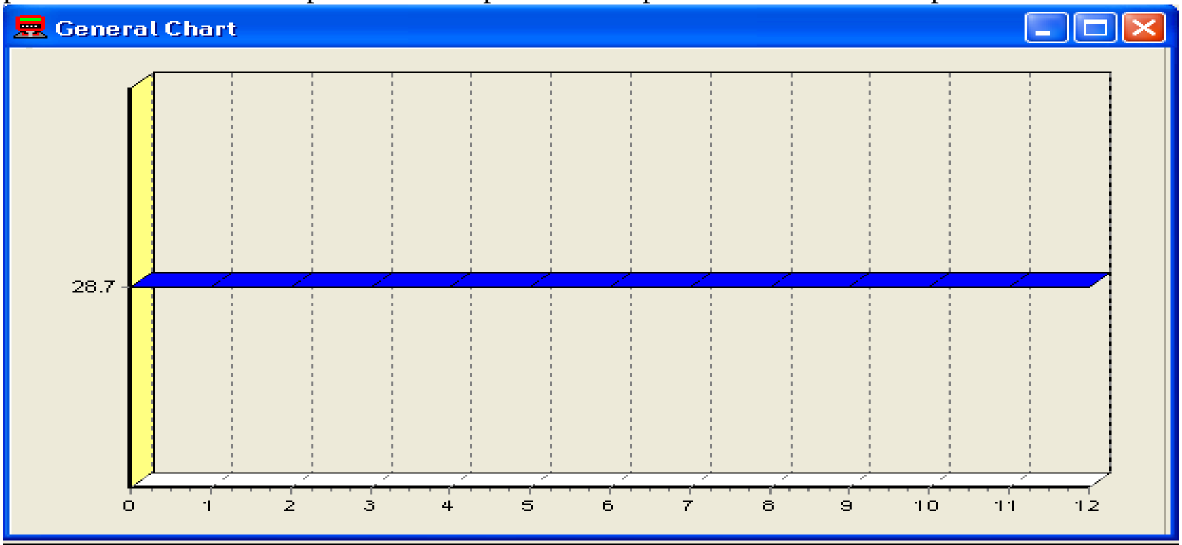
From the main menu click "General Test" icon to open the wetting test window



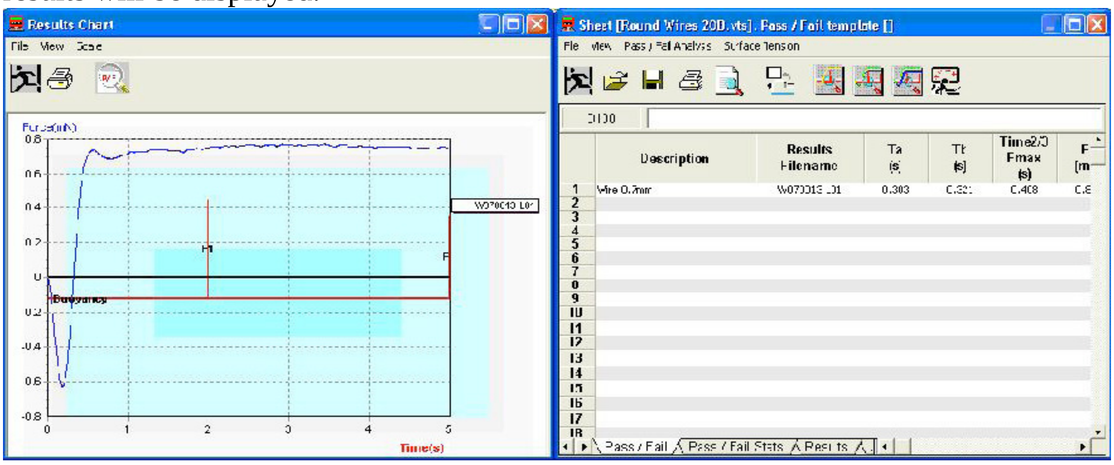
From the wetting test window, either click "Select" icon to display the component sheet or select "select component" in the main bar to open component sheet. Click "open" icon to display the component database. There are default component files stored already. Components created by the operator will also be available. Highlight the desired component file and click "open". The component parameter sheet will be displayed. All the parameters can be viewed by using left/right direction buttons. Highlight the required component and click the Select icon. It will be noticed that the line number of the left change to <--> to show the component has been selected. Click "Exit" icon to back to the wetting test window where all the information is now displayed.



Check the information is correct, if you need to re-select another component or edit, click “select” icon and locate the component as before. The test is now ready to start. Click “General Test” icon.
If the receptacle is cold, the temperature graph will appear and the systems will proceed to heat the receptacle to the specified temperature set in the test parameters.



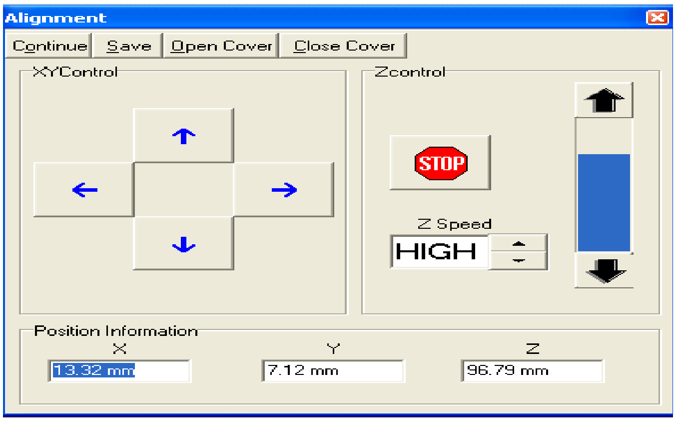
Once the temperature has been reached, the on screen instructions will need to be followed to guide one through the rest of the test.
Note: there is an “Abort” icon which when clicking will terminate the test at any point before contact is made. The test will end after the specified test time and the test results will be displayed.



When the test has finished, it will be asked if there is a requirement to test another component. Choose “yes” to continue the testing or select “No” to go back to the results window where you can analyse the results and view graph. At the bottom of the result sheet, various tabs can be viewed and analysed. To save the results, select “Save as” from the dropdown menu of File.

11. Alignment

To align a component and save the position, open the component sheet by selecting the Manage components icon. Click “Open” icon and load the component file desired into the sheet. Highlight the component to be aligned and click “Align component” icon. The machine will then proceed to align and display the alignment window.



Using the arrow buttons bring the solder pellet/bath up towards the component until a gap of about 5mm is achieved and the component centered round the pellet. There are two speeds (high/low) to control the z-axis movement. When alignment is fixed to desired level click ‘save’. This saves the position information into the component parameter file. Click “continue” to go back to the component sheet.

12. Analysing Results

From the main menu, select the “Analyse” icon and the pass/fail sheet will be displayed.
Select “Load result” icon to view single file or multiple files, and then click “open”. From here, there are choices to view a single graph or view multiple graphs.

- View a single graph, highlight a line and click “display graph” icon
- View all the graphs loaded into the sheet, select the “multiple graphs” icon
- View all the graphs loaded into the sheet, also highlight a graph you choose, click “Highlight a graph”.

13. Set Temperature

This icon is used to turn the receptacle heater ON or OFF. If the heater is ON, one can enter the temperature required.

14. View Temperature Profile

After turning the heater ON, enter the temperature required. This icon can be clicked to view the temperature profile, and monitor how the temperature is going to change against time (second).

15. Saving Results

After a test has finished, the results are automatically saved into a folder called Result. This folder is located on the C:\program files\Gen3 Must3 or alternatively save the files to anywhere on the computer. [41]

Appendix 7 Wetting Balance Test Screening DoE Graphs

RUN 1

Test Details

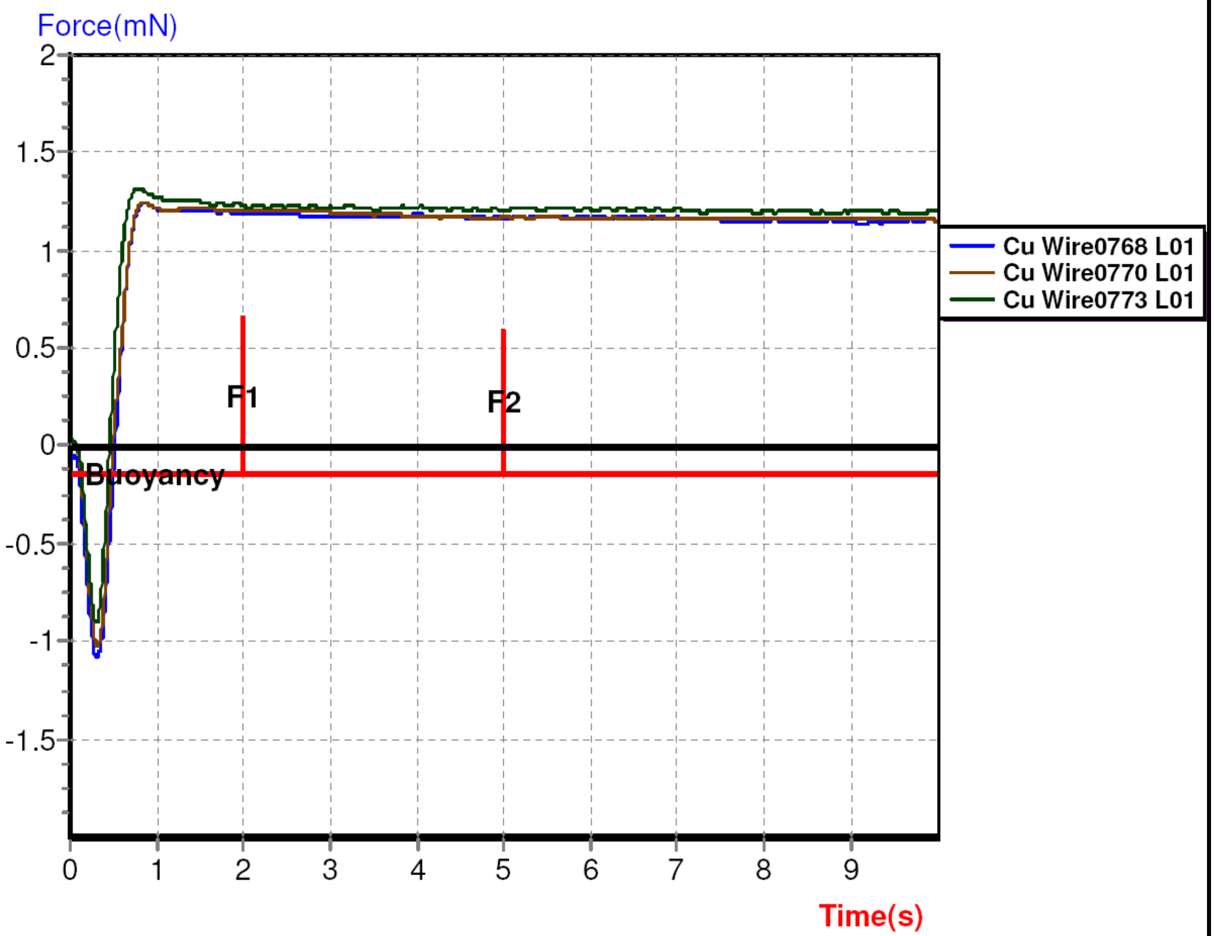
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ACu Wire0768 L01	0.505	0.525	0.645	1.326	1.306	1.243	0.840	Pass
DOE - SN100C	ACu Wire0770 L01	0.480	0.495	0.645	1.344	1.309	1.246	0.835	Pass
DOE - SN100C	ACu Wire0773 L01	0.445	0.460	0.575	1.368	1.344	1.315	0.765	Pass
	Standard Dev	0.030	0.033	0.040	0.021	0.021	0.041	0.042	
	Mean	0.477	0.493	0.622	1.346	1.320	1.268	0.813	
	Max	0.505	0.525	0.645	1.368	1.344	1.315	0.840	
	Min	0.445	0.460	0.575	1.326	1.306	1.243	0.765	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 2

Test Details

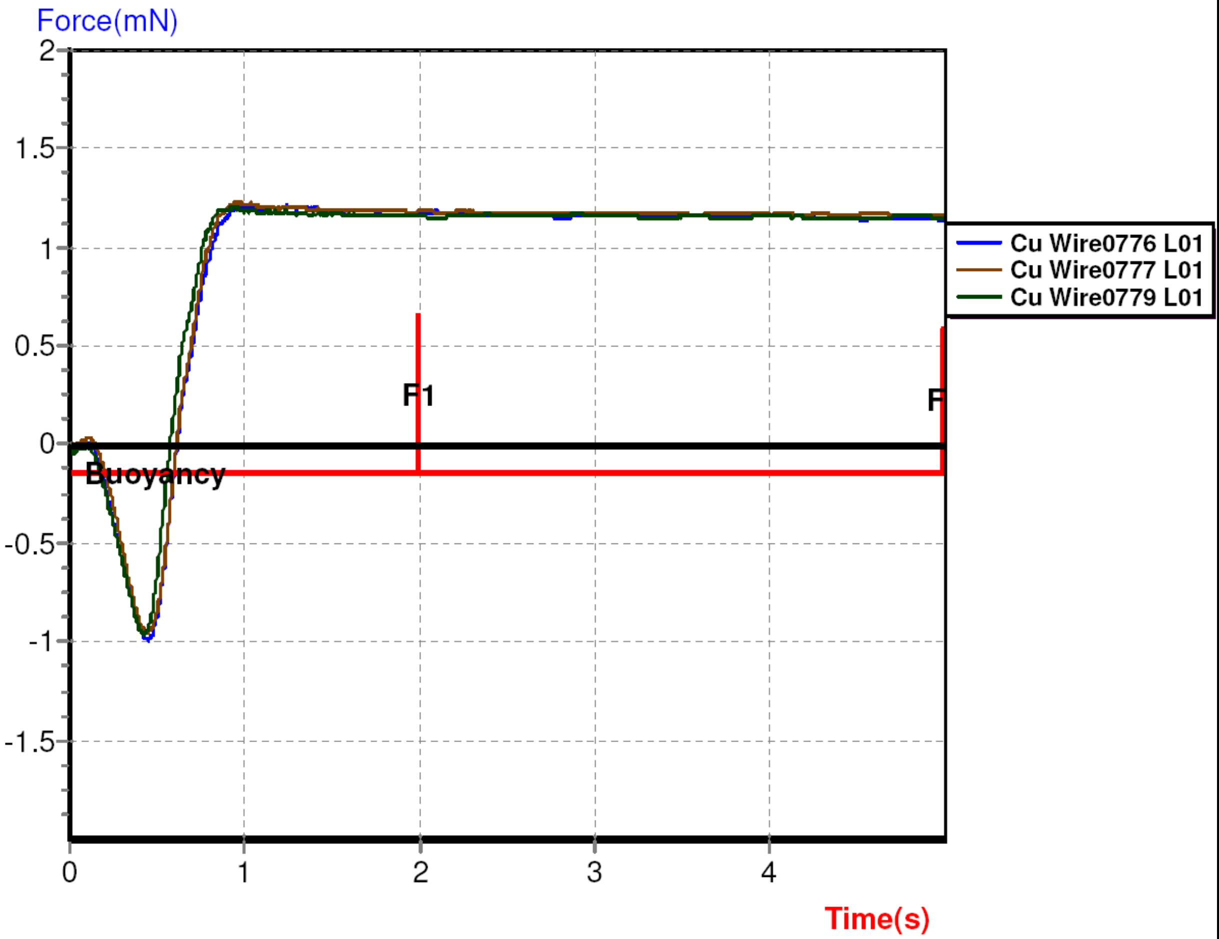
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0776 L01		0.597	0.615	0.756	1.316	1.278	1.212	1.239	Pass
DOE - SN100C ACu Wire0777 L01		0.597	0.612	0.747	1.326	1.299	1.229	0.942	Pass
DOE - SN100C ACu Wire0779 L01		0.561	0.576	0.717	1.302	1.292	1.205	0.939	Pass
	Standard Dev	0.021	0.022	0.020	0.012	0.011	0.012	0.172	
	Mean	0.585	0.601	0.740	1.315	1.290	1.215	1.040	
	Max	0.597	0.615	0.756	1.326	1.299	1.229	1.239	
	Min	0.561	0.576	0.717	1.302	1.278	1.205	0.939	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 3

Test Details

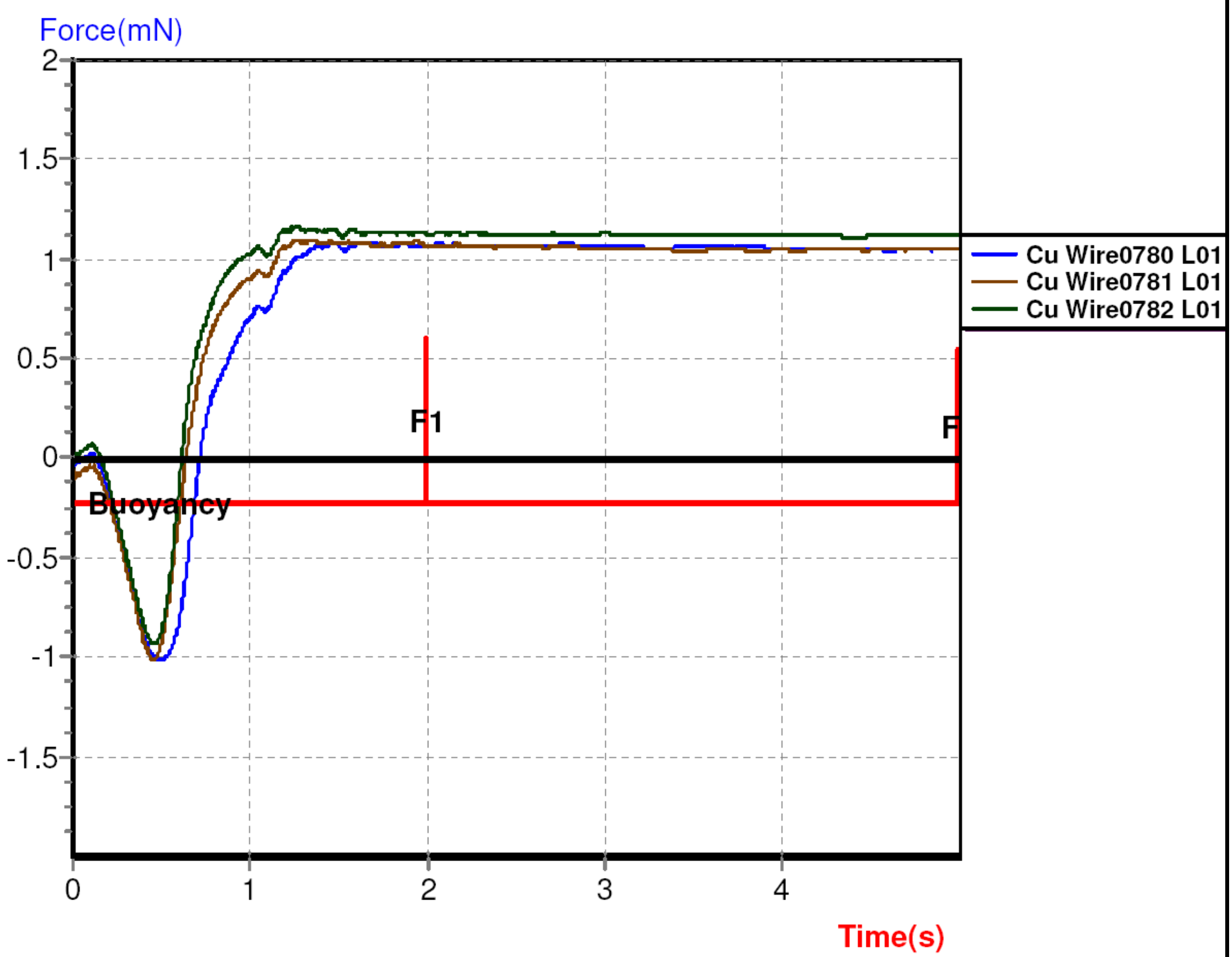
Component : DOE - SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0780 L01		0.684	0.717	1.011	1.298	1.285	1.085	1.461	Fail
DOE - SN100C ACu Wire0781 L01		0.606	0.639	0.831	1.291	1.281	1.098	1.257	Fail
DOE - SN100C ACu Wire0782 L01		0.591	0.615	0.783	1.357	1.346	1.167	1.254	Pass
	Standard Dev	0.050	0.053	0.120	0.036	0.037	0.044	0.119	
	Mean	0.627	0.657	0.875	1.315	1.304	1.117	1.324	
	Max	0.684	0.717	1.011	1.357	1.346	1.167	1.461	
	Min	0.591	0.615	0.783	1.291	1.281	1.085	1.254	

Number of Tests : 003 **Passing rate :** 33.3 %



RUN 4

Test Details

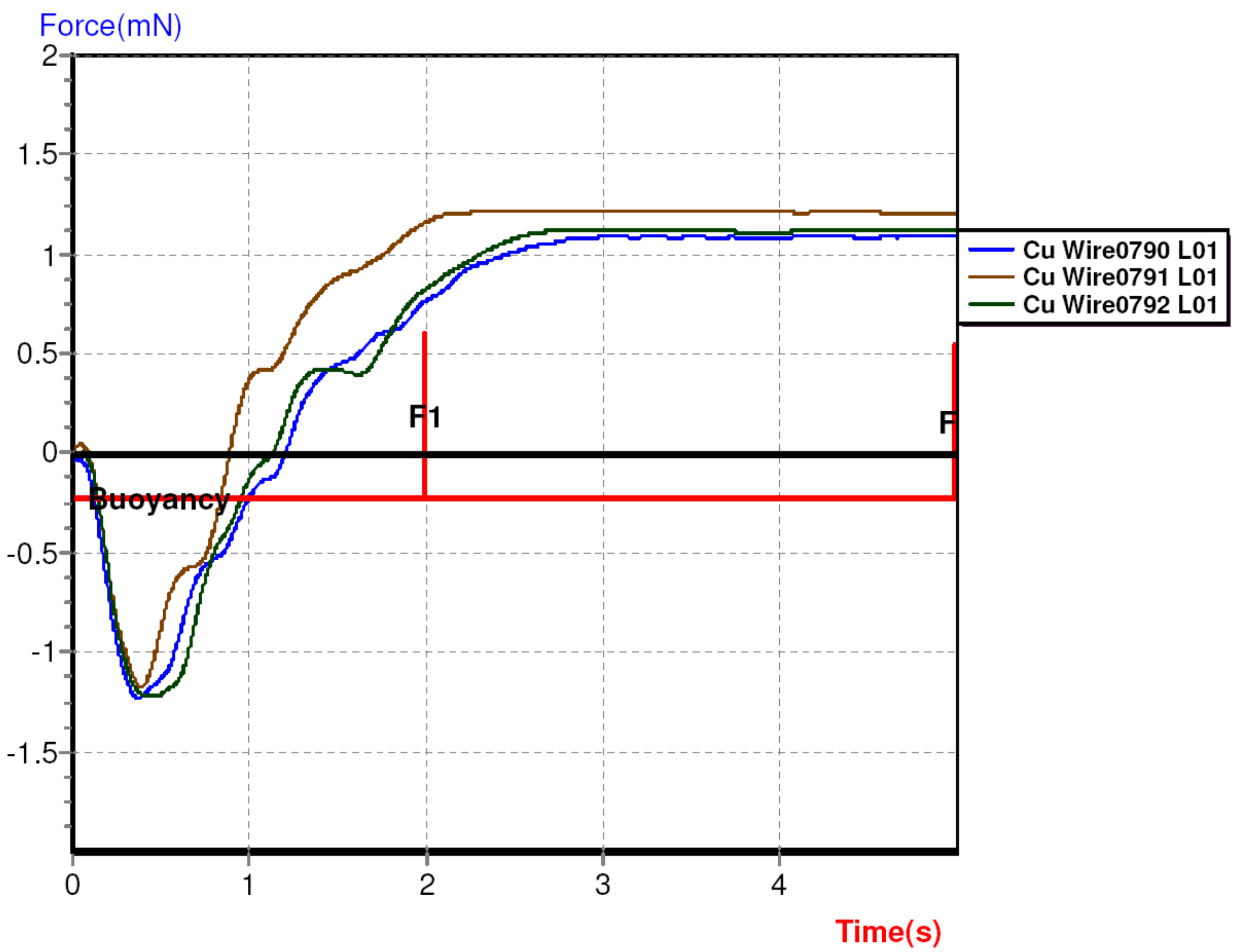
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0790 L01		0.993	1.206	1.953	0.999	1.322	1.095	4.758	Fail
DOE - SN100C ACu Wire0791 L01		0.840	0.888	1.407	1.395	1.436	1.222	3.114	Fail
DOE - SN100C ACu Wire0792 L01		0.951	1.128	1.899	1.057	1.350	1.126	4.512	Fail
	Standard Dev	0.079	0.166	0.301	0.214	0.059	0.066	0.887	
	Mean	0.928	1.074	1.753	1.150	1.369	1.148	4.128	
	Max	0.993	1.206	1.953	1.395	1.436	1.222	4.758	
	Min	0.840	0.888	1.407	0.999	1.322	1.095	3.114	

Number of Tests : 003 **Passing rate :** 0.0 %



RUN 5

Test Details

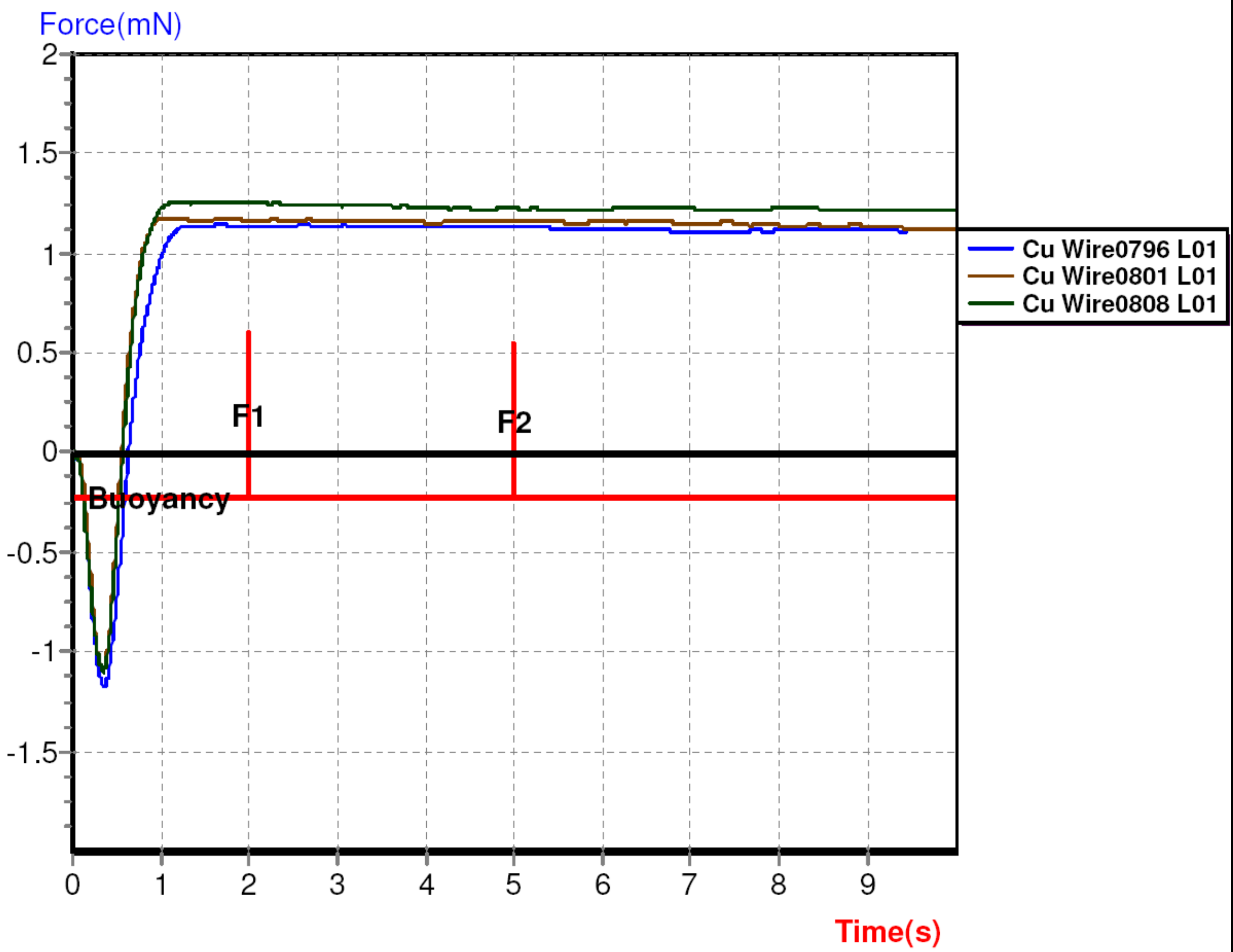
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0796 L01		0.595	0.640	0.865	1.367	1.364	1.143	1.620	Pass
DOE - SN100C ACu Wire0801 L01		0.520	0.555	0.710	1.398	1.388	1.181	1.005	Pass
DOE - SN100C ACu Wire0808 L01		0.530	0.570	0.740	1.488	1.457	1.264	1.840	Pass
	Standard Dev	0.041	0.045	0.082	0.063	0.048	0.062	0.433	
	Mean	0.548	0.588	0.772	1.418	1.403	1.196	1.488	
	Max	0.595	0.640	0.865	1.488	1.457	1.264	1.840	
	Min	0.520	0.555	0.710	1.367	1.364	1.143	1.005	

Number of Tests : 003 Passing rate : 100.0 %



RUN 6

Test Details

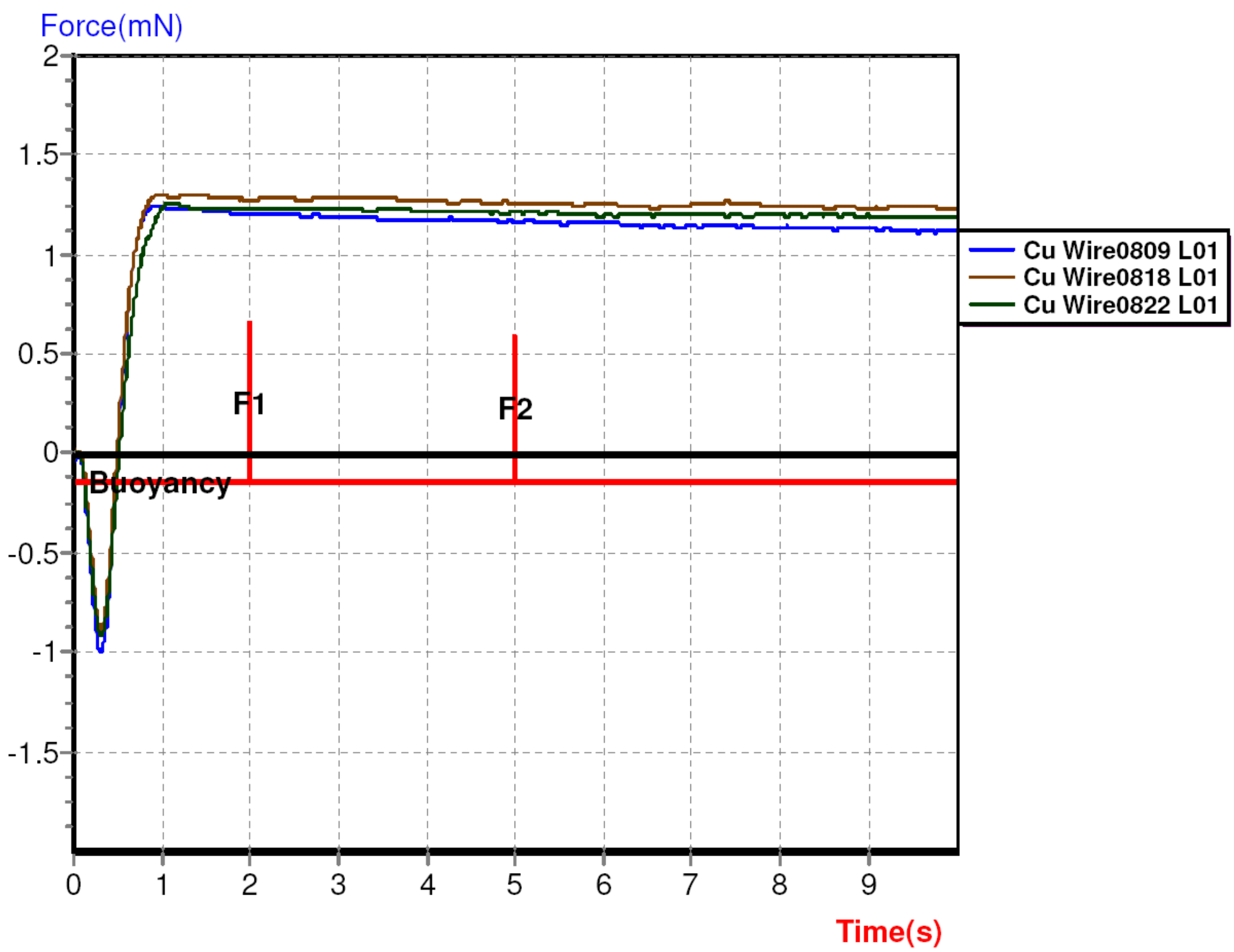
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0809 L01		0.485	0.500	0.640	1.344	1.306	1.246	0.910	Pass
DOE - SN100C ACu Wire0818 L01		0.475	0.495	0.650	1.416	1.402	1.302	0.950	Pass
DOE - SN100C ACu Wire0822 L01		0.495	0.520	0.715	1.371	1.351	1.260	1.085	Pass
	Standard Dev	0.010	0.013	0.041	0.036	0.048	0.029	0.092	
	Mean	0.485	0.505	0.668	1.377	1.353	1.269	0.982	
	Max	0.495	0.520	0.715	1.416	1.402	1.302	1.085	
	Min	0.475	0.495	0.640	1.344	1.306	1.246	0.910	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 7

Test Details

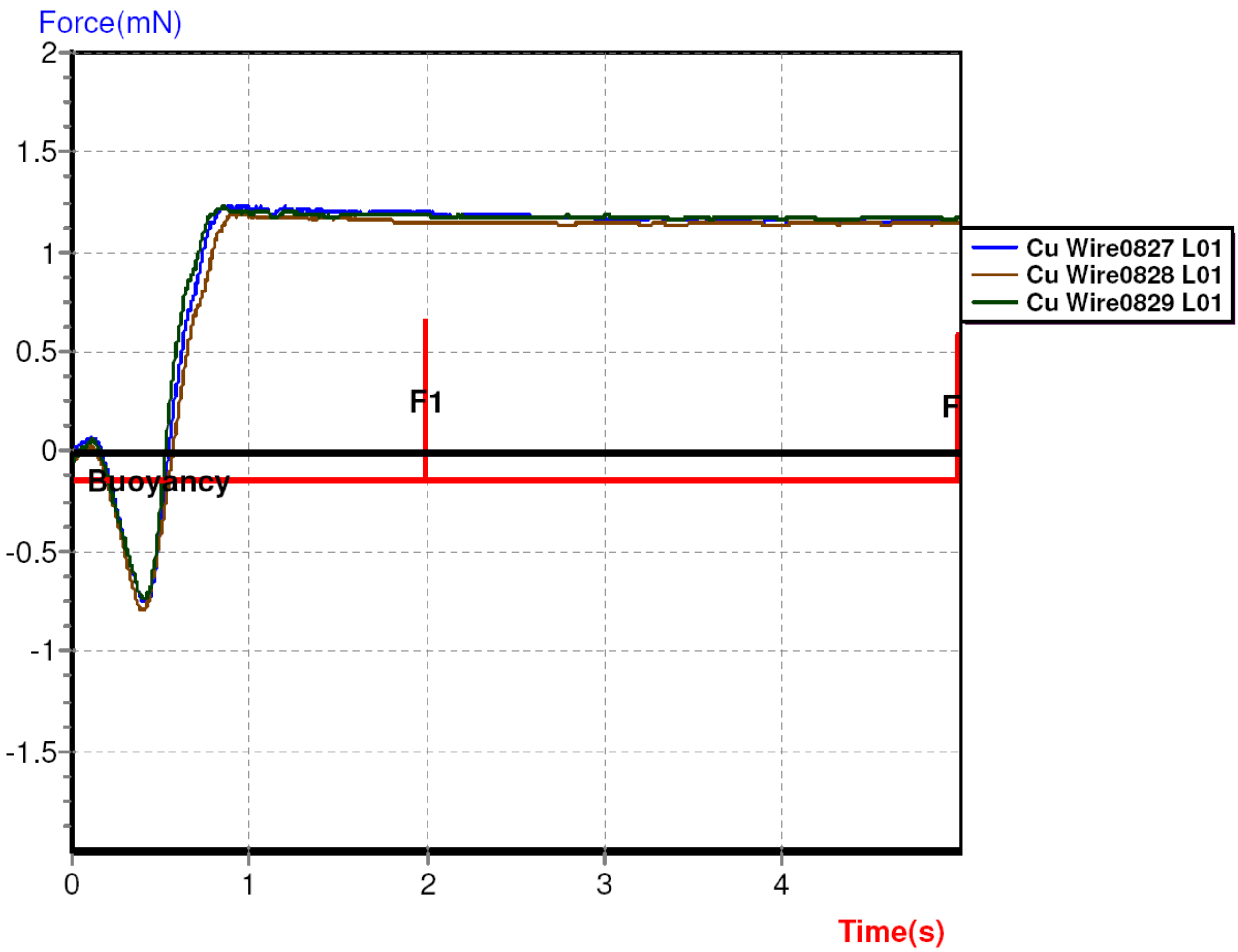
Component : DOE - SN100C Alloy
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ACu Wire0827 L01	0.531	0.546	0.696	1.337	1.285	1.233	0.966	Pass
DOE - SN100C	ACu Wire0828 L01	0.549	0.570	0.738	1.289	1.282	1.191	0.915	Pass
DOE - SN100C	ACu Wire0829 L01	0.513	0.528	0.645	1.323	1.309	1.226	0.849	Pass
	Standard Dev	0.018	0.021	0.047	0.025	0.015	0.022	0.059	
	Mean	0.531	0.548	0.693	1.316	1.292	1.217	0.910	
	Max	0.549	0.570	0.738	1.337	1.309	1.233	0.966	
	Min	0.513	0.528	0.645	1.289	1.282	1.191	0.849	

Number of Tests : 003   **Passing rate :** 100.0 %



RUN 8

Test Details

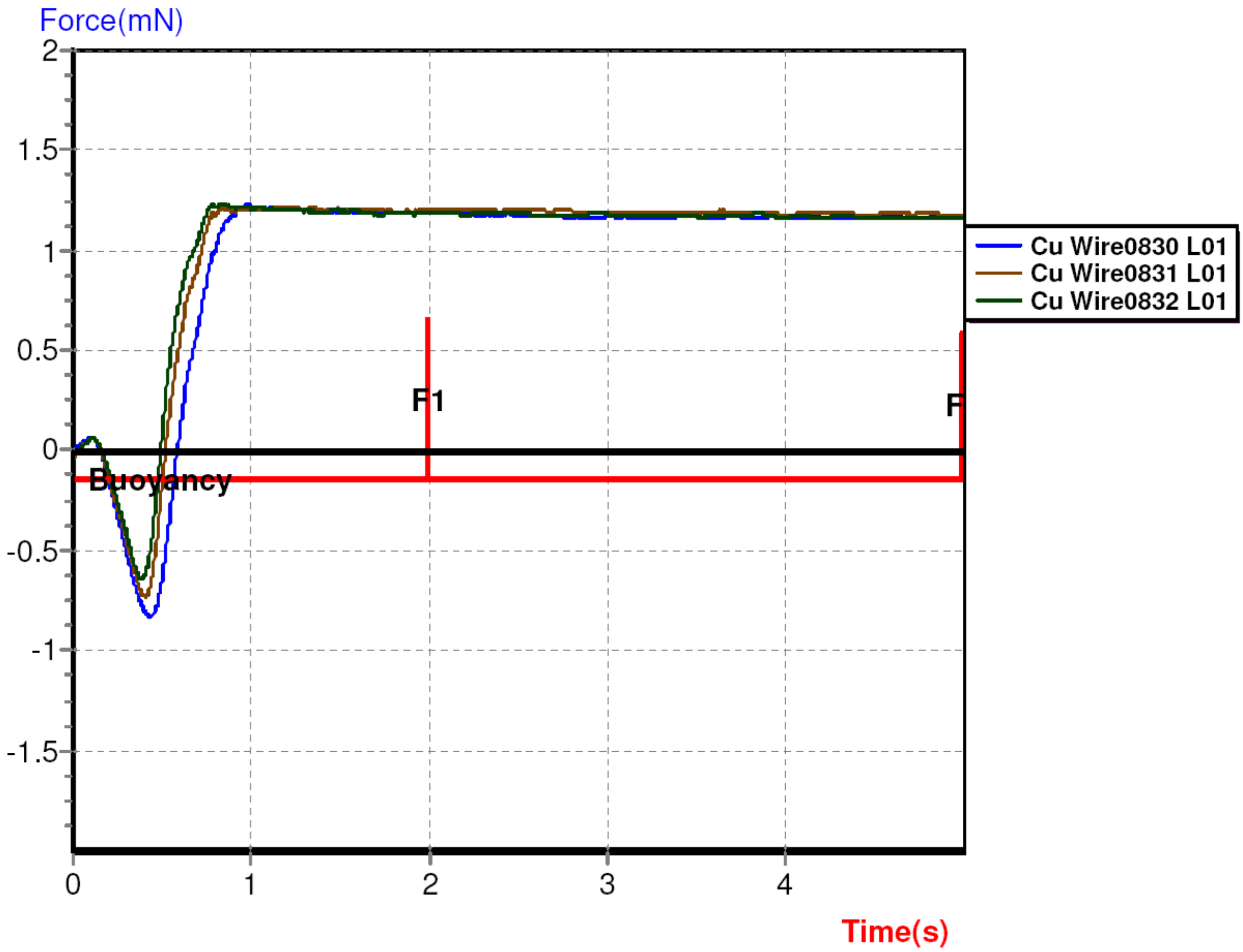
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ACu Wire0830 L01	0.570	0.588	0.741	1.323	1.299	1.226	0.963	Pass
DOE - SN100C	ACu Wire0831 L01	0.504	0.519	0.657	1.337	1.320	1.222	0.855	Pass
DOE - SN100C	ACu Wire0832 L01	0.480	0.492	0.612	1.323	1.302	1.236	0.852	Pass
	Standard Dev	0.047	0.050	0.065	0.008	0.011	0.007	0.063	
	Mean	0.518	0.533	0.670	1.328	1.307	1.228	0.890	
	Max	0.570	0.588	0.741	1.337	1.320	1.236	0.963	
	Min	0.480	0.492	0.612	1.323	1.299	1.222	0.852	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 9

Test Details

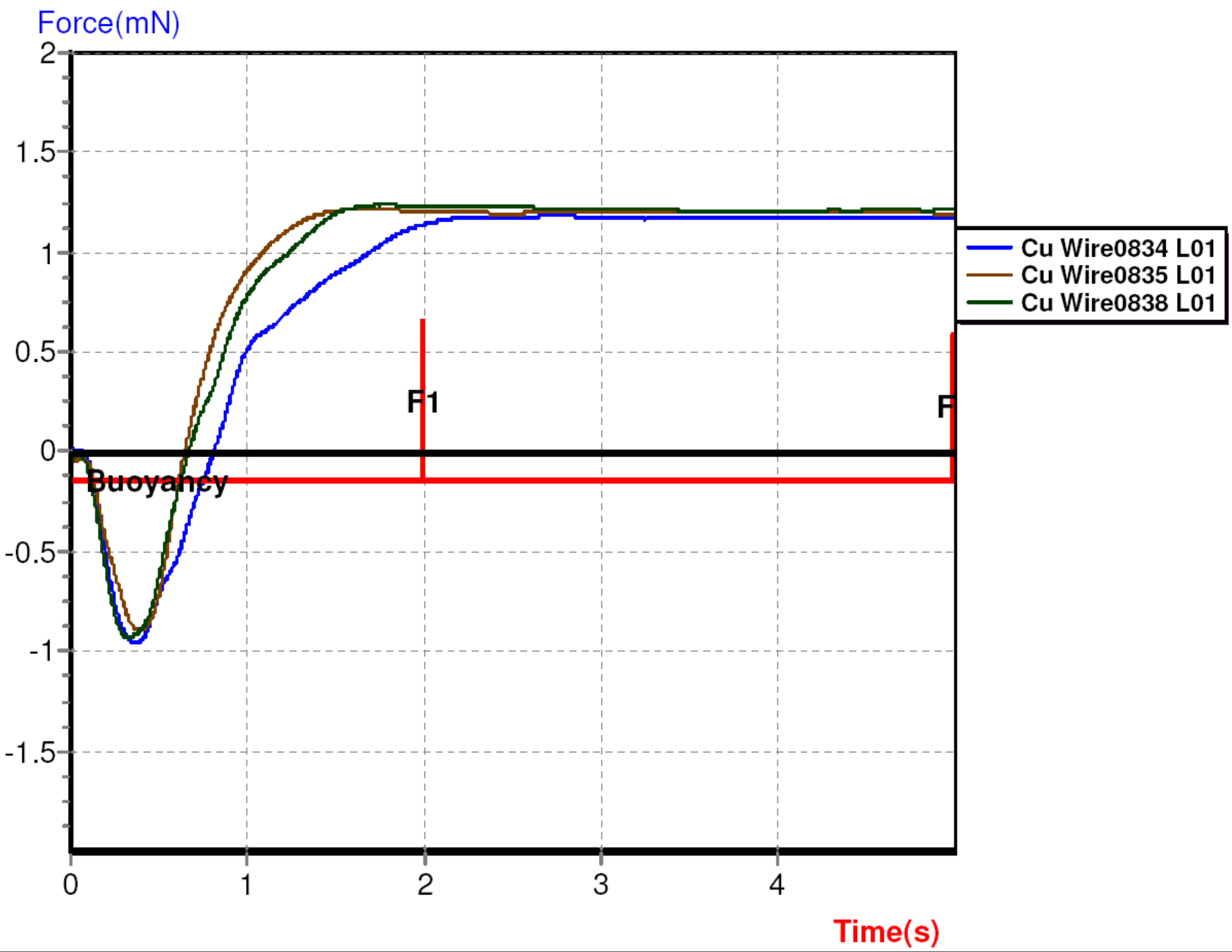
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0834 L01		0.753	0.810	1.344	1.278	1.316	1.185	2.649	Fail
DOE - SN100C ACu Wire0835 L01		0.615	0.645	0.927	1.344	1.330	1.215	1.572	Fail
DOE - SN100C ACu Wire0838 L01		0.627	0.669	1.032	1.368	1.351	1.240	1.722	Fail
	Standard Dev	0.076	0.089	0.217	0.046	0.017	0.028	0.583	
	Mean	0.665	0.708	1.101	1.330	1.332	1.213	1.981	
	Max	0.753	0.810	1.344	1.368	1.351	1.240	2.649	
	Min	0.615	0.645	0.927	1.278	1.316	1.185	1.572	

Number of Tests : 003 **Passing rate :** 0.0 %



RUN 10

Test Details

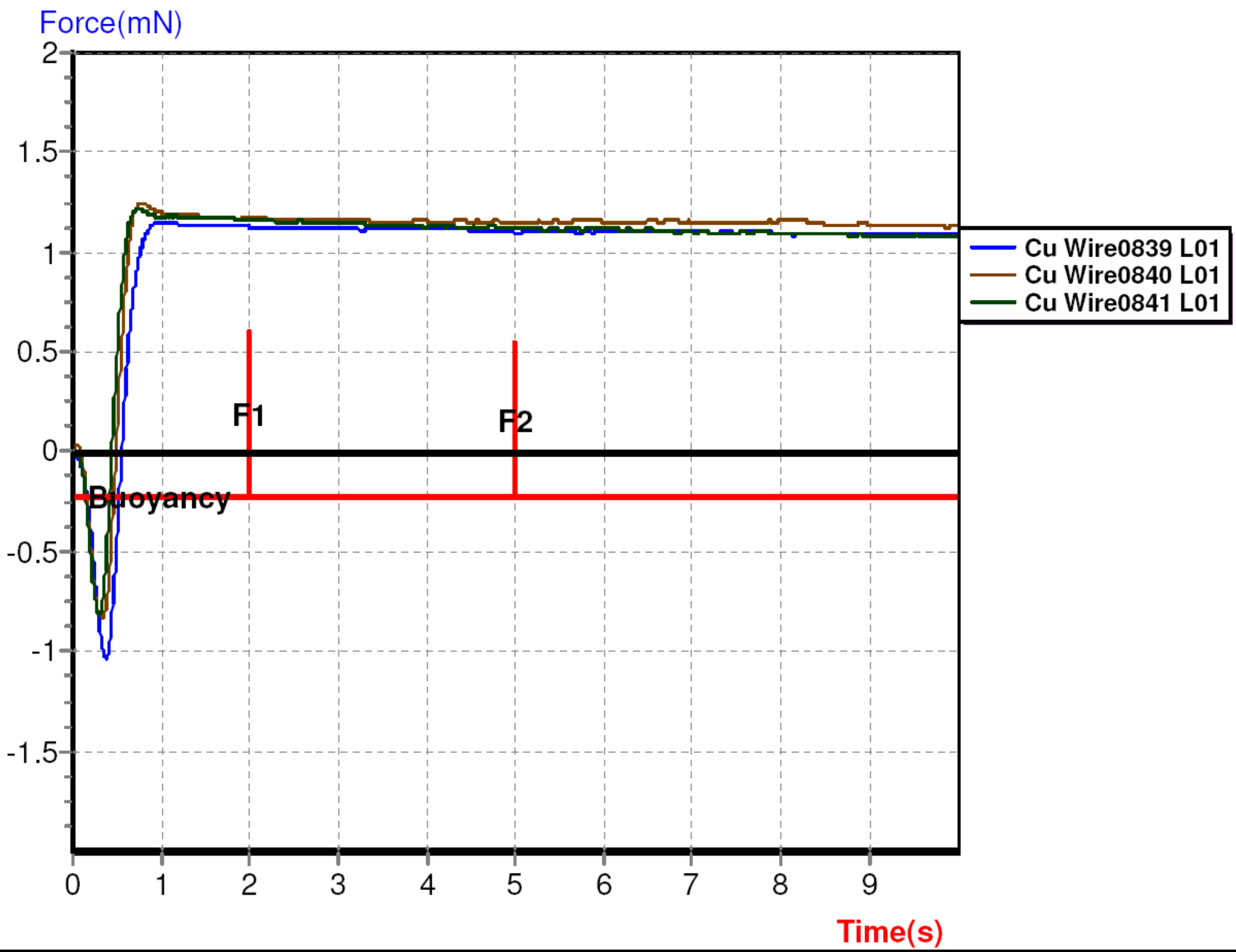
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu	Wire0839 L01	0.525	0.555	0.680	1.357	1.329	1.154	0.980	Pass
DOE - SN100C ACu	Wire0840 L01	0.465	0.490	0.590	1.405	1.384	1.246	0.755	Pass
DOE - SN100C ACu	Wire0841 L01	0.420	0.445	0.550	1.391	1.357	1.219	0.735	Pass
	Standard Dev	0.053	0.055	0.067	0.025	0.028	0.048	0.136	
	Mean	0.470	0.497	0.607	1.384	1.357	1.206	0.823	
	Max	0.525	0.555	0.680	1.405	1.384	1.246	0.980	
	Min	0.420	0.445	0.550	1.357	1.329	1.154	0.735	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 11

Test Details

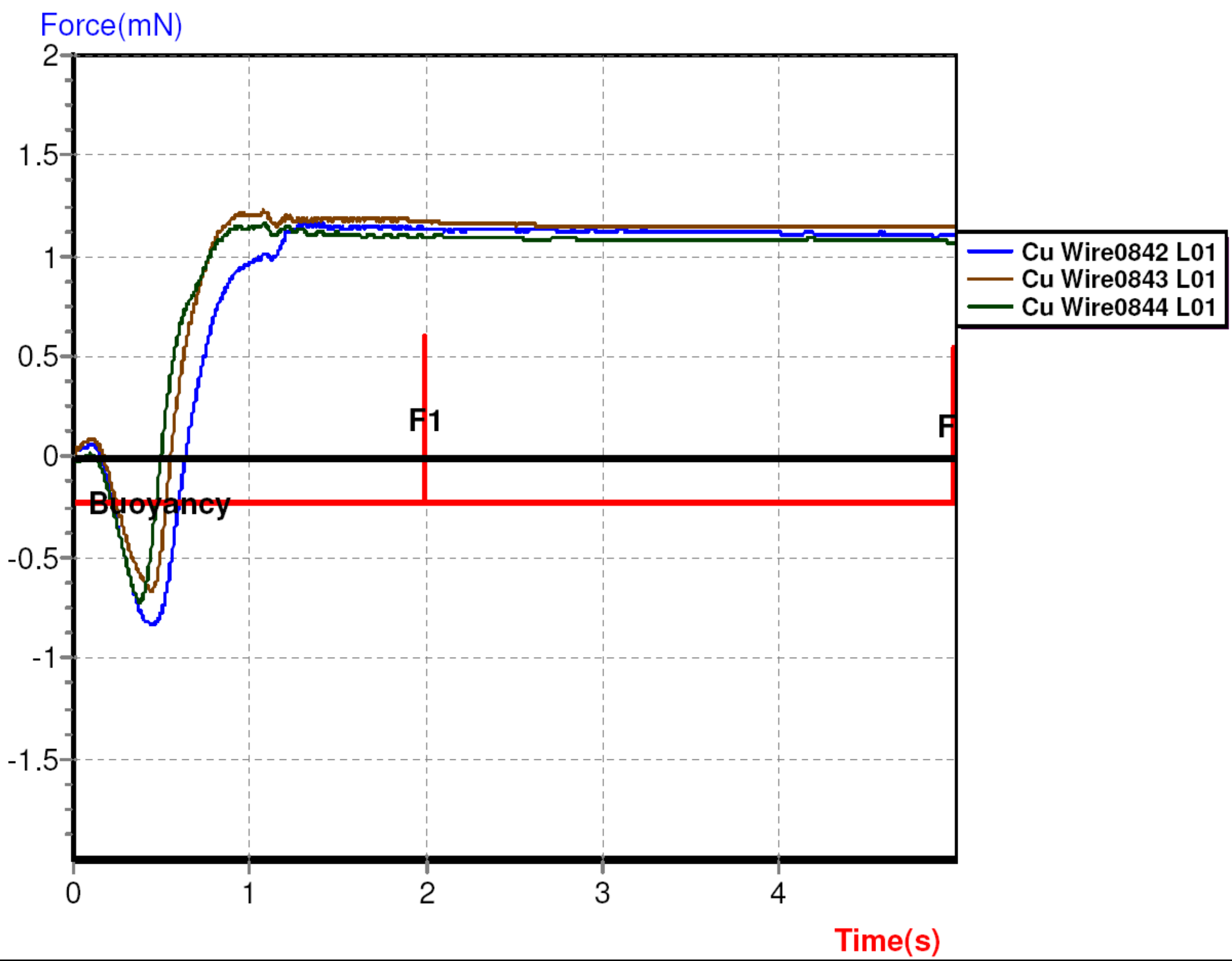
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0842 L01		0.597	0.636	0.831	1.371	1.343	1.171	1.299	Pass
DOE - SN100C ACu Wire0843 L01		0.525	0.552	0.705	1.408	1.381	1.226	1.077	Pass
DOE - SN100C ACu Wire0844 L01		0.468	0.495	0.657	1.326	1.302	1.167	1.077	Pass
	Standard Dev	0.065	0.071	0.090	0.041	0.040	0.033	0.128	
	Mean	0.530	0.561	0.731	1.368	1.342	1.188	1.151	
	Max	0.597	0.636	0.831	1.408	1.381	1.226	1.299	
	Min	0.468	0.495	0.657	1.326	1.302	1.167	1.077	

Number of Tests : 003 **Passing rate :** 100.0 %



RUN 12

Test Details

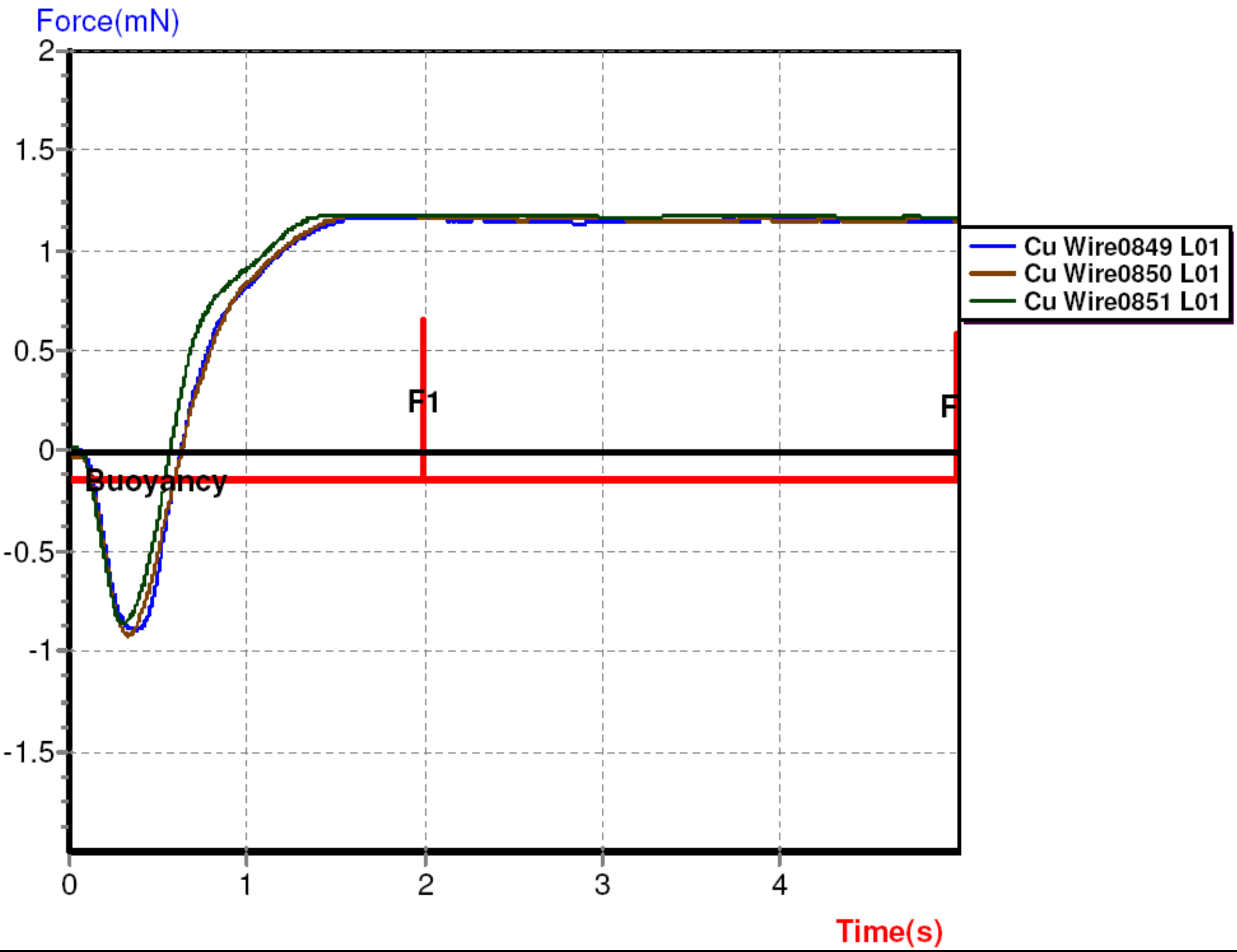
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0849 L01		0.594	0.627	0.948	1.299	1.289	1.164	1.581	Pass
DOE - SN100C ACu Wire0850 L01		0.597	0.630	0.942	1.306	1.292	1.178	1.626	Pass
DOE - SN100C ACu Wire0851 L01		0.540	0.567	0.840	1.316	1.306	1.181	1.587	Pass
	Standard Dev	0.032	0.034	0.061	0.009	0.009	0.009	0.024	
	Mean	0.577	0.609	0.910	1.307	1.295	1.174	1.598	
	Max	0.597	0.630	0.948	1.316	1.306	1.181	1.626	
	Min	0.540	0.570	0.840	1.299	1.289	1.164	1.581	

Number of Tests : 003 Passing rate : 100.0 %



RUN 13

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

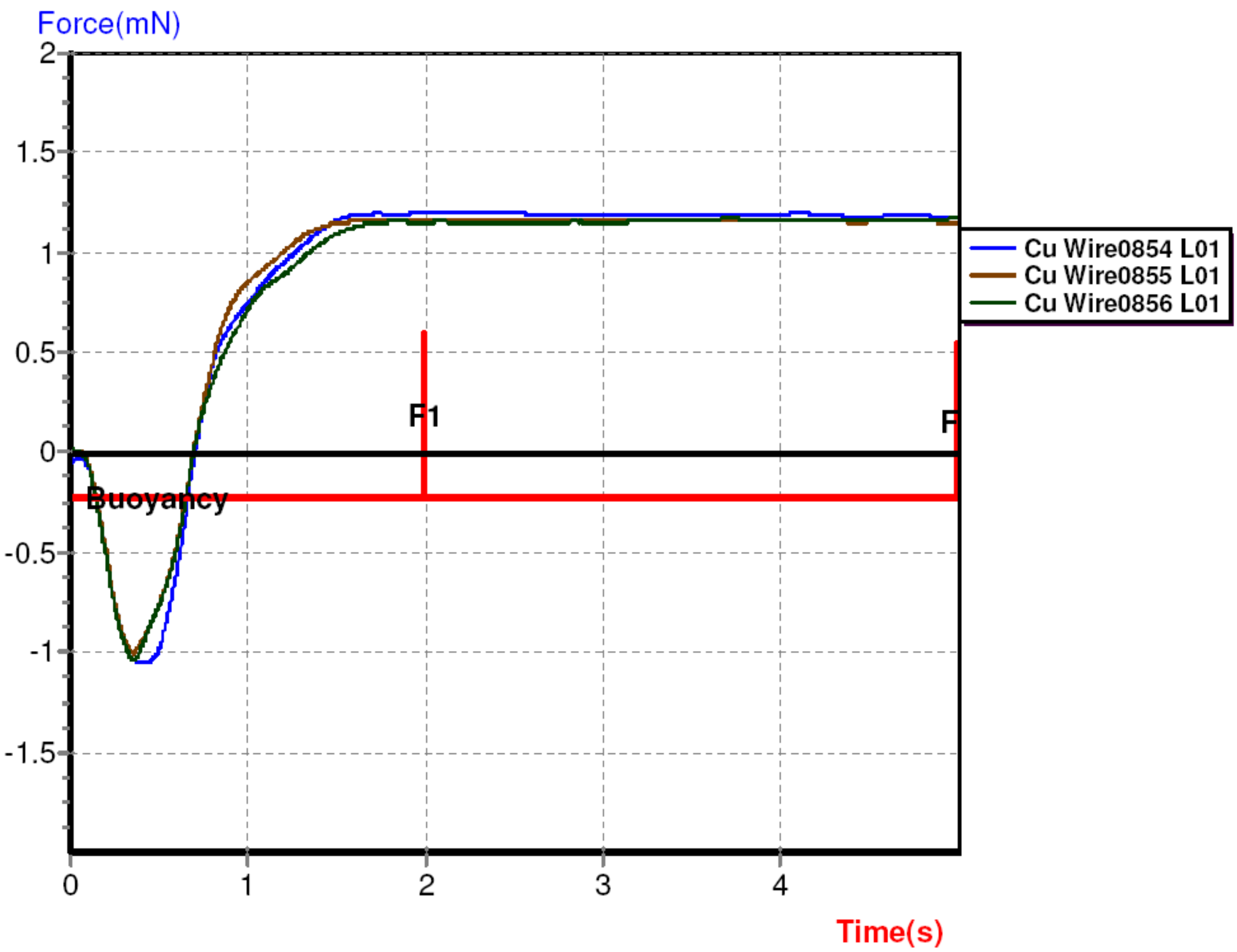
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0854 L01		0.663	0.702	1.044	1.429	1.408	1.205	2.208	Fail
DOE - SN100C ACu Wire0855 L01		0.645	0.693	0.924	1.391	1.381	1.167	2.817	Fail
DOE - SN100C ACu Wire0856 L01		0.648	0.696	1.044	1.384	1.402	1.171	3.663	Fail
	Standard Dev	0.010	0.005	0.069	0.024	0.014	0.021	0.731	
	Mean	0.652	0.697	1.004	1.402	1.397	1.181	2.896	
	Max	0.663	0.702	1.044	1.429	1.408	1.205	3.663	
	Min	0.645	0.693	0.924	1.384	1.381	1.167	2.208	

Number of Tests : 003 Passing rate : 0.0 %



RUN 14

Test Details

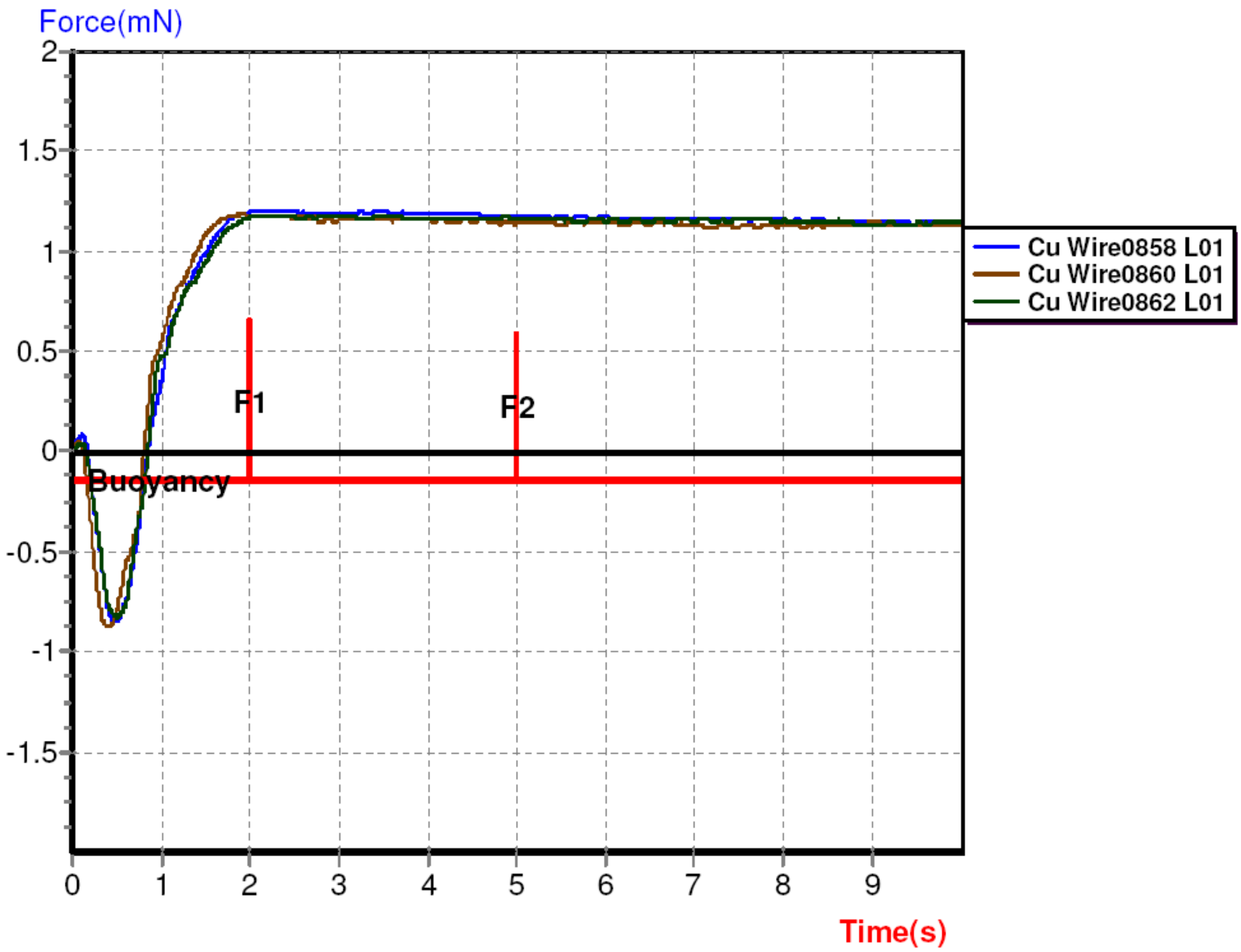
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0858 L01		0.810	0.850	1.265	1.337	1.316	1.209	2.120	Fail
DOE - SN100C ACu Wire0860 L01		0.790	0.810	1.150	1.316	1.278	1.185	1.845	Fail
DOE - SN100C ACu Wire0862 L01		0.830	0.850	1.250	1.309	1.302	1.181	2.080	Fail
	Standard Dev	0.020	0.023	0.063	0.014	0.019	0.015	0.149	
	Mean	0.810	0.837	1.222	1.321	1.299	1.191	2.015	
	Max	0.830	0.850	1.265	1.337	1.316	1.209	2.120	
	Min	0.790	0.810	1.150	1.309	1.278	1.181	1.845	

Number of Tests : 003 Passing rate : 0.0 %



RUN 15

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

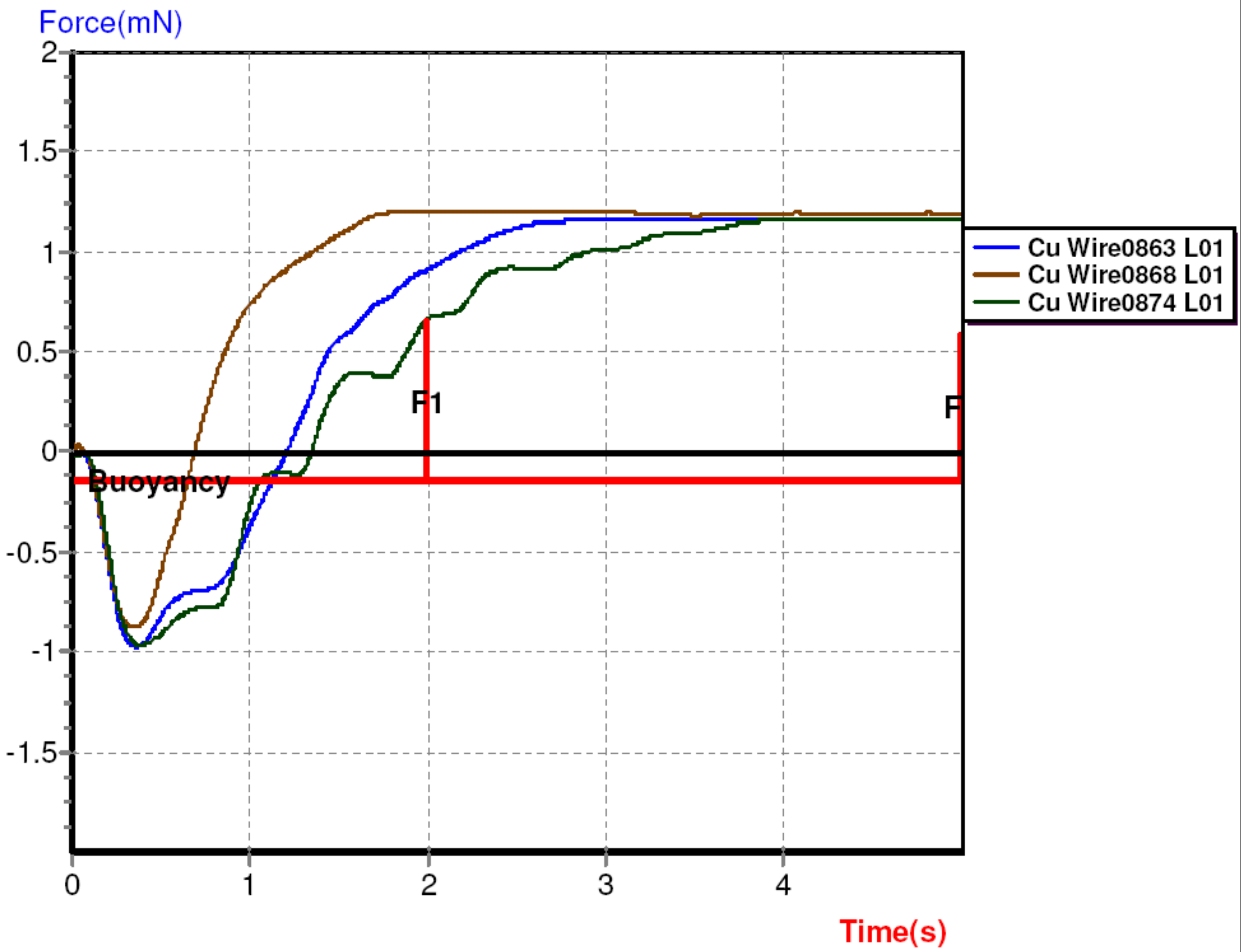
Test parameter line : 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0863 L01		1.128	1.206	1.782	1.051	1.299	1.164	2.862	Fail
DOE - SN100C ACu Wire0868 L01		0.651	0.690	1.062	1.344	1.333	1.209	1.830	Fail
DOE - SN100C ACu Wire0874 L01		1.062	1.344	2.235	0.807	1.302	1.167	4.536	Fail
	Standard Dev	0.258	0.345	0.592	0.269	0.019	0.025	1.366	
	Mean	0.947	1.080	1.693	1.067	1.312	1.180	3.076	
	Max	1.128	1.344	2.235	1.344	1.333	1.209	4.536	
	Min	0.651	0.690	1.062	0.807	1.299	1.164	1.830	

Number of Tests : 003 Passing rate : 0.0 %



RUN 16

Test Details

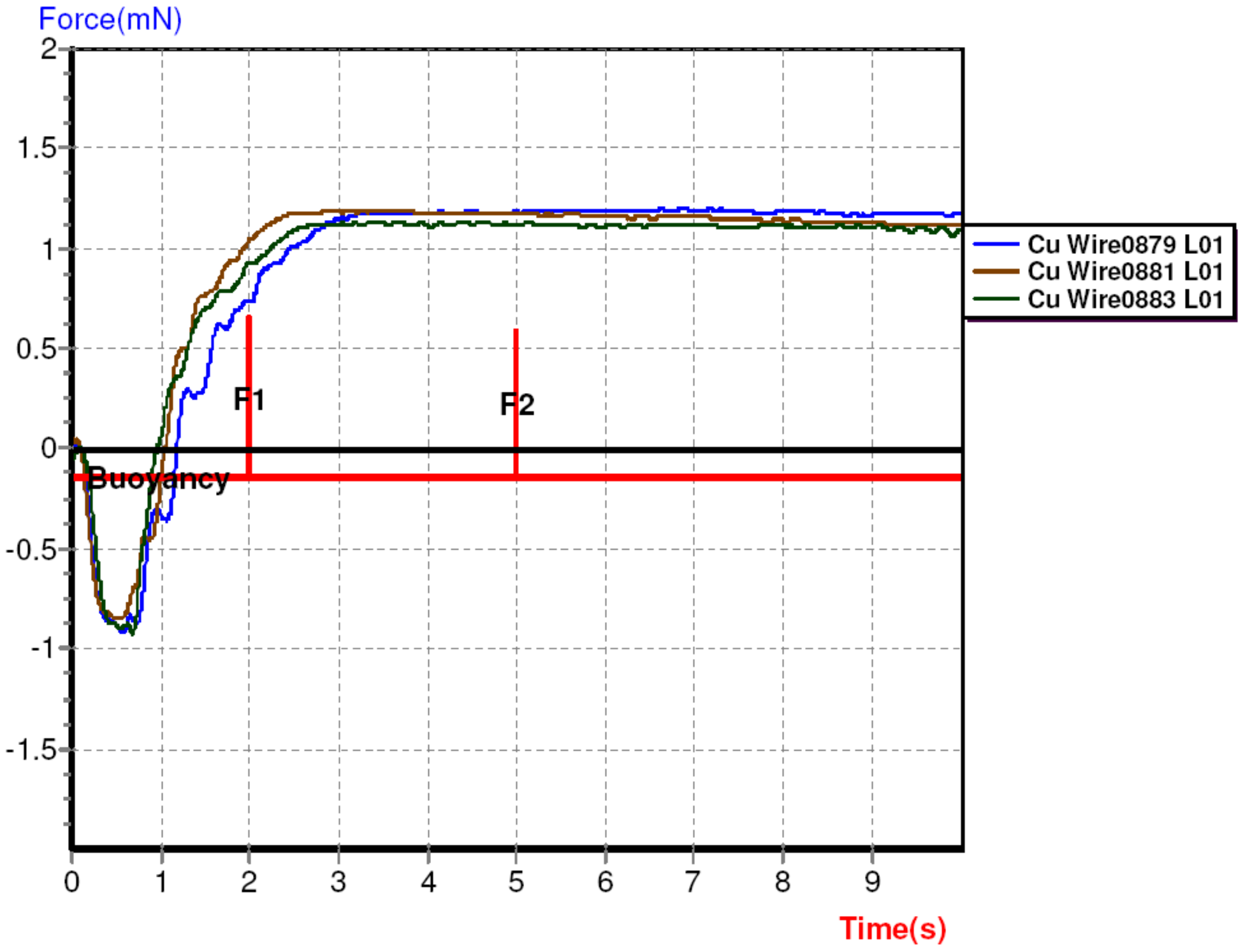
Component : DOE - SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0879 L01		1.160	1.180	2.070	0.868	1.323	1.198	6.610	Fail
DOE - SN100C ACu Wire0881 L01		1.000	1.050	1.595	1.182	1.316	1.195	3.435	Fail
DOE - SN100C ACu Wire0883 L01		0.900	0.955	1.620	1.068	1.258	1.140	4.380	Fail
	Standard Dev	0.131	0.113	0.267	0.159	0.036	0.033	1.630	
	Mean	1.020	1.062	1.762	1.040	1.299	1.178	4.808	
	Max	1.160	1.180	2.070	1.182	1.323	1.198	6.610	
	Min	0.900	0.955	1.595	0.868	1.258	1.140	3.435	

Number of Tests : 003 Passing rate : 0.0 %



RUN 17

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

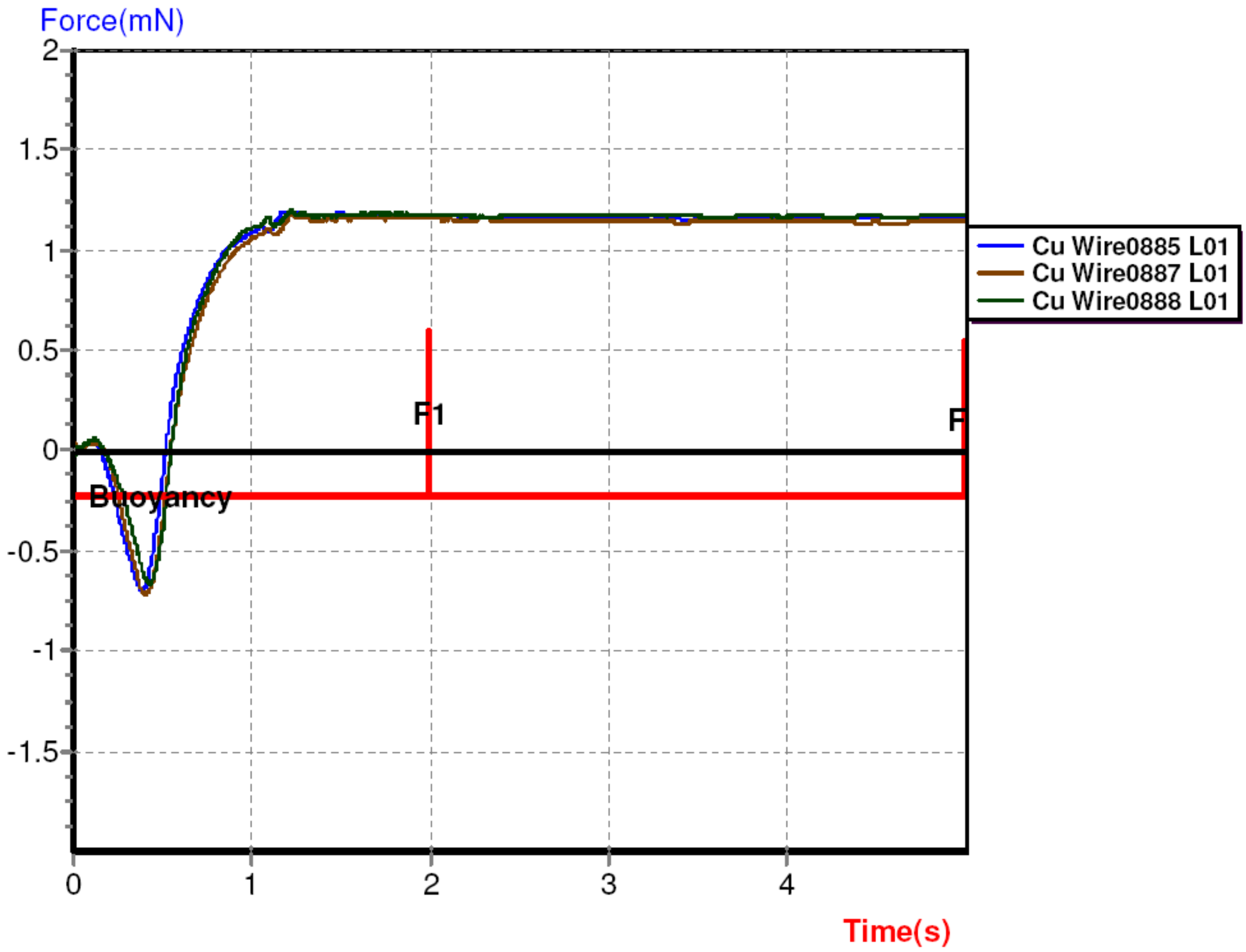
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0885 L01		0.483	0.516	0.723	1.398	1.388	1.195	1.170	Pass
DOE - SN100C ACu Wire0887 L01		0.516	0.546	0.756	1.395	1.381	1.178	1.212	Pass
DOE - SN100C ACu Wire0888 L01		0.519	0.549	0.744	1.408	1.408	1.202	1.209	Pass
	Standard Dev	0.020	0.018	0.017	0.007	0.014	0.012	0.023	
	Mean	0.506	0.537	0.741	1.400	1.392	1.191	1.197	
	Max	0.519	0.549	0.756	1.408	1.408	1.202	1.212	
	Min	0.483	0.516	0.723	1.395	1.381	1.178	1.170	

Number of Tests : 003 Passing rate : 100.0 %



RUN 18

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

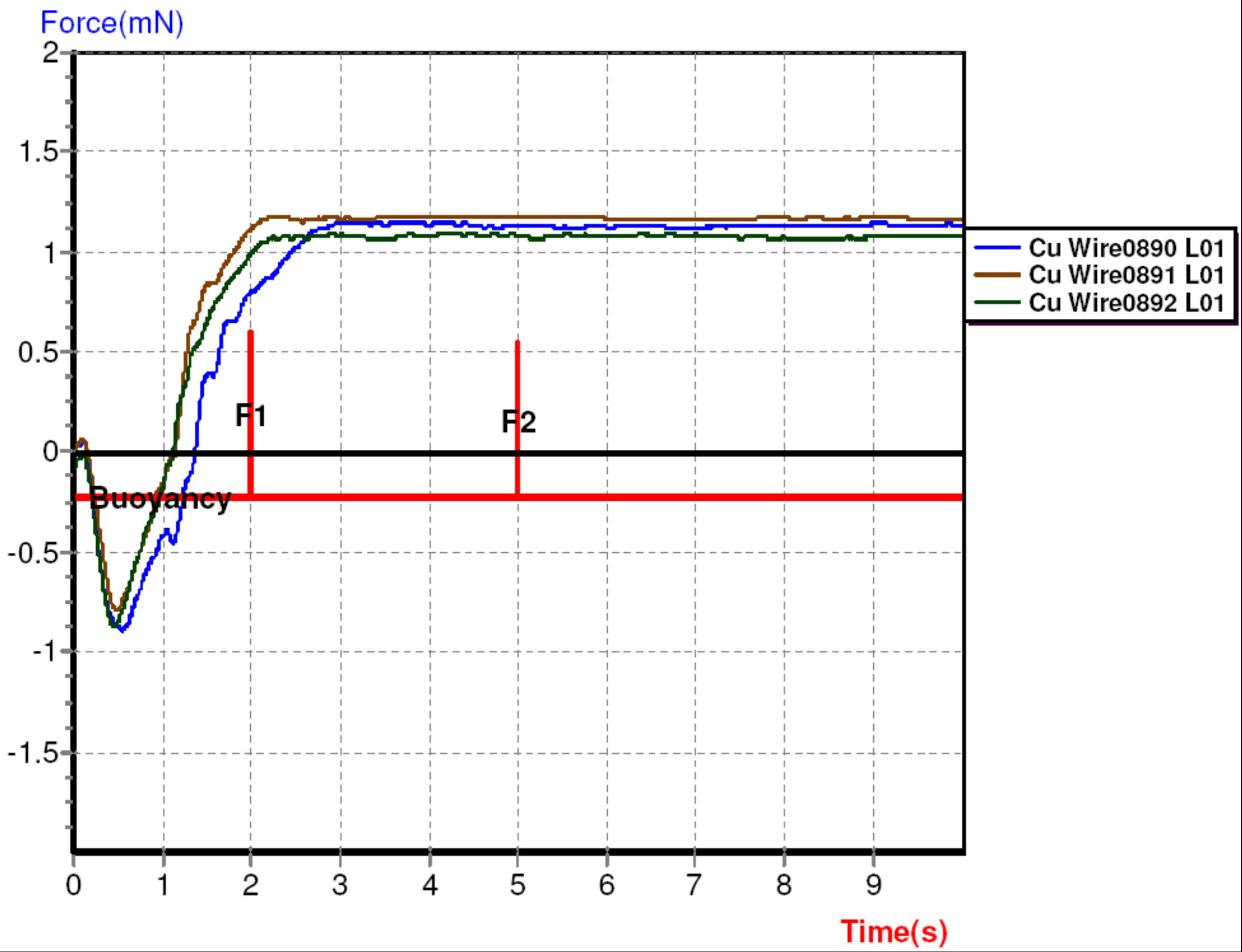
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0890 L01		1.230	1.370	1.925	1.030	1.360	1.154	3.070	Fail
DOE - SN100C ACu Wire0891 L01		0.920	1.145	1.450	1.350	1.402	1.181	4.095	Fail
DOE - SN100C ACu Wire0892 L01		0.970	1.125	1.570	1.226	1.315	1.092	2.880	Fail
	Standard Dev	0.166	0.136	0.247	0.161	0.043	0.046	0.654	
	Mean	1.040	1.213	1.648	1.202	1.359	1.142	3.348	
	Max	1.230	1.370	1.925	1.350	1.402	1.181	4.095	
	Min	0.920	1.125	1.450	1.030	1.315	1.092	2.880	

Number of Tests : 003 Passing rate : 0.0 %



RUN 19

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

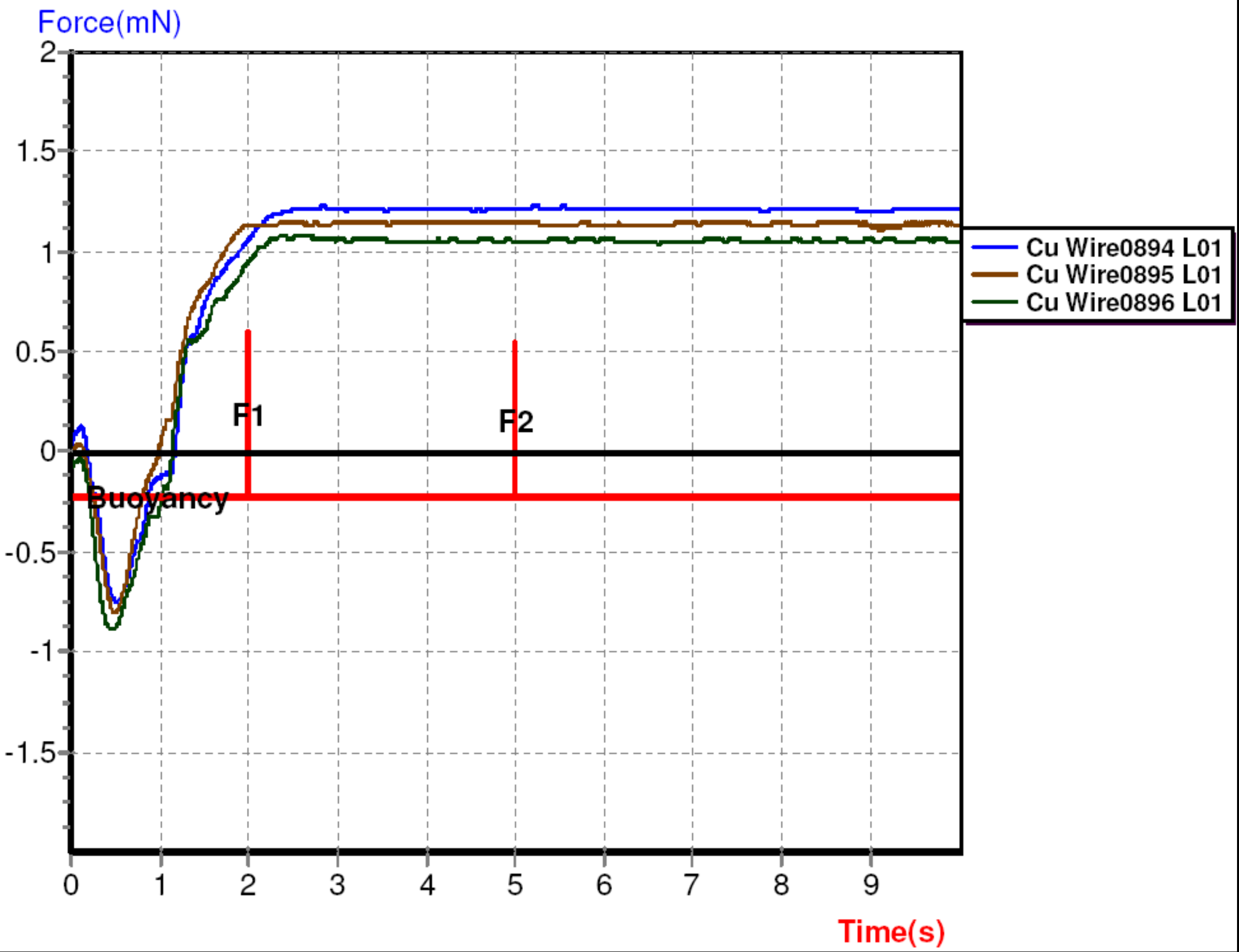
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0894 L01		0.870	1.170	1.580	1.295	1.446	1.226	2.815	Fail
DOE - SN100C ACu Wire0895 L01		0.800	0.985	1.425	1.364	1.381	1.154	3.150	Fail
DOE - SN100C ACu Wire0896 L01		1.020	1.140	1.590	1.185	1.285	1.078	2.380	Fail
	Standard Dev	0.112	0.099	0.093	0.090	0.081	0.074	0.386	
	Mean	0.897	1.098	1.532	1.281	1.371	1.152	2.782	
	Max	1.020	1.170	1.590	1.364	1.446	1.226	3.150	
	Min	0.800	0.985	1.425	1.185	1.285	1.078	2.380	

Number of Tests : 003 Passing rate : 0.0 %



RUN 20

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

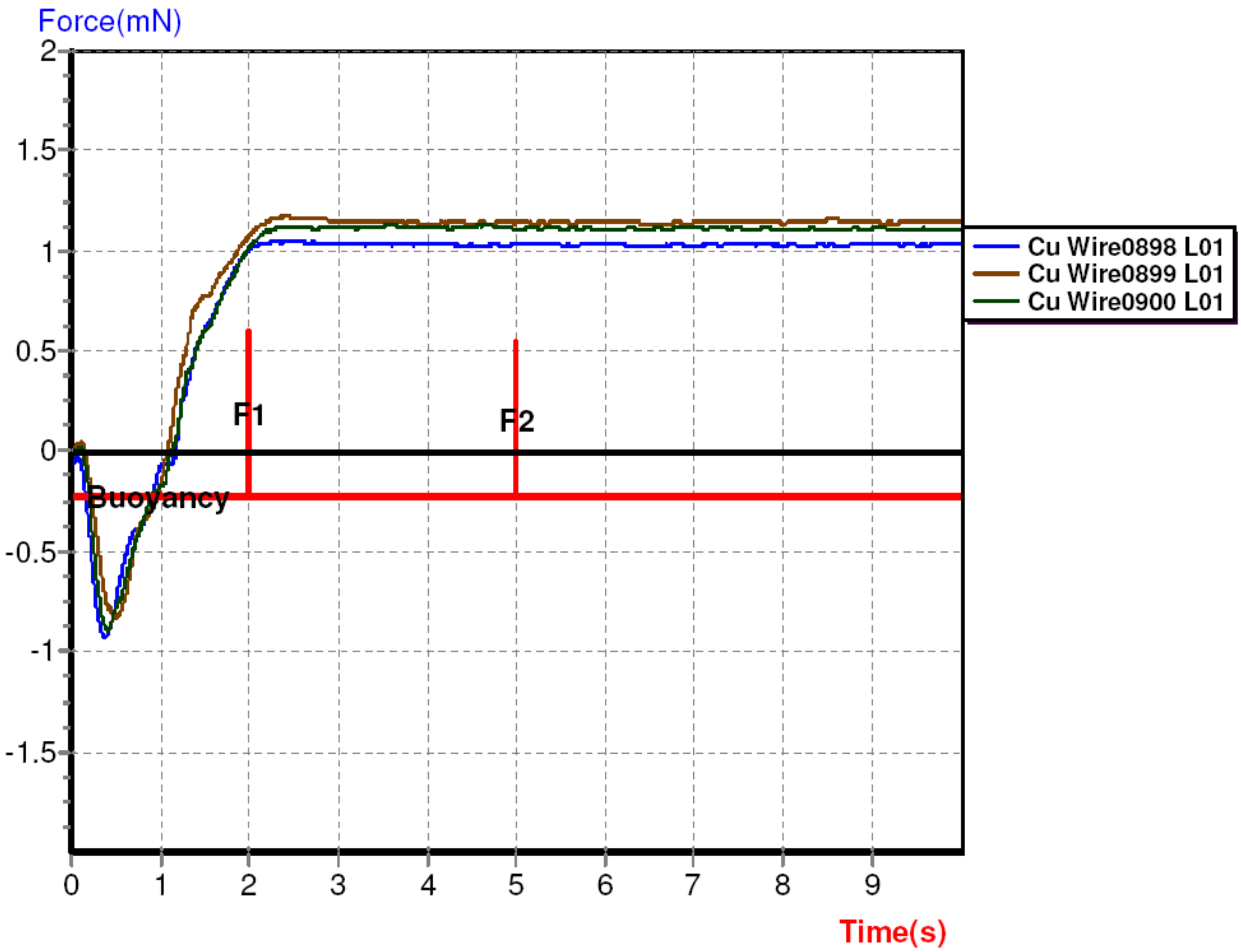
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0898 L01		0.915	1.175	1.615	1.240	1.267	1.054	2.275	Fail
DOE - SN100C ACu Wire0899 L01		0.970	1.085	1.545	1.305	1.374	1.171	2.350	Fail
DOE - SN100C ACu Wire0900 L01		0.890	1.120	1.675	1.254	1.343	1.133	3.545	Fail
	Standard Dev	0.041	0.045	0.065	0.034	0.055	0.060	0.713	
	Mean	0.925	1.127	1.612	1.266	1.328	1.119	2.723	
	Max	0.970	1.175	1.675	1.305	1.374	1.171	3.545	
	Min	0.890	1.085	1.545	1.240	1.267	1.054	2.275	

Number of Tests : 003 Passing rate : 0.0 %



RUN 21

Test Details

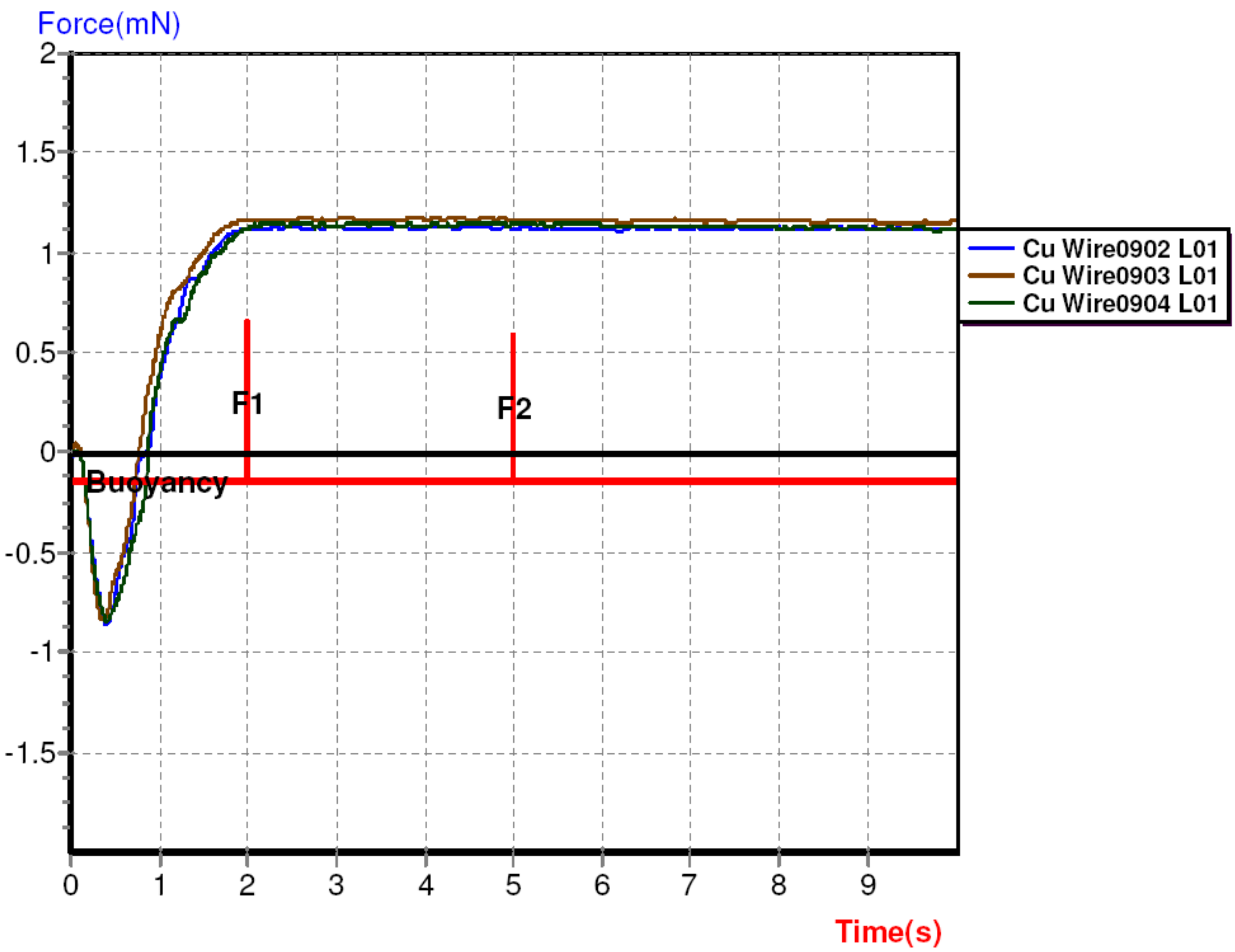
Component : DOE - SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0902 L01		0.745	0.855	1.250	1.264	1.258	1.136	2.955	Fail
DOE - SN100C ACu Wire0903 L01		0.725	0.770	1.135	1.295	1.302	1.178	3.840	Fail
DOE - SN100C ACu Wire0904 L01		0.855	0.875	1.350	1.264	1.285	1.154	2.540	Fail
	Standard Dev	0.070	0.056	0.108	0.018	0.023	0.021	0.664	
	Mean	0.775	0.833	1.245	1.275	1.282	1.156	3.112	
	Max	0.855	0.875	1.350	1.295	1.302	1.178	3.840	
	Min	0.725	0.770	1.135	1.264	1.258	1.136	2.540	

Number of Tests : 003 Passing rate : 0.0 %



RUN 22

Test Details

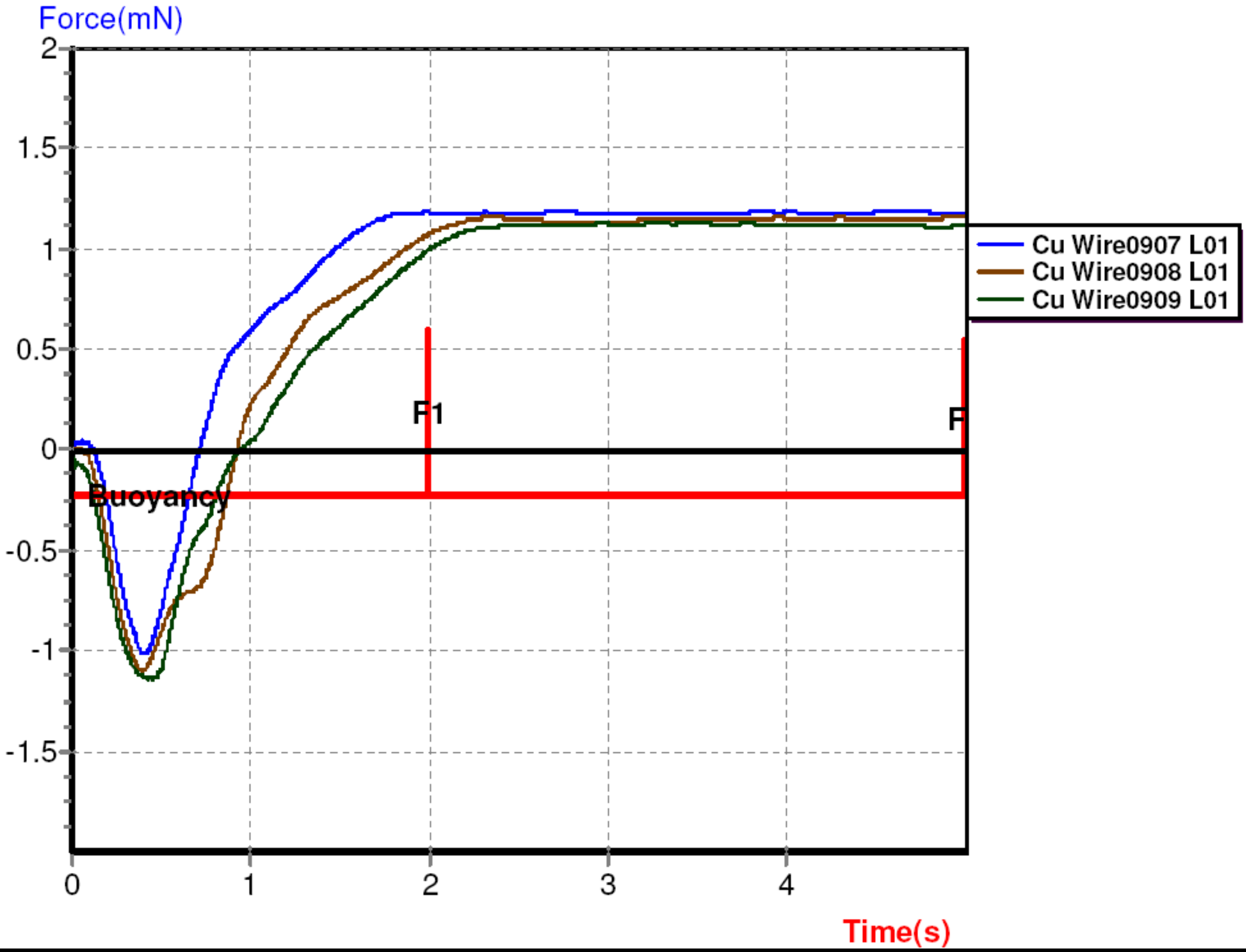
Component : DOE - SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1 = 0.60 mN @ 2.00 s		F2 = 0.54 mN @ 5.00 s	
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 240.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0907 L01		0.654	0.714	1.242	1.412	1.412	1.185	1.965	Fail
DOE - SN100C ACu Wire0908 L01		0.867	0.921	1.512	1.309	1.391	1.160	4.914	Fail
DOE - SN100C ACu Wire0909 L01		0.804	0.936	1.668	1.233	1.346	1.129	2.934	Fail
	Standard Dev	0.109	0.124	0.216	0.090	0.033	0.028	1.503	
	Mean	0.775	0.857	1.474	1.318	1.383	1.158	3.271	
	Max	0.867	0.936	1.668	1.412	1.412	1.185	4.914	
	Min	0.654	0.714	1.242	1.233	1.346	1.129	1.965	

Number of Tests : 003 Passing rate : 0.0 %



RUN 23

Test Details

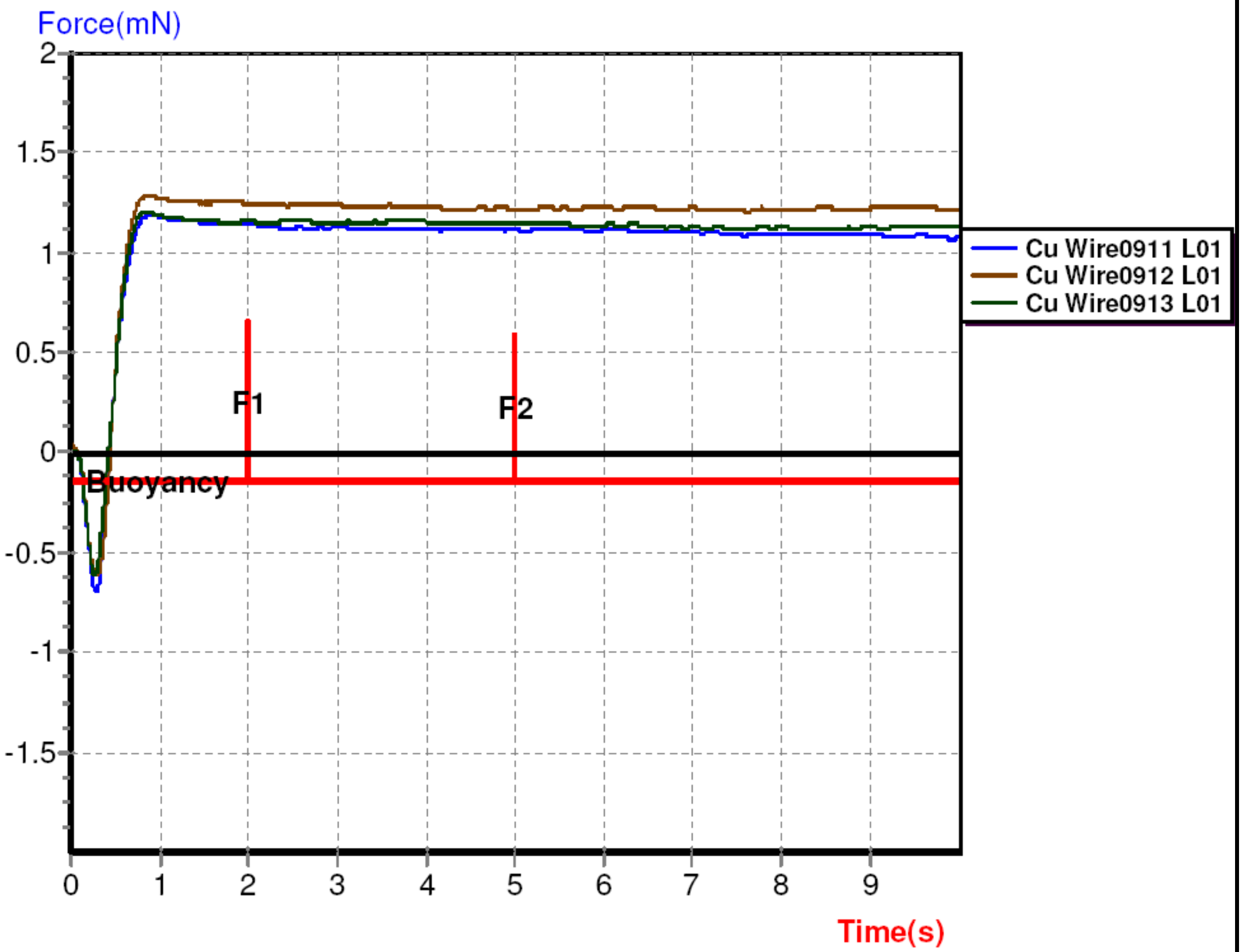
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.65 mN @ 2.00 s	F2	= 0.58 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu	Wire0911 L01	0.415	0.435	0.590	1.282	1.254	1.188	0.860	Pass
DOE - SN100C ACu	Wire0912 L01	0.420	0.440	0.585	1.385	1.361	1.288	0.845	Pass
DOE - SN100C ACu	Wire0913 L01	0.390	0.420	0.585	1.295	1.282	1.205	0.820	Pass
	Standard Dev	0.016	0.010	0.003	0.056	0.055	0.053	0.020	
	Mean	0.408	0.432	0.587	1.321	1.299	1.227	0.842	
	Max	0.420	0.440	0.590	1.385	1.361	1.288	0.860	
	Min	0.390	0.420	0.585	1.282	1.254	1.188	0.820	

Number of Tests : 003   Passing rate : 100.0 %



RUN 24

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

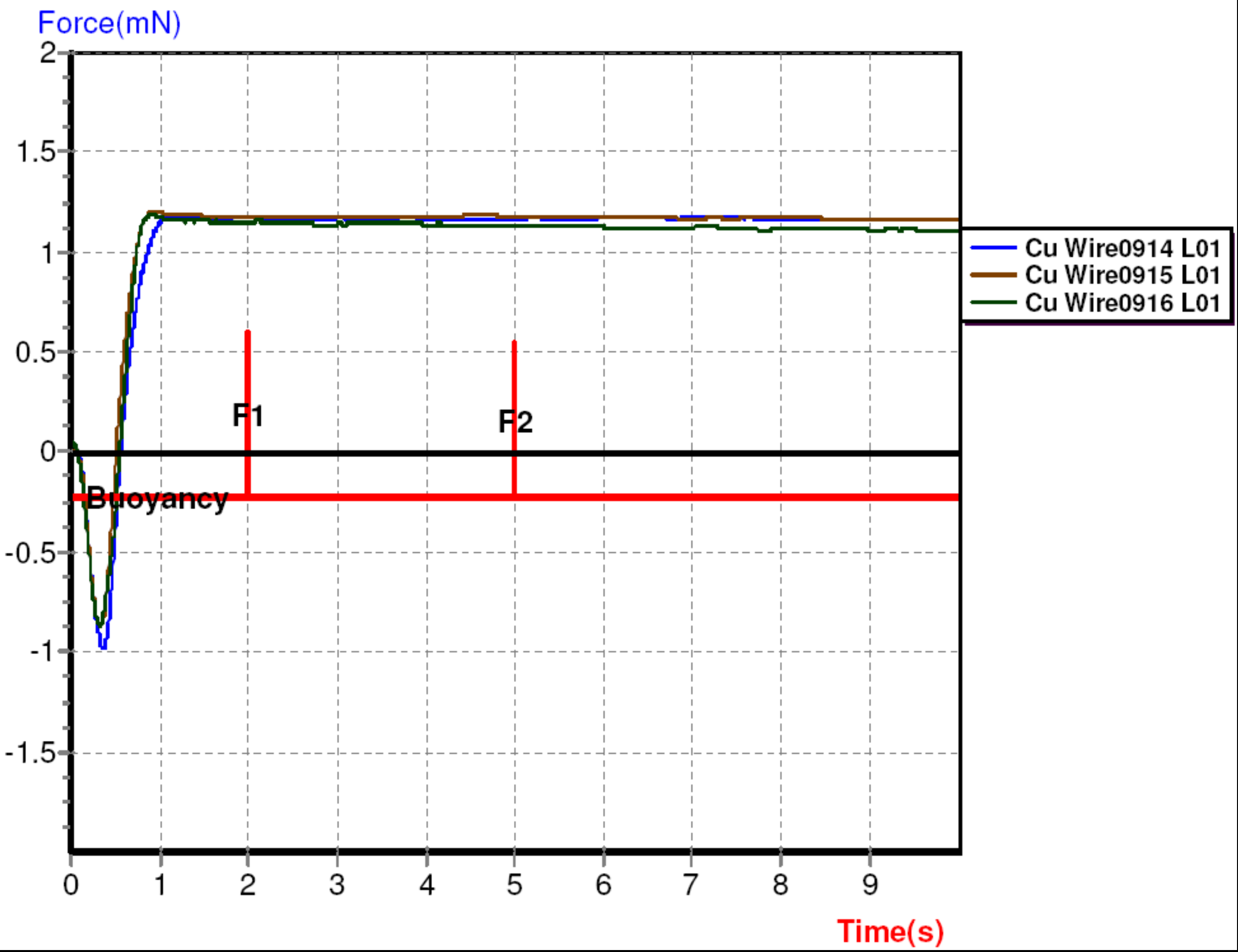
Test parameter line : 1

Test Limits and Conditions

F1	= 0.60 mN @ 2.00 s	F2	= 0.54 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 25.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 10 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ACu Wire0914 L01		0.525	0.560	0.755	1.402	1.398	1.181	1.120	Pass
DOE - SN100C ACu Wire0915 L01		0.480	0.515	0.665	1.405	1.408	1.205	0.915	Pass
DOE - SN100C ACu Wire0916 L01		0.515	0.550	0.685	1.384	1.364	1.188	0.880	Pass
	Standard Dev	0.024	0.024	0.047	0.011	0.023	0.012	0.130	
	Mean	0.507	0.542	0.702	1.397	1.390	1.191	0.972	
	Max	0.525	0.560	0.755	1.405	1.408	1.205	1.120	
	Min	0.480	0.515	0.665	1.384	1.364	1.181	0.880	

Number of Tests : 003 Passing rate : 100.0 %



Appendix 8 Wetting Balance Test Detailed DoE Graphs

RUN 1

Test Details

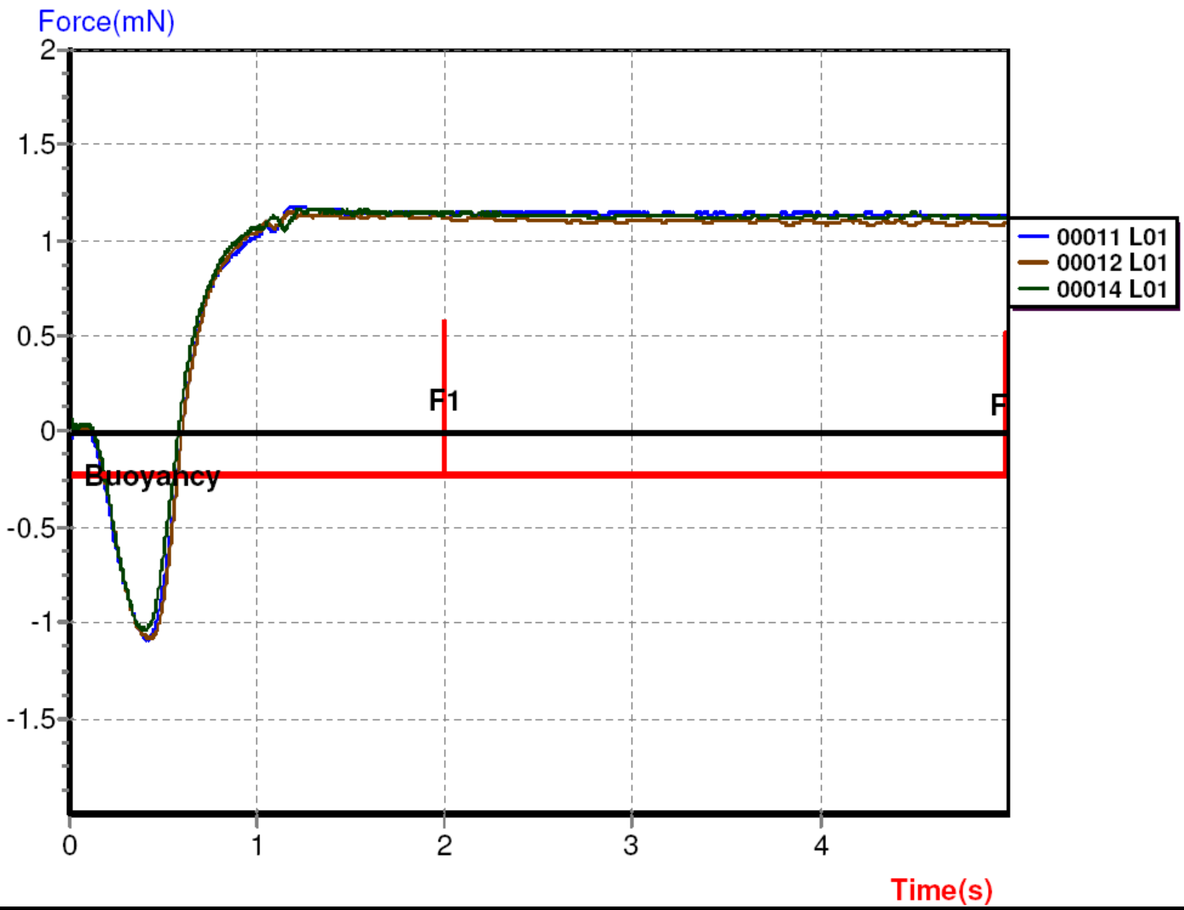
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00011 L01	0.573	0.600	0.765	1.377	1.364	1.181	1.230	Pass
SN100C Alloy	00012 L01	0.573	0.600	0.756	1.353	1.326	1.154	1.167	Pass
SN100C Alloy	00014 L01	0.552	0.579	0.750	1.377	1.346	1.167	1.299	Pass
	Standard Dev	0.012	0.012	0.008	0.014	0.019	0.014	0.066	
	Mean	0.566	0.593	0.757	1.369	1.345	1.167	1.232	
	Max	0.573	0.600	0.765	1.377	1.364	1.181	1.299	
	Min	0.552	0.579	0.750	1.353	1.326	1.154	1.167	

Number of Tests : 003 Passing rate : 100.0 %



RUN 2

Test Details

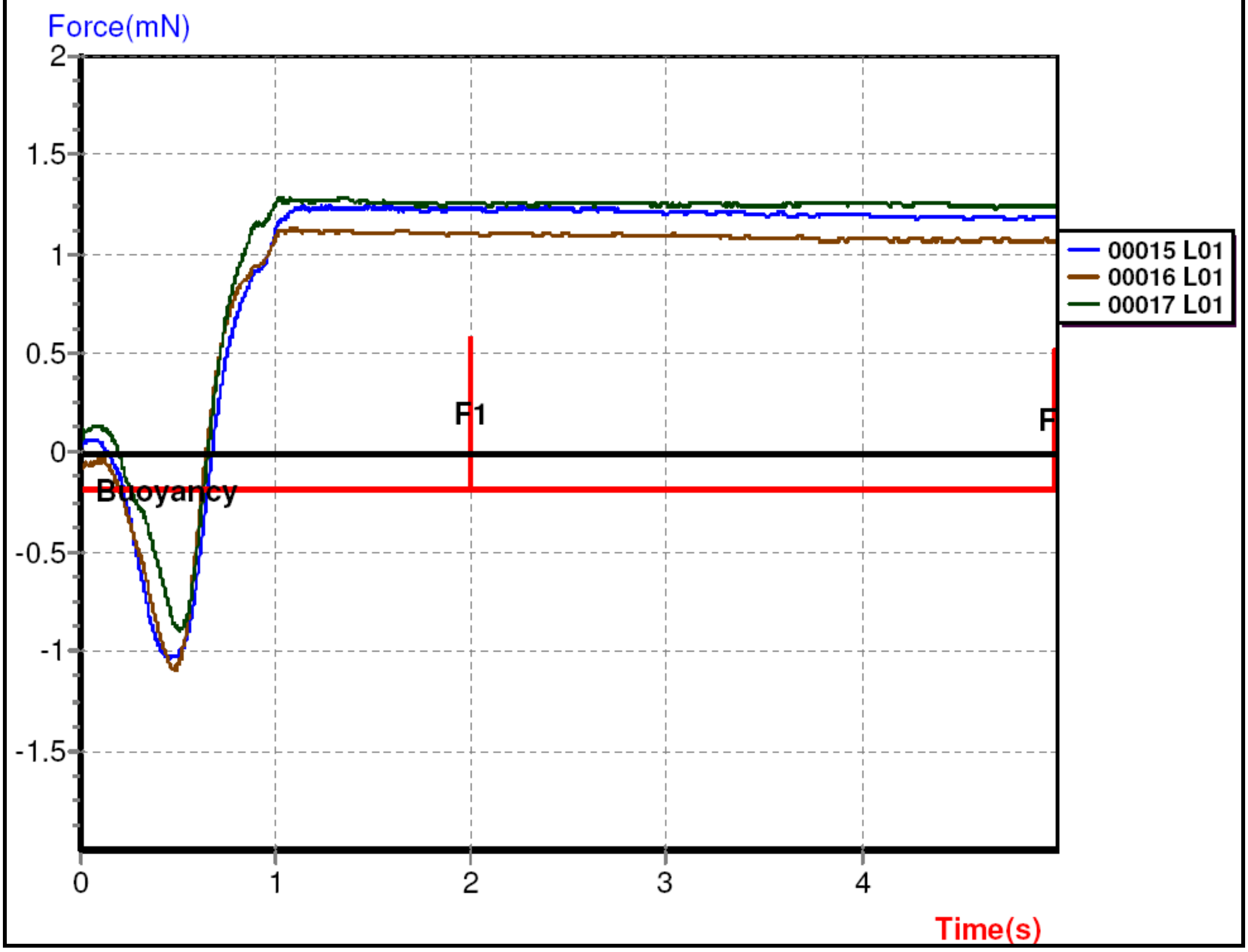
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00015 L01	0.651	0.672	0.855	1.414	1.380	1.243	1.479	Fail
SN100C Alloy	00016 L01	0.624	0.645	0.774	1.290	1.249	1.133	1.077	Fail
SN100C Alloy	00017 L01	0.633	0.651	0.780	1.445	1.435	1.291	1.347	Fail
	Standard Dev	0.014	0.014	0.045	0.082	0.096	0.081	0.205	
	Mean	0.636	0.656	0.803	1.383	1.354	1.222	1.301	
	Max	0.651	0.672	0.855	1.445	1.435	1.291	1.479	
	Min	0.624	0.645	0.774	1.290	1.249	1.133	1.077	

Number of Tests : 003 Passing rate : 0.0 %



RUN 3

Test Details

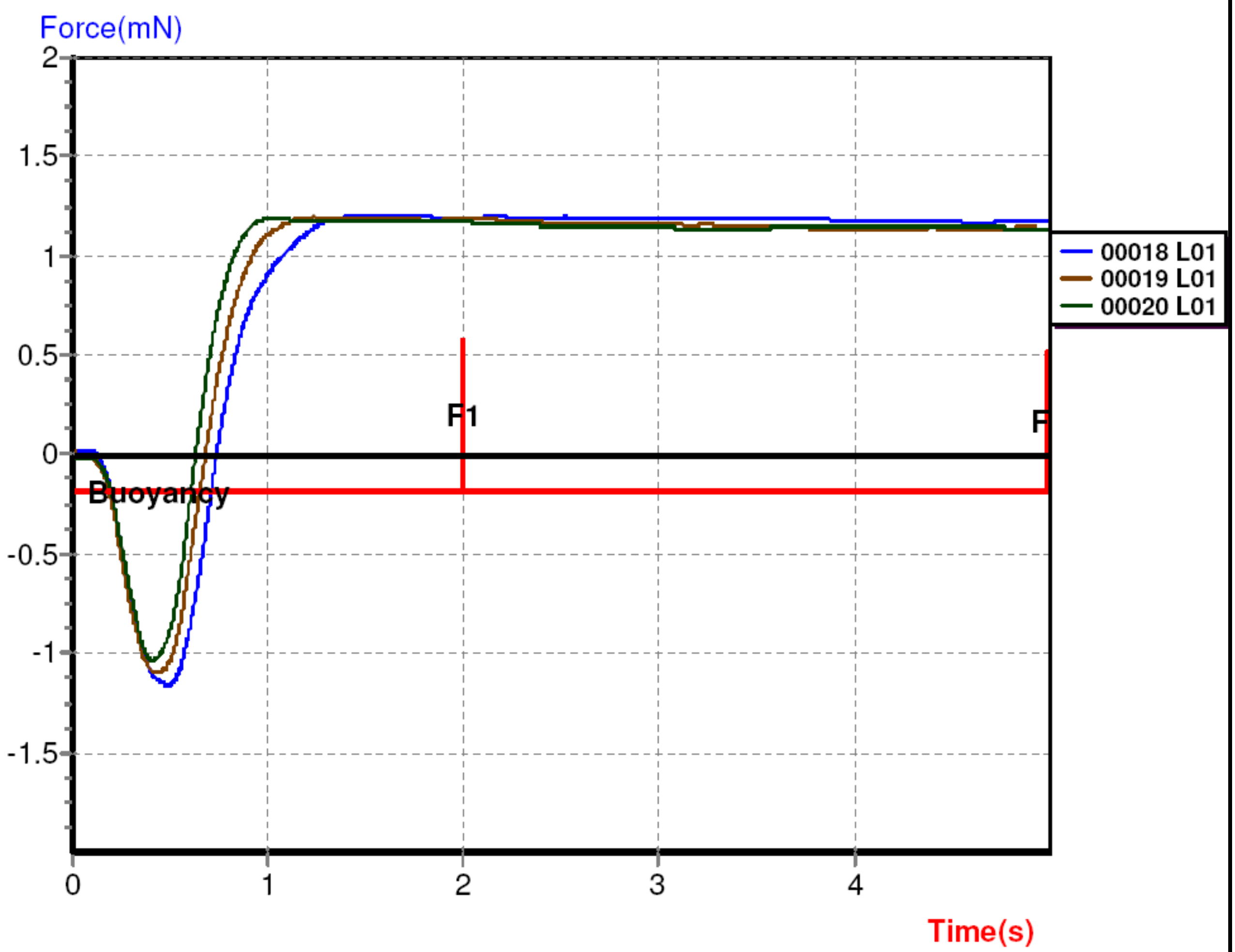
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00018 L01	0.711	0.738	0.933	1.380	1.366	1.205	1.467	Fail
SN100C Alloy	00019 L01	0.651	0.681	0.837	1.369	1.321	1.198	1.227	Fail
SN100C Alloy	00020 L01	0.606	0.630	0.759	1.355	1.321	1.191	1.011	Fail
	Standard Dev	0.053	0.054	0.087	0.012	0.026	0.007	0.228	
	Mean	0.656	0.683	0.843	1.368	1.336	1.198	1.235	
	Max	0.711	0.738	0.933	1.380	1.366	1.205	1.467	
	Min	0.606	0.630	0.759	1.355	1.321	1.191	1.011	

Number of Tests : 003 Passing rate : 0.0 %



RUN 4

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

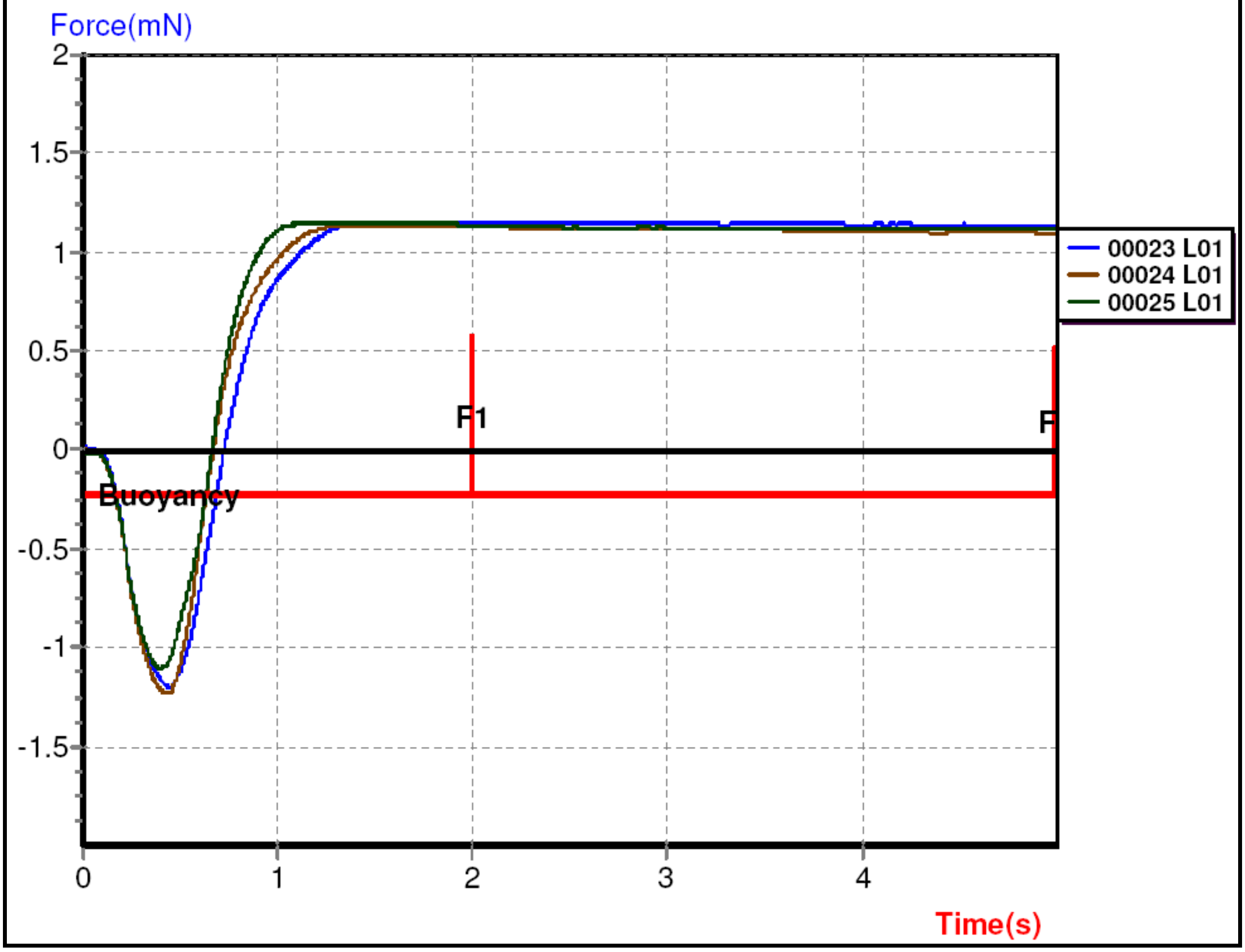
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00023 L01	0.684	0.726	0.936	1.381	1.367	1.154	1.434	Fail
SN100C Alloy	00024 L01	0.633	0.666	0.861	1.364	1.329	1.140	1.416	Fail
SN100C Alloy	00025 L01	0.633	0.663	0.804	1.367	1.346	1.154	1.710	Fail
	Standard Dev	0.029	0.036	0.066	0.009	0.019	0.008	0.165	
	Mean	0.650	0.685	0.867	1.371	1.348	1.149	1.520	
	Max	0.684	0.726	0.936	1.381	1.367	1.154	1.710	
	Min	0.633	0.663	0.804	1.364	1.329	1.140	1.416	

Number of Tests : 003 Passing rate : 0.0 %



RUN 5

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

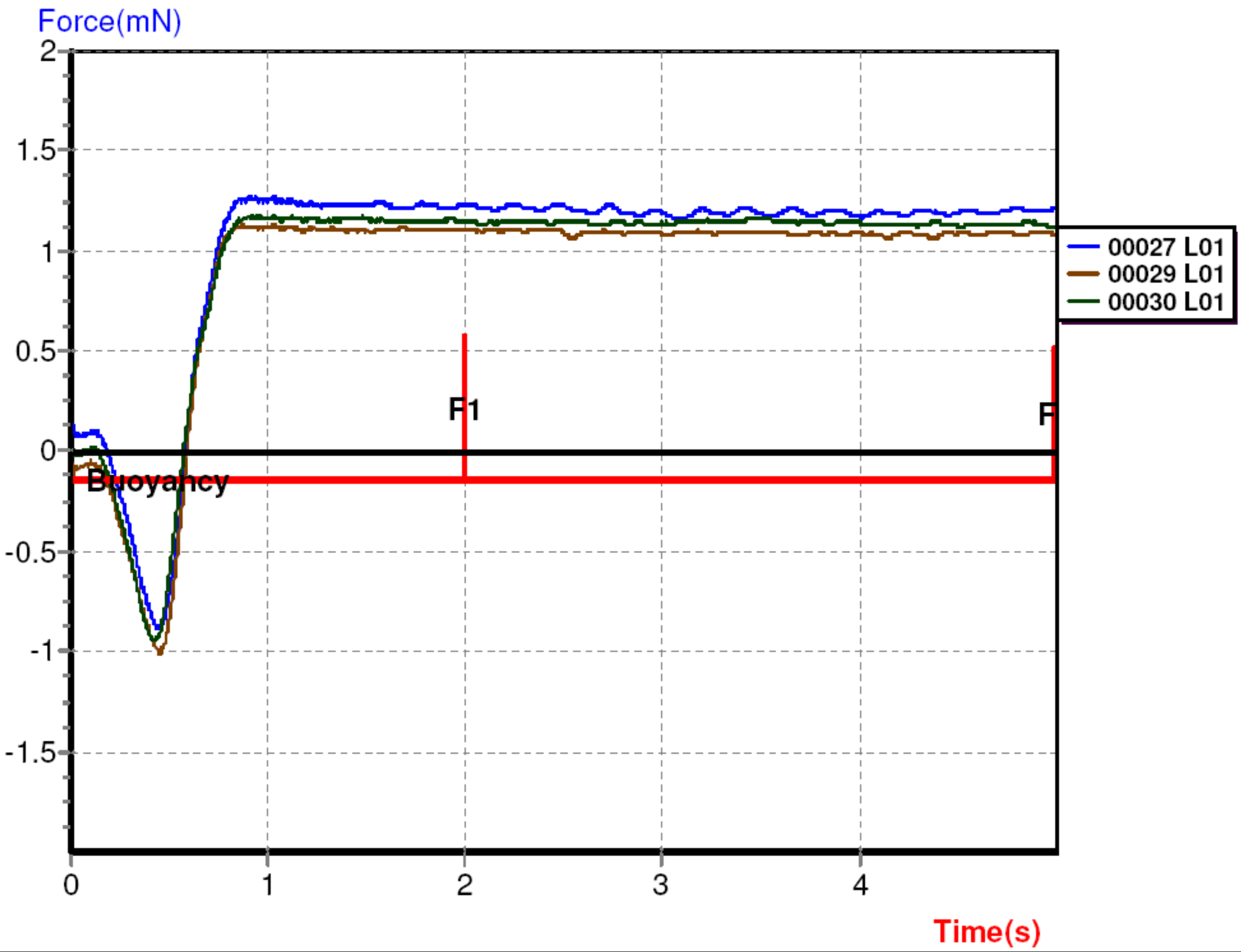
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00027 L01	0.567	0.579	0.708	1.371	1.354	1.271	0.897	Pass
SN100C Alloy	00029 L01	0.573	0.588	0.702	1.247	1.220	1.129	0.867	Pass
SN100C Alloy	00030 L01	0.555	0.570	0.714	1.289	1.264	1.174	0.897	Pass
	Standard Dev	0.009	0.009	0.006	0.063	0.068	0.072	0.017	
	Mean	0.565	0.579	0.708	1.302	1.279	1.191	0.887	
	Max	0.573	0.588	0.714	1.371	1.354	1.271	0.897	
	Min	0.555	0.570	0.702	1.247	1.220	1.129	0.867	

Number of Tests : 003 Passing rate : 100.0 %



RUN 6

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

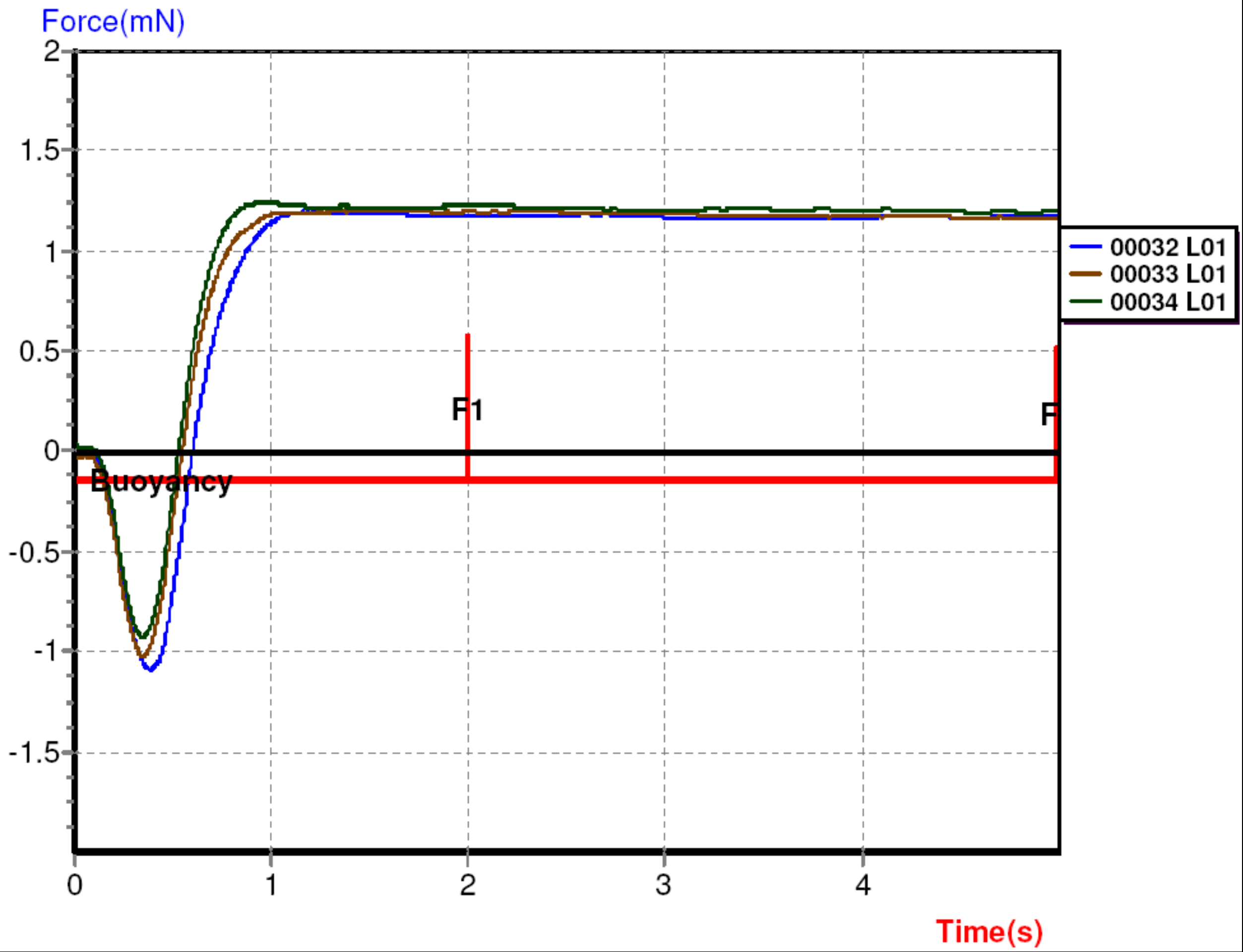
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00032 L01	0.579	0.600	0.777	1.316	1.316	1.198	1.161	Pass
SN100C Alloy	00033 L01	0.525	0.546	0.696	1.337	1.306	1.205	1.572	Pass
SN100C Alloy	00034 L01	0.510	0.528	0.663	1.368	1.337	1.243	0.915	Pass
	Standard Dev	0.036	0.037	0.059	0.026	0.016	0.024	0.332	
	Mean	0.538	0.558	0.712	1.340	1.320	1.215	1.216	
	Max	0.579	0.600	0.777	1.368	1.337	1.243	1.572	
	Min	0.510	0.528	0.663	1.316	1.306	1.198	0.915	

Number of Tests : 003 Passing rate : 100.0 %



RUN 7

Test Details

Component : SN100C Alloy

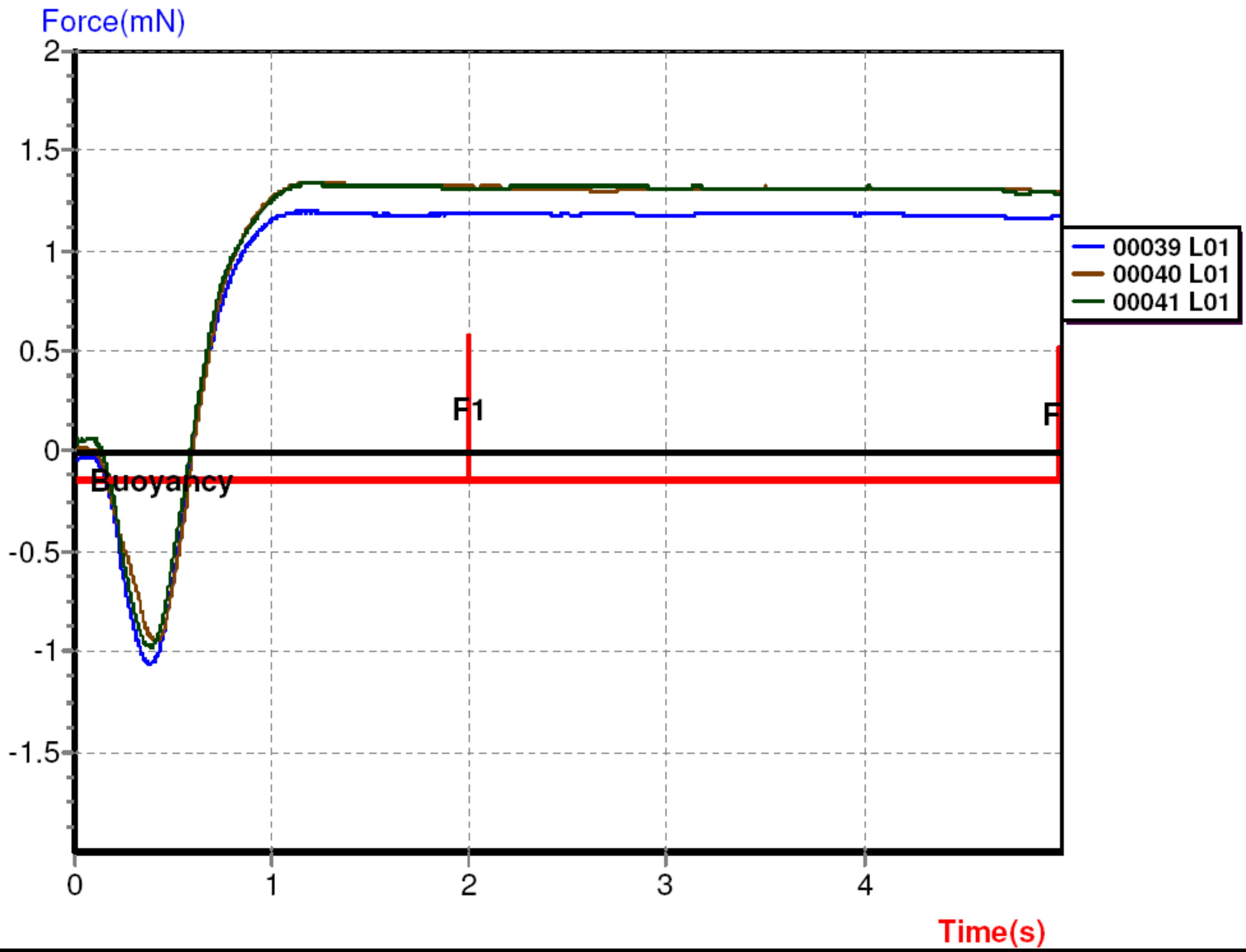
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00039 L01	0.573	0.594	0.765	1.323	1.313	1.198	1.116	Pass
SN100C Alloy	00040 L01	0.582	0.603	0.774	1.461	1.440	1.346	1.203	Pass
SN100C Alloy	00041 L01	0.564	0.585	0.762	1.454	1.426	1.339	1.179	Pass
	Standard Dev	0.009	0.009	0.006	0.078	0.070	0.084	0.045	
	Mean	0.573	0.594	0.767	1.413	1.393	1.295	1.166	
	Max	0.582	0.603	0.774	1.461	1.440	1.346	1.203	
	Min	0.564	0.585	0.762	1.323	1.313	1.198	1.116	

Number of Tests : 003   Passing rate : 100.0 %



RUN 8

Test Details

Component : SN100C Alloy

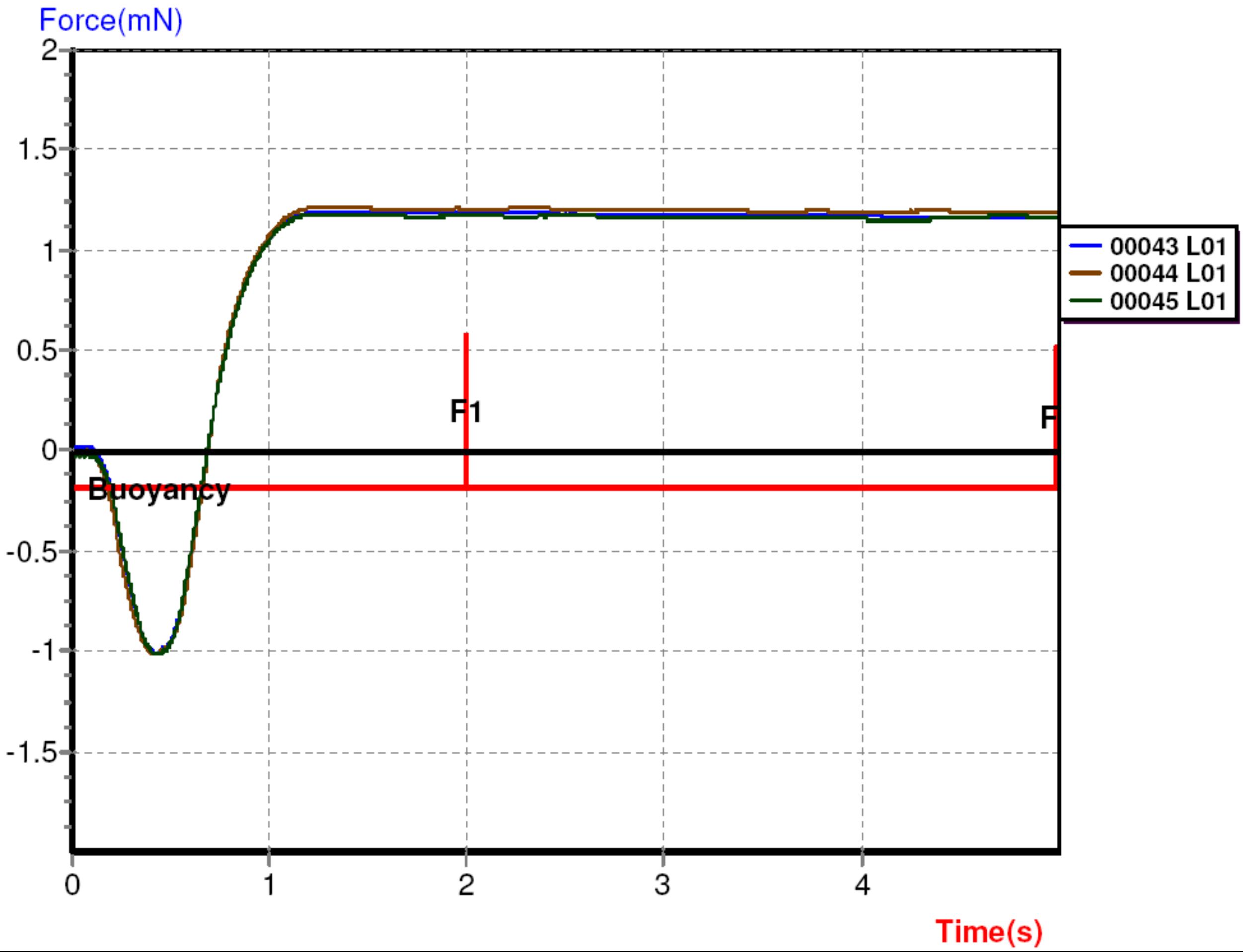
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00043 L01	0.660	0.687	0.858	1.376	1.345	1.195	2.157	Fail
SN100C Alloy	00044 L01	0.660	0.690	0.858	1.393	1.380	1.219	1.242	Fail
SN100C Alloy	00045 L01	0.654	0.684	0.858	1.359	1.352	1.178	1.188	Fail
	Standard Dev	0.003	0.003	0.000	0.017	0.018	0.021	0.545	
	Mean	0.658	0.687	0.858	1.376	1.359	1.197	1.529	
	Max	0.660	0.690	0.858	1.393	1.380	1.219	2.157	
	Min	0.654	0.684	0.858	1.359	1.345	1.178	1.188	

Number of Tests : 003   Passing rate : 0.0 %



RUN 9

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

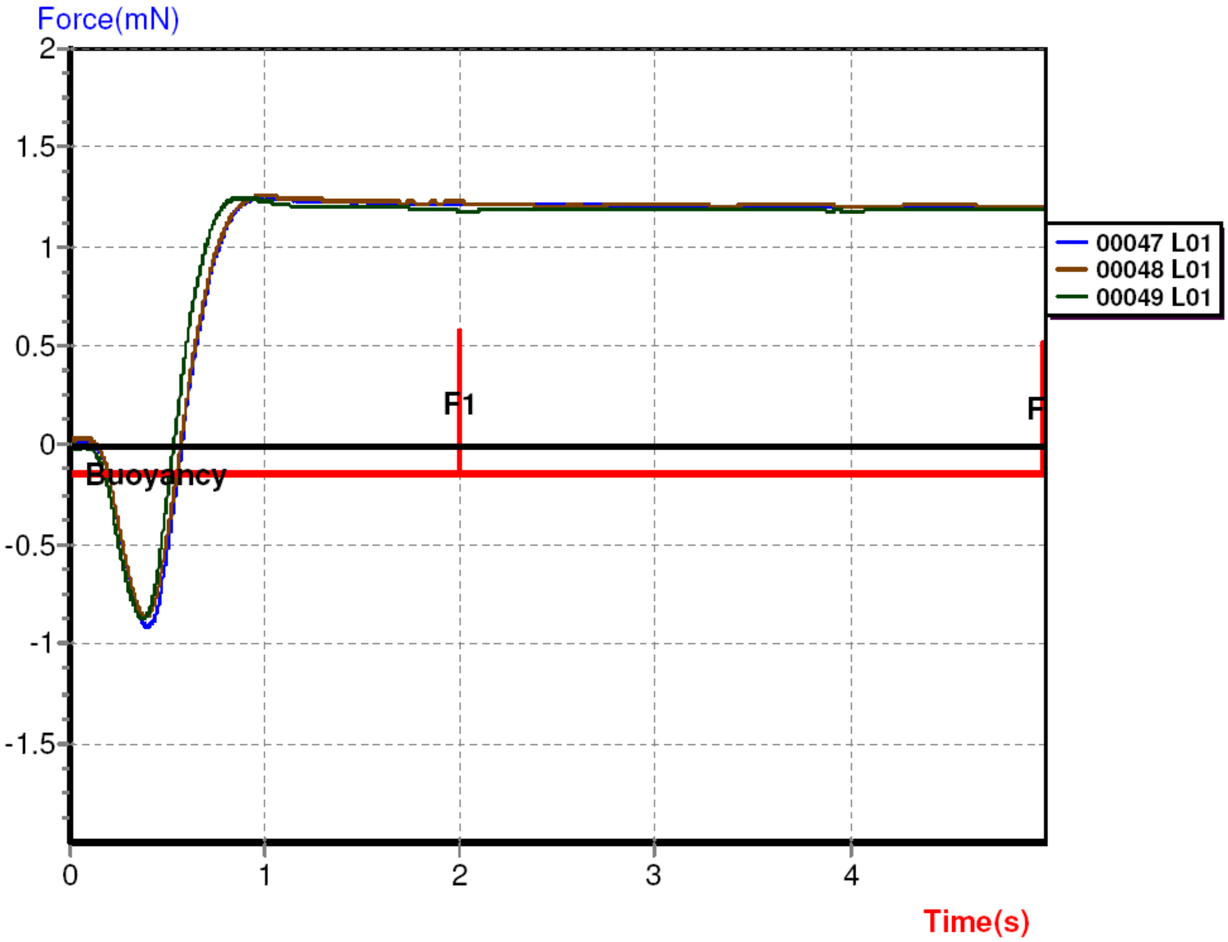
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00047 L01	0.552	0.570	0.714	1.354	1.340	1.253	0.975	Pass
SN100C Alloy	00048 L01	0.546	0.567	0.708	1.364	1.337	1.257	0.990	Pass
SN100C Alloy	00049 L01	0.513	0.531	0.654	1.320	1.323	1.250	0.867	Pass
	Standard Dev	0.021	0.022	0.033	0.023	0.009	0.003	0.067	
	Mean	0.537	0.556	0.692	1.346	1.333	1.253	0.944	
	Max	0.552	0.570	0.714	1.364	1.340	1.257	0.990	
	Min	0.513	0.531	0.654	1.320	1.323	1.250	0.867	

Number of Tests : 003 Passing rate : 100.0 %



RUN 10

Test Details

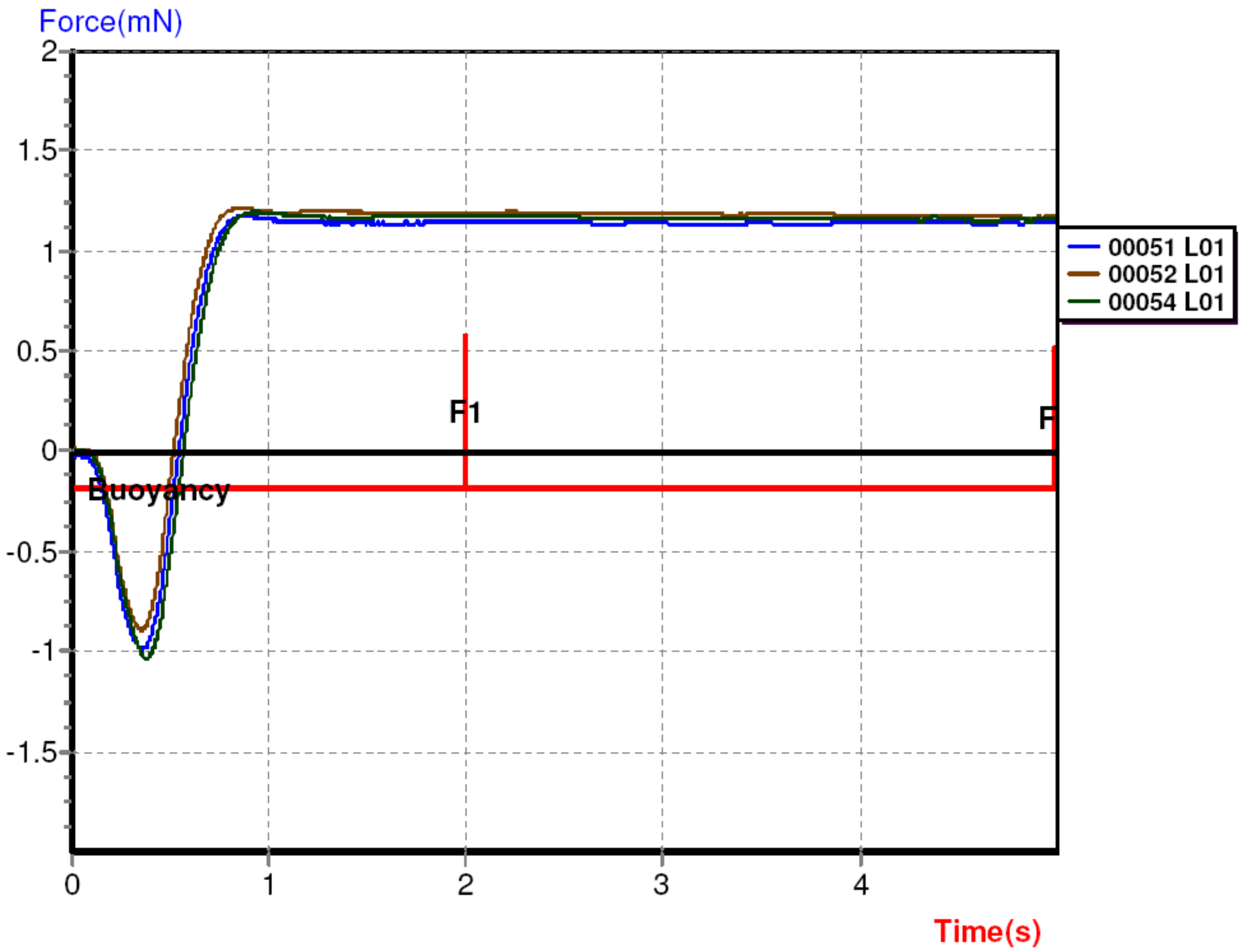
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00051 L01	0.519	0.540	0.657	1.335	1.331	1.174	0.846	Pass
SN100C Alloy	00052 L01	0.495	0.516	0.633	1.373	1.355	1.219	0.843	Pass
SN100C Alloy	00054 L01	0.543	0.567	0.684	1.355	1.345	1.198	0.918	Pass
	Standard Dev	0.024	0.026	0.026	0.019	0.012	0.022	0.042	
	Mean	0.519	0.541	0.658	1.354	1.344	1.197	0.869	
	Max	0.543	0.567	0.684	1.373	1.355	1.219	0.918	
	Min	0.495	0.516	0.633	1.335	1.331	1.174	0.843	

Number of Tests : 003 Passing rate : 100.0 %



RUN 11

Test Details

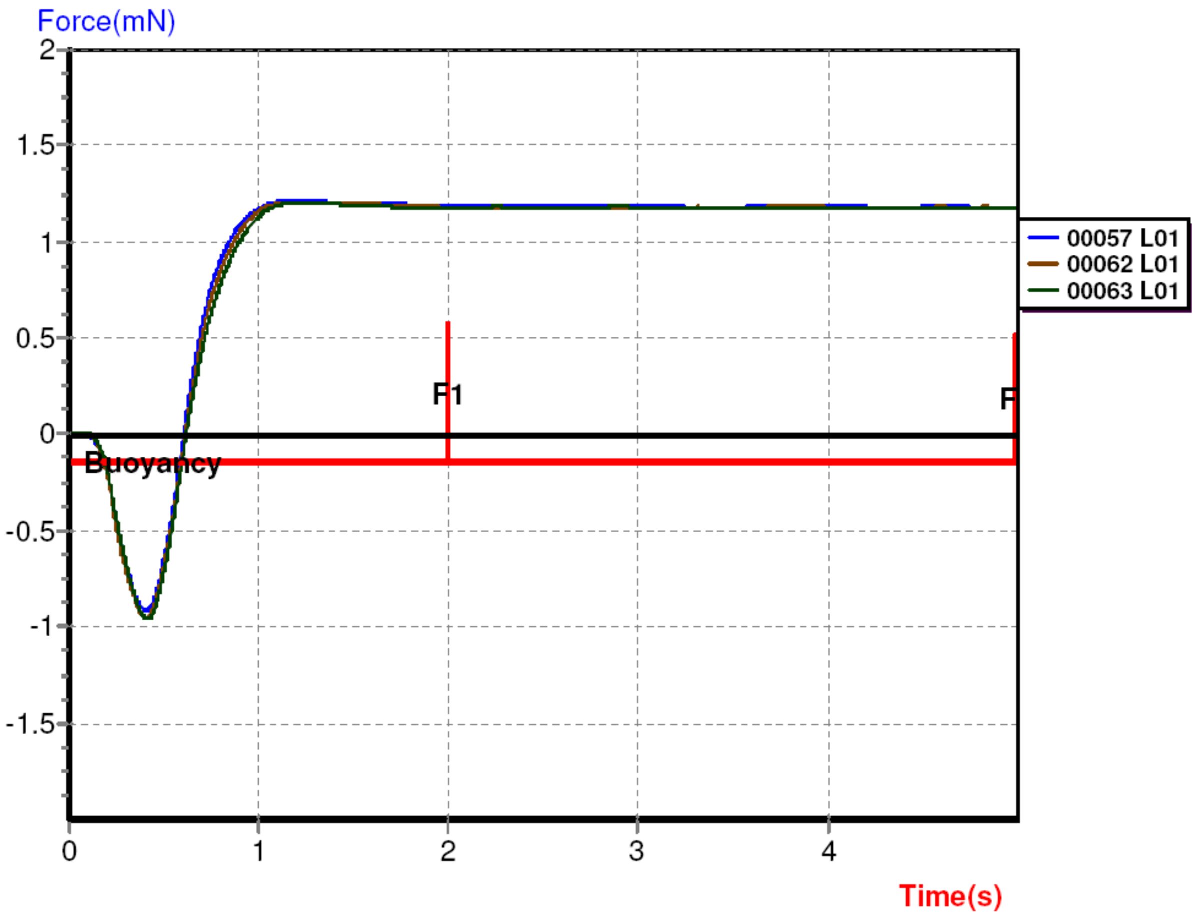
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00057 L01	0.585	0.603	0.762	1.330	1.316	1.219	1.131	Pass
SN100C Alloy	00062 L01	0.594	0.615	0.780	1.320	1.320	1.209	1.146	Pass
SN100C Alloy	00063 L01	0.597	0.618	0.804	1.313	1.309	1.205	1.179	Pass
	Standard Dev	0.006	0.008	0.021	0.009	0.005	0.007	0.025	
	Mean	0.592	0.612	0.782	1.321	1.315	1.211	1.152	
	Max	0.597	0.618	0.804	1.330	1.320	1.219	1.179	
	Min	0.585	0.603	0.762	1.313	1.309	1.205	1.131	

Number of Tests : 003 Passing rate : 100.0 %



RUN 12

Test Details

Component : SN100C Alloy

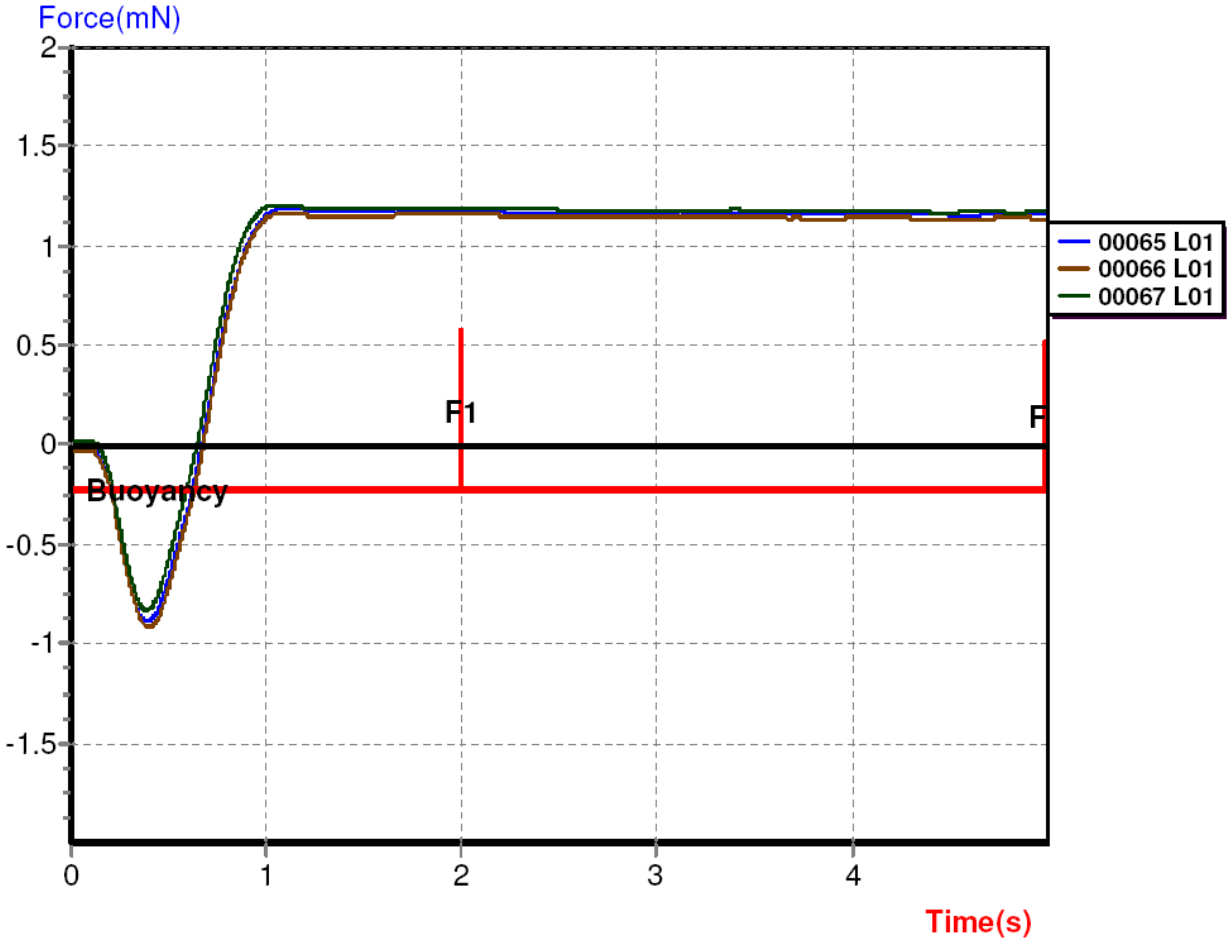
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00065 L01	0.621	0.669	0.831	1.405	1.398	1.191	1.074	Fail
SN100C Alloy	00066 L01	0.630	0.678	0.831	1.388	1.367	1.167	1.062	Fail
SN100C Alloy	00067 L01	0.588	0.645	0.804	1.422	1.402	1.209	1.062	Pass
	Standard Dev	0.022	0.017	0.016	0.017	0.019	0.021	0.007	
	Mean	0.613	0.664	0.822	1.405	1.389	1.189	1.066	
	Max	0.630	0.678	0.831	1.422	1.402	1.209	1.074	
	Min	0.588	0.645	0.804	1.388	1.367	1.167	1.062	

Number of Tests : 003   Passing rate : 33.3 %



RUN 13

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

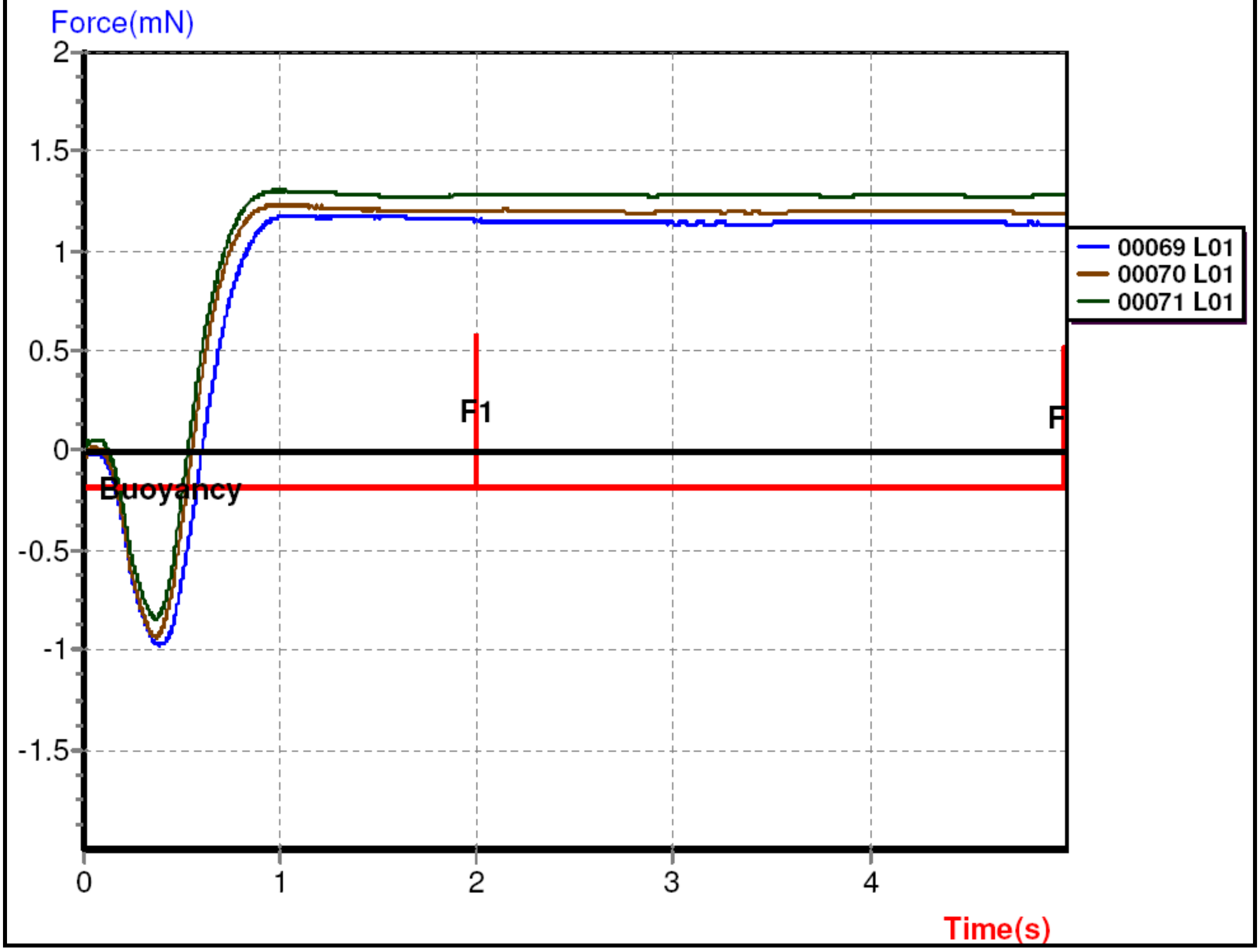
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00069 L01	0.573	0.603	0.747	1.342	1.324	1.178	1.020	Pass
SN100C Alloy	00070 L01	0.525	0.549	0.687	1.390	1.380	1.236	0.978	Pass
SN100C Alloy	00071 L01	0.504	0.528	0.675	1.466	1.469	1.308	0.957	Pass
	Standard Dev	0.035	0.039	0.039	0.062	0.073	0.066	0.032	
	Mean	0.534	0.560	0.703	1.399	1.391	1.241	0.985	
	Max	0.573	0.603	0.747	1.466	1.469	1.308	1.020	
	Min	0.504	0.528	0.675	1.342	1.324	1.178	0.957	

Number of Tests : 003 Passing rate : 100.0 %



RUN 14

Test Details

Component : SN100C Alloy

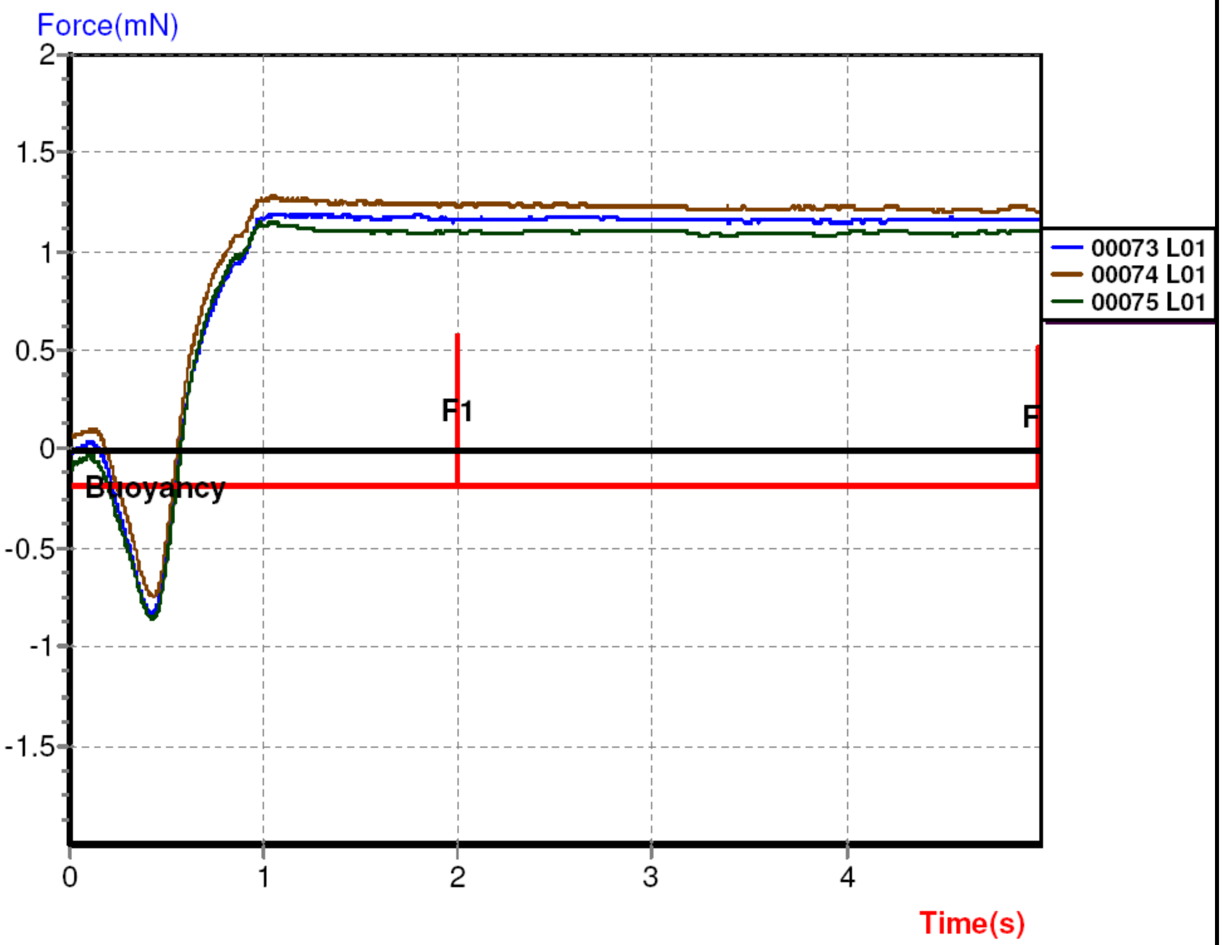
Test parameter filename : Bath Parameters.vts | Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00073 L01	0.540	0.564	0.768	1.345	1.349	1.195	1.053	Pass
SN100C Alloy	00074 L01	0.534	0.555	0.729	1.417	1.386	1.281	1.032	Pass
SN100C Alloy	00075 L01	0.549	0.570	0.738	1.287	1.287	1.150	1.029	Pass
	Standard Dev	0.008	0.008	0.020	0.066	0.050	0.067	0.013	
	Mean	0.541	0.563	0.745	1.350	1.340	1.209	1.038	
	Max	0.549	0.570	0.768	1.417	1.386	1.281	1.053	
	Min	0.534	0.555	0.729	1.287	1.287	1.150	1.029	

Number of Tests : 003 Passing rate : 100.0 %



RUN 15

Test Details

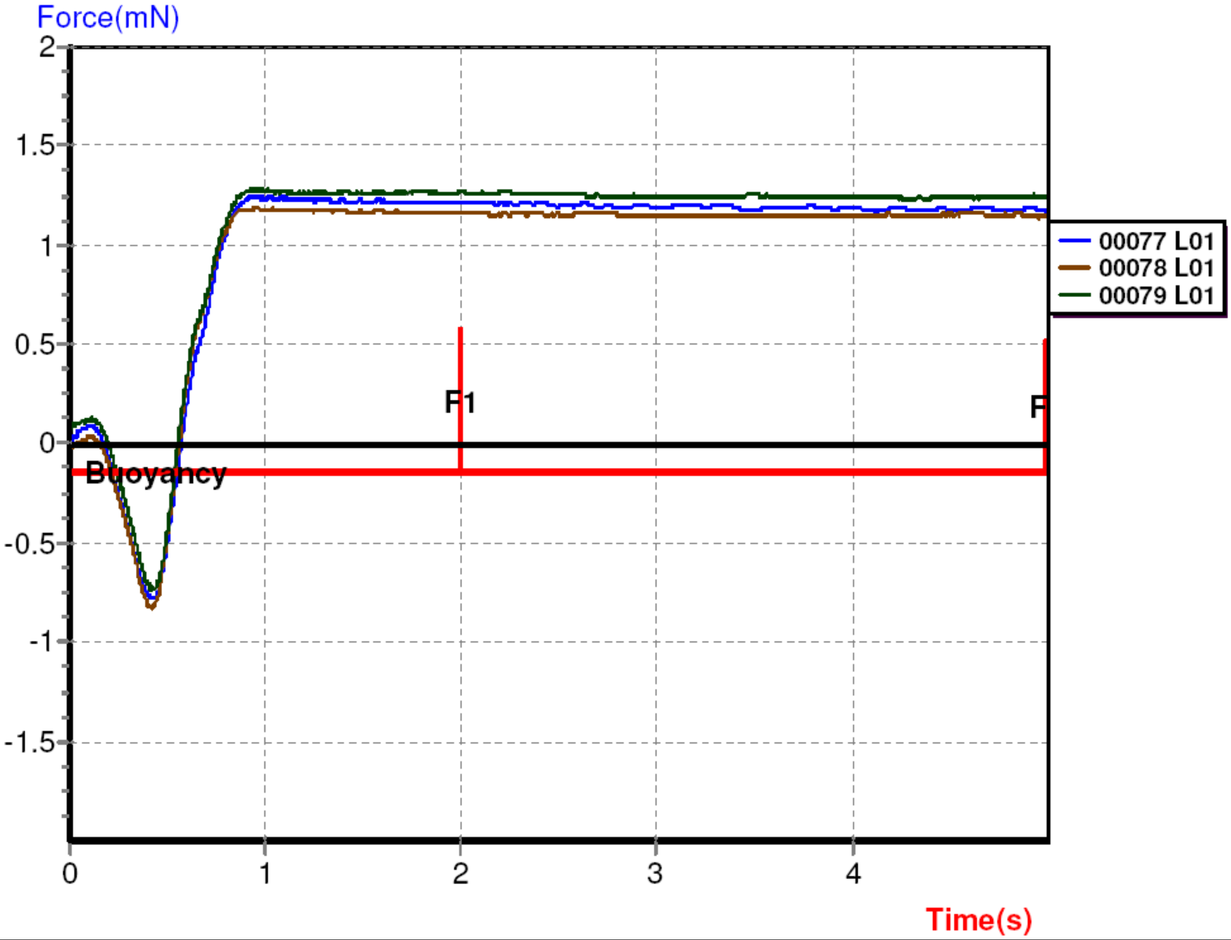
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00077 L01	0.549	0.567	0.735	1.354	1.306	1.246	0.942	Pass
SN100C Alloy	00078 L01	0.540	0.558	0.711	1.302	1.282	1.188	0.939	Pass
SN100C Alloy	00079 L01	0.534	0.552	0.723	1.406	1.385	1.284	0.942	Pass
	Standard Dev	0.008	0.008	0.012	0.052	0.054	0.049	0.002	
	Mean	0.541	0.559	0.723	1.354	1.324	1.240	0.941	
	Max	0.549	0.567	0.735	1.406	1.385	1.284	0.942	
	Min	0.534	0.552	0.711	1.302	1.282	1.188	0.939	

Number of Tests : 003 Passing rate : 100.0 %



RUN 16

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

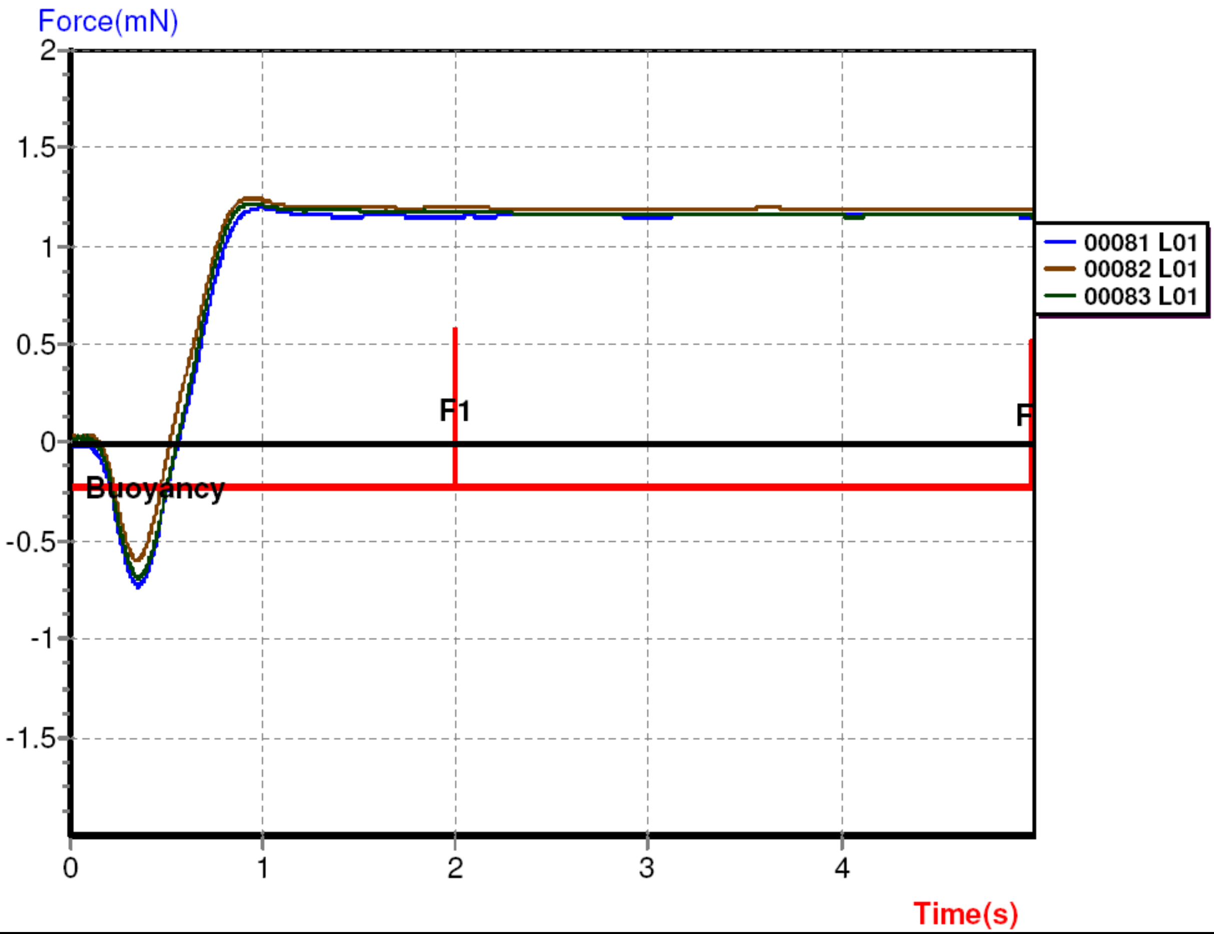
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00081 L01	0.504	0.558	0.741	1.384	1.384	1.198	0.975	Pass
SN100C Alloy	00082 L01	0.468	0.519	0.714	1.429	1.419	1.243	0.915	Pass
SN100C Alloy	00083 L01	0.501	0.552	0.726	1.408	1.384	1.222	0.951	Pass
	Standard Dev	0.020	0.021	0.014	0.022	0.020	0.022	0.030	
	Mean	0.491	0.543	0.727	1.407	1.396	1.221	0.947	
	Max	0.504	0.558	0.741	1.429	1.419	1.243	0.975	
	Min	0.468	0.519	0.714	1.384	1.384	1.198	0.915	

Number of Tests : 003 Passing rate : 100.0 %



RUN 17

Test Details

Component : SN100C Alloy

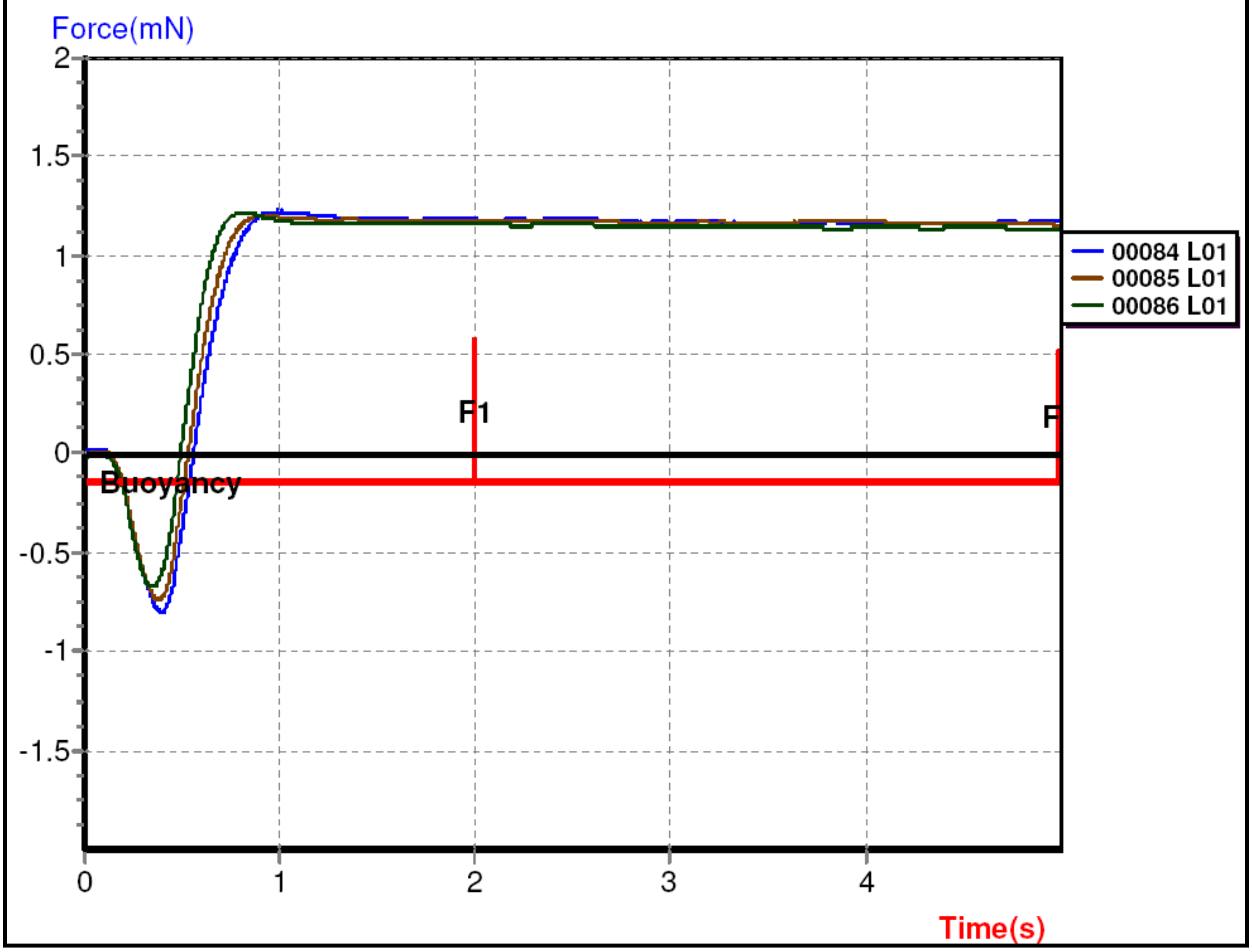
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00084 L01	0.537	0.555	0.705	1.323	1.309	1.226	0.987	Pass
SN100C Alloy	00085 L01	0.510	0.531	0.660	1.313	1.292	1.202	0.882	Pass
SN100C Alloy	00086 L01	0.474	0.492	0.609	1.299	1.275	1.219	0.792	Pass
	Standard Dev	0.032	0.032	0.048	0.012	0.017	0.012	0.098	
	Mean	0.507	0.526	0.658	1.312	1.292	1.215	0.887	
	Max	0.537	0.555	0.705	1.323	1.309	1.226	0.987	
	Min	0.474	0.492	0.609	1.299	1.275	1.202	0.792	

Number of Tests : 003   Passing rate : 100.0 %



RUN 18

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

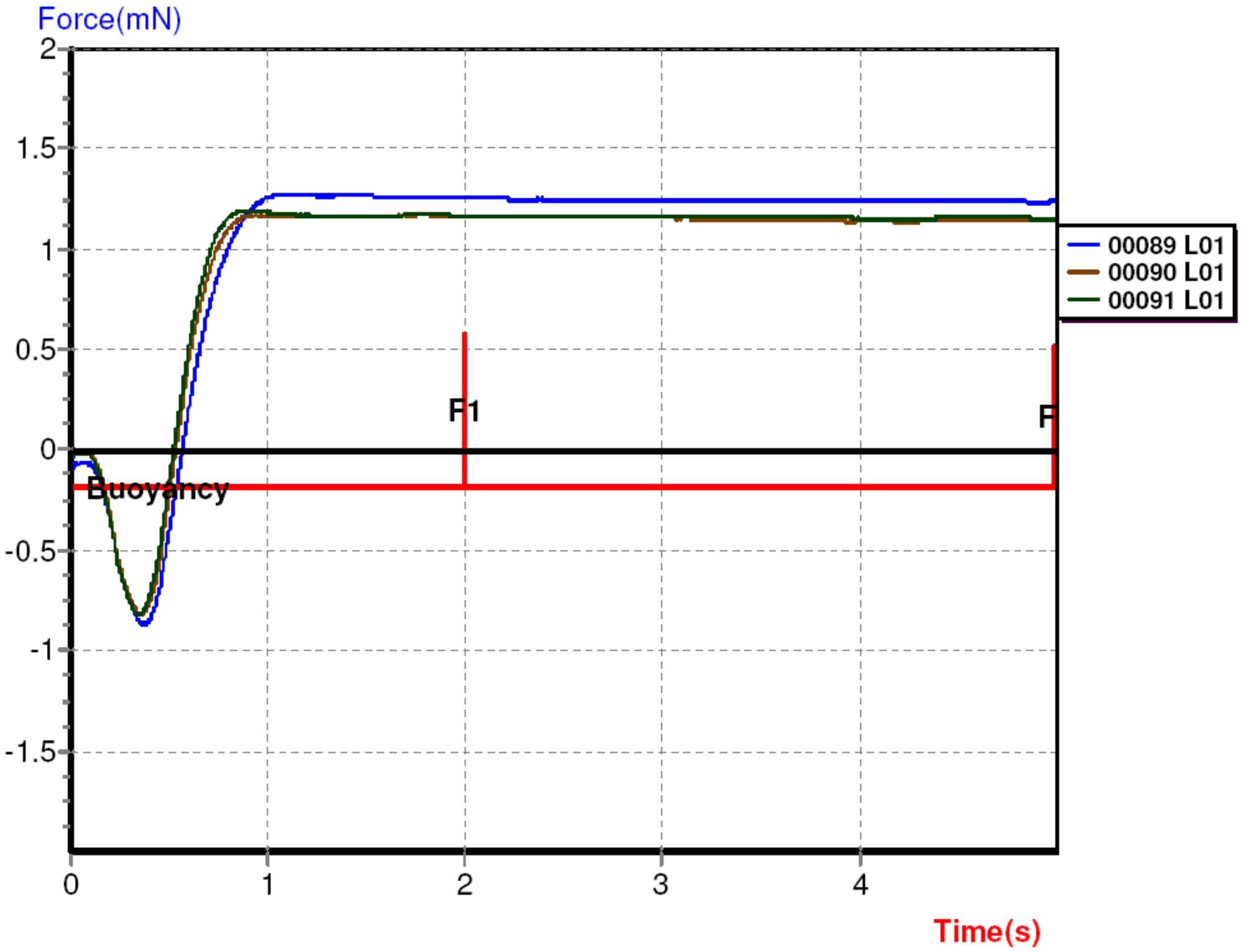
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00089 L01	0.534	0.564	0.738	1.445	1.424	1.274	1.050	Pass
SN100C Alloy	00090 L01	0.504	0.531	0.666	1.352	1.331	1.171	0.912	Pass
SN100C Alloy	00091 L01	0.495	0.522	0.654	1.352	1.335	1.195	0.891	Pass
	Standard Dev	0.020	0.022	0.045	0.054	0.053	0.054	0.086	
	Mean	0.511	0.539	0.686	1.383	1.363	1.213	0.951	
	Max	0.534	0.564	0.738	1.445	1.424	1.274	1.050	
	Min	0.495	0.522	0.654	1.352	1.331	1.171	0.891	

Number of Tests : 003 Passing rate : 100.0 %



RUN 19

Test Details

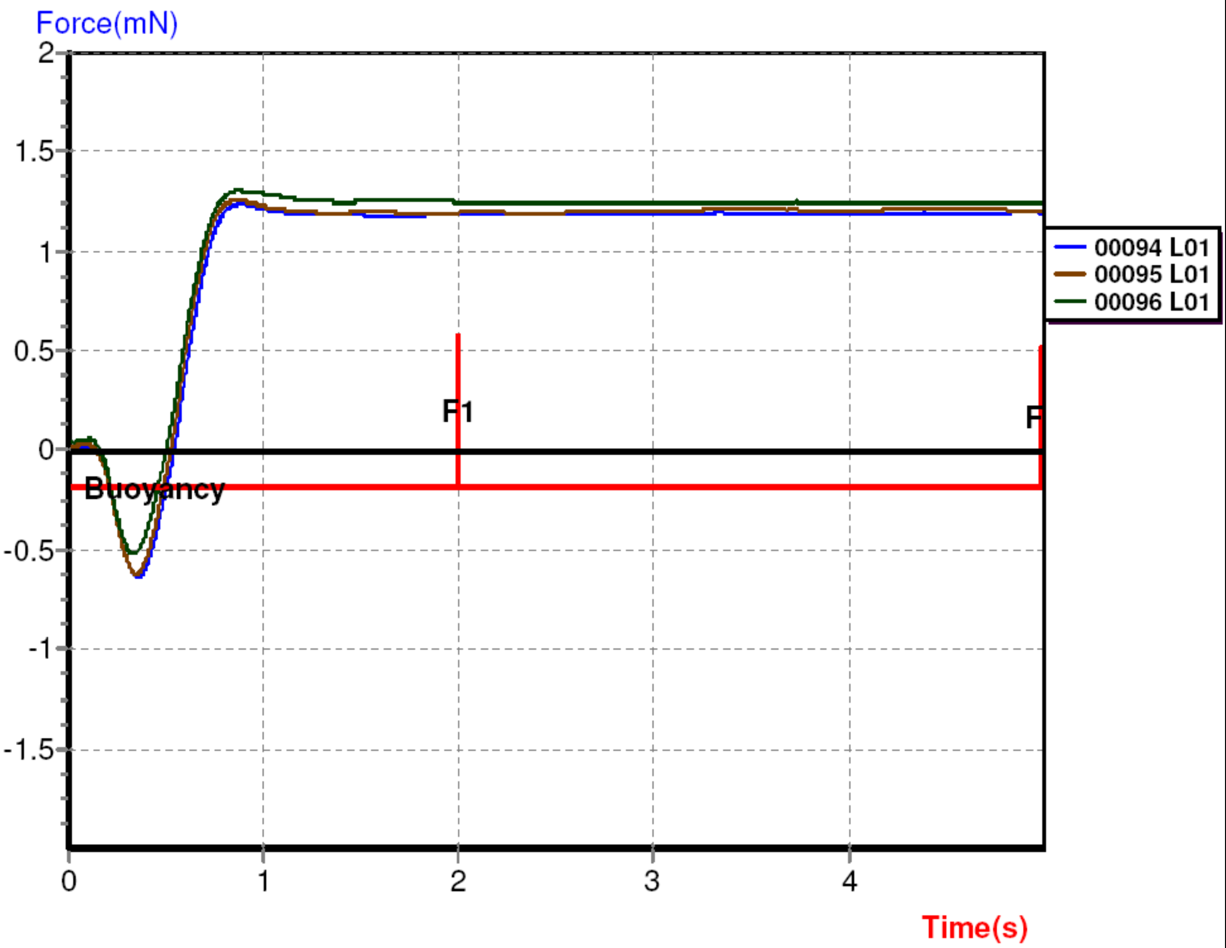
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00094 L01	0.504	0.537	0.675	1.376	1.380	1.243	0.894	Pass
SN100C Alloy	00095 L01	0.486	0.522	0.657	1.380	1.390	1.260	0.843	Pass
SN100C Alloy	00096 L01	0.456	0.501	0.651	1.435	1.435	1.308	0.852	Pass
	Standard Dev	0.024	0.018	0.012	0.033	0.029	0.034	0.027	
	Mean	0.482	0.520	0.661	1.397	1.401	1.271	0.863	
	Max	0.504	0.537	0.675	1.435	1.435	1.308	0.894	
	Min	0.456	0.501	0.651	1.376	1.380	1.243	0.843	

Number of Tests : 003 Passing rate : 100.0 %



RUN 20

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

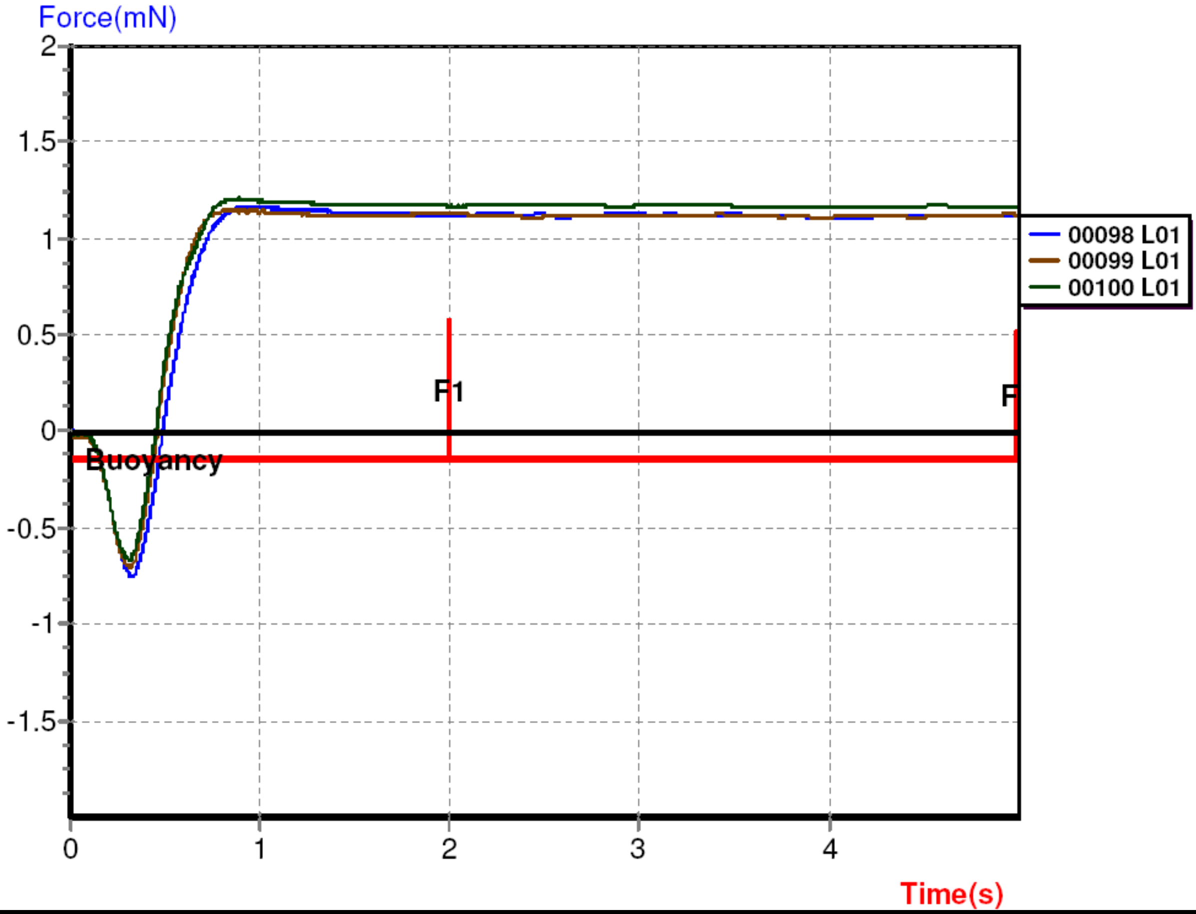
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00098 L01	0.465	0.486	0.636	1.261	1.261	1.164	0.912	Pass
SN100C Alloy	00099 L01	0.435	0.456	0.585	1.271	1.264	1.150	0.825	Pass
SN100C Alloy	00100 L01	0.429	0.447	0.594	1.306	1.302	1.212	0.891	Pass
	Standard Dev	0.019	0.020	0.027	0.023	0.023	0.033	0.045	
	Mean	0.443	0.463	0.605	1.279	1.276	1.175	0.876	
	Max	0.465	0.486	0.636	1.306	1.302	1.212	0.912	
	Min	0.429	0.447	0.585	1.261	1.261	1.150	0.825	

Number of Tests : 003 Passing rate : 100.0 %



RUN 21

Test Details

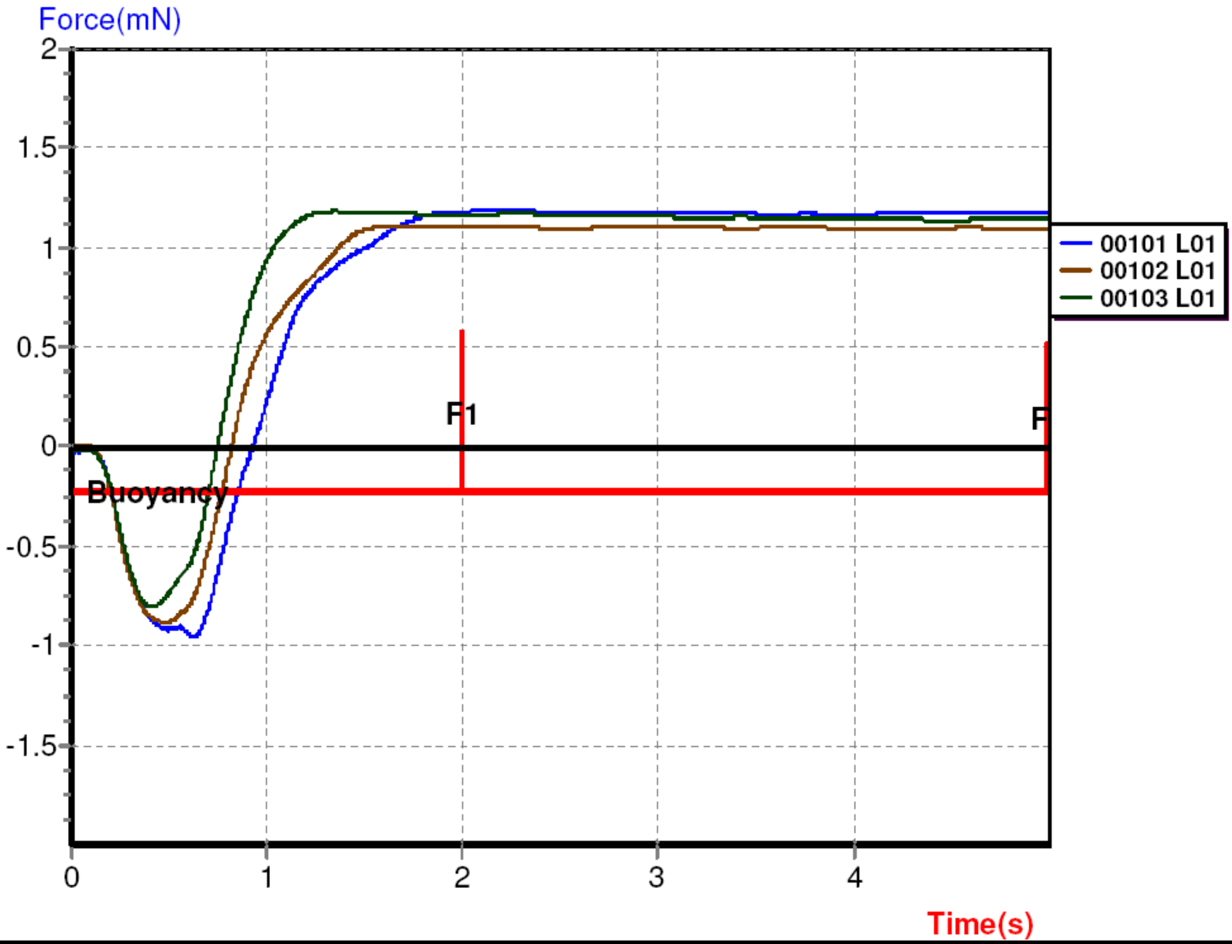
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00101 L01	0.849	0.927	1.221	1.412	1.402	1.188	2.208	Fail
SN100C Alloy	00102 L01	0.768	0.819	1.119	1.336	1.322	1.112	1.806	Fail
SN100C Alloy	00103 L01	0.702	0.747	0.933	1.391	1.377	1.185	1.335	Fail
	Standard Dev	0.074	0.091	0.146	0.039	0.041	0.043	0.437	
	Mean	0.773	0.831	1.091	1.380	1.367	1.162	1.783	
	Max	0.849	0.927	1.221	1.412	1.402	1.188	2.208	
	Min	0.702	0.747	0.933	1.336	1.322	1.112	1.335	

Number of Tests : 003   Passing rate : 0.0 %



RUN 22

Test Details

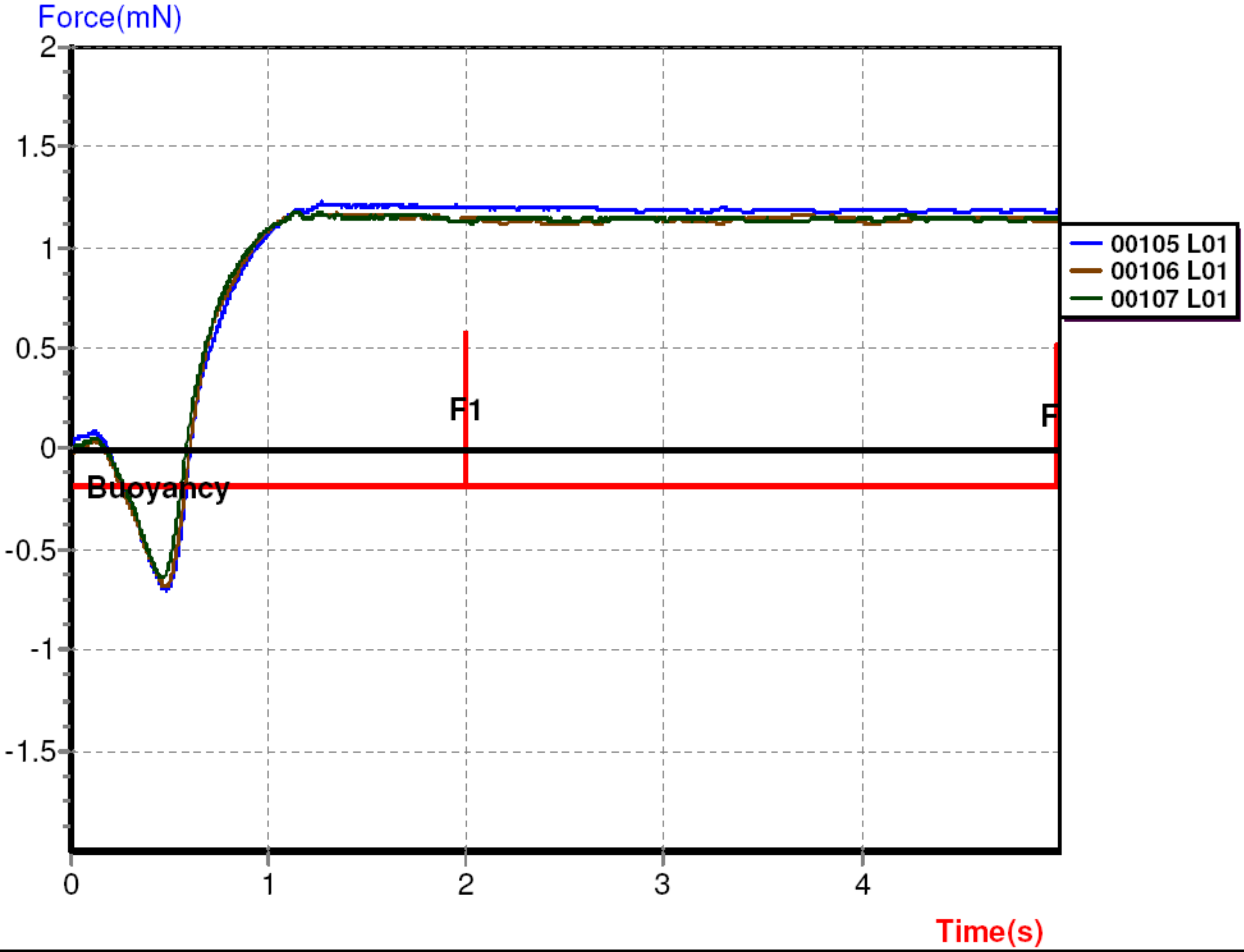
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 4.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00105 L01	0.585	0.606	0.828	1.386	1.369	1.226	1.266	Pass
SN100C Alloy	00106 L01	0.576	0.600	0.792	1.331	1.324	1.178	1.131	Pass
SN100C Alloy	00107 L01	0.558	0.582	0.771	1.321	1.335	1.178	1.134	Pass
	Standard Dev	0.014	0.012	0.029	0.035	0.023	0.028	0.077	
	Mean	0.573	0.596	0.797	1.346	1.343	1.194	1.177	
	Max	0.585	0.606	0.828	1.386	1.369	1.226	1.266	
	Min	0.558	0.582	0.771	1.321	1.324	1.178	1.131	

Number of Tests : 003 Passing rate : 100.0 %



RUN 23

Test Details

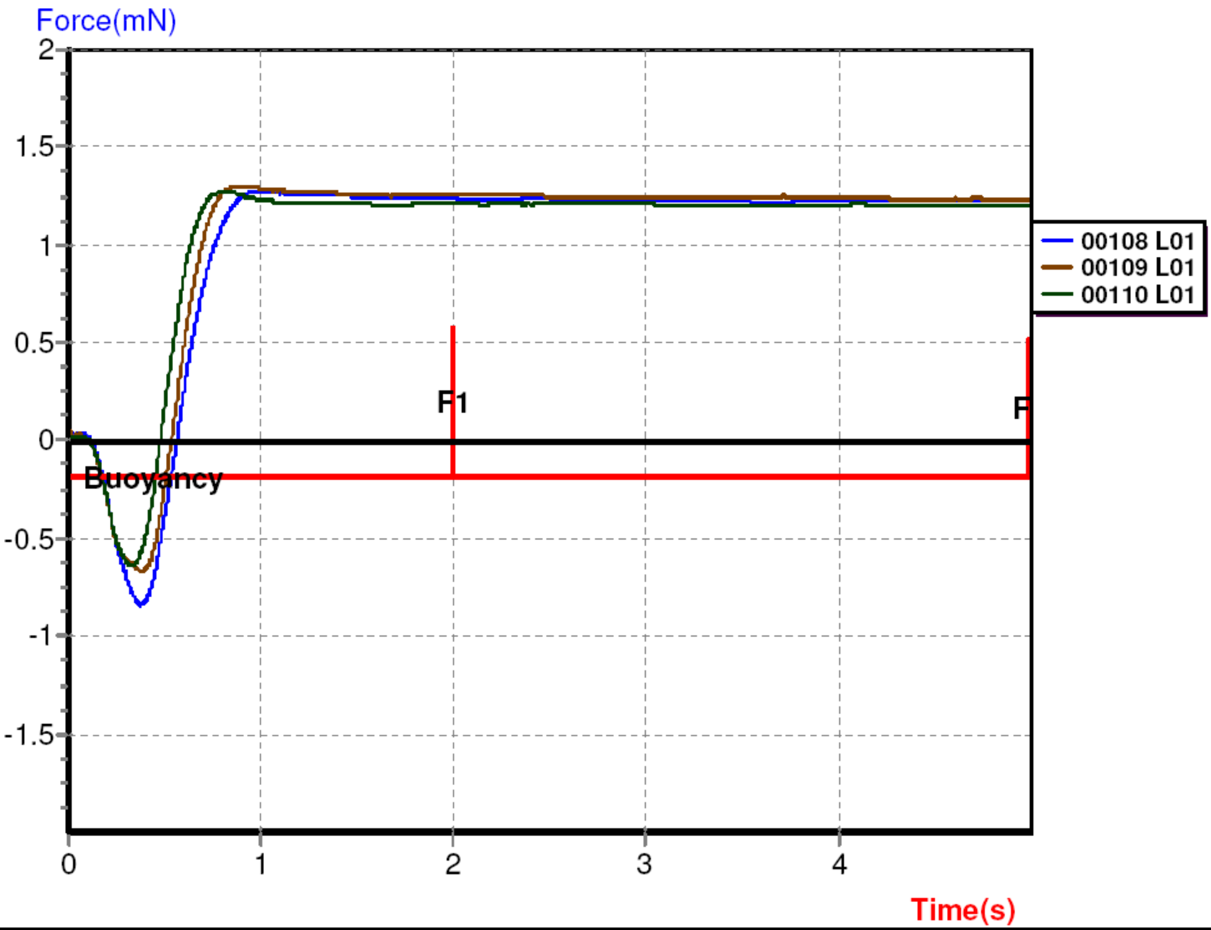
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00108 L01	0.534	0.561	0.714	1.424	1.414	1.277	0.996	Pass
SN100C Alloy	00109 L01	0.507	0.534	0.660	1.445	1.417	1.305	0.882	Pass
SN100C Alloy	00110 L01	0.453	0.477	0.597	1.397	1.390	1.274	0.792	Pass
	Standard Dev	0.041	0.043	0.059	0.024	0.015	0.017	0.102	
	Mean	0.498	0.524	0.657	1.422	1.407	1.286	0.890	
	Max	0.534	0.561	0.714	1.445	1.417	1.305	0.996	
	Min	0.453	0.477	0.597	1.397	1.390	1.274	0.792	

Number of Tests : 003 Passing rate : 100.0 %



RUN 24

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

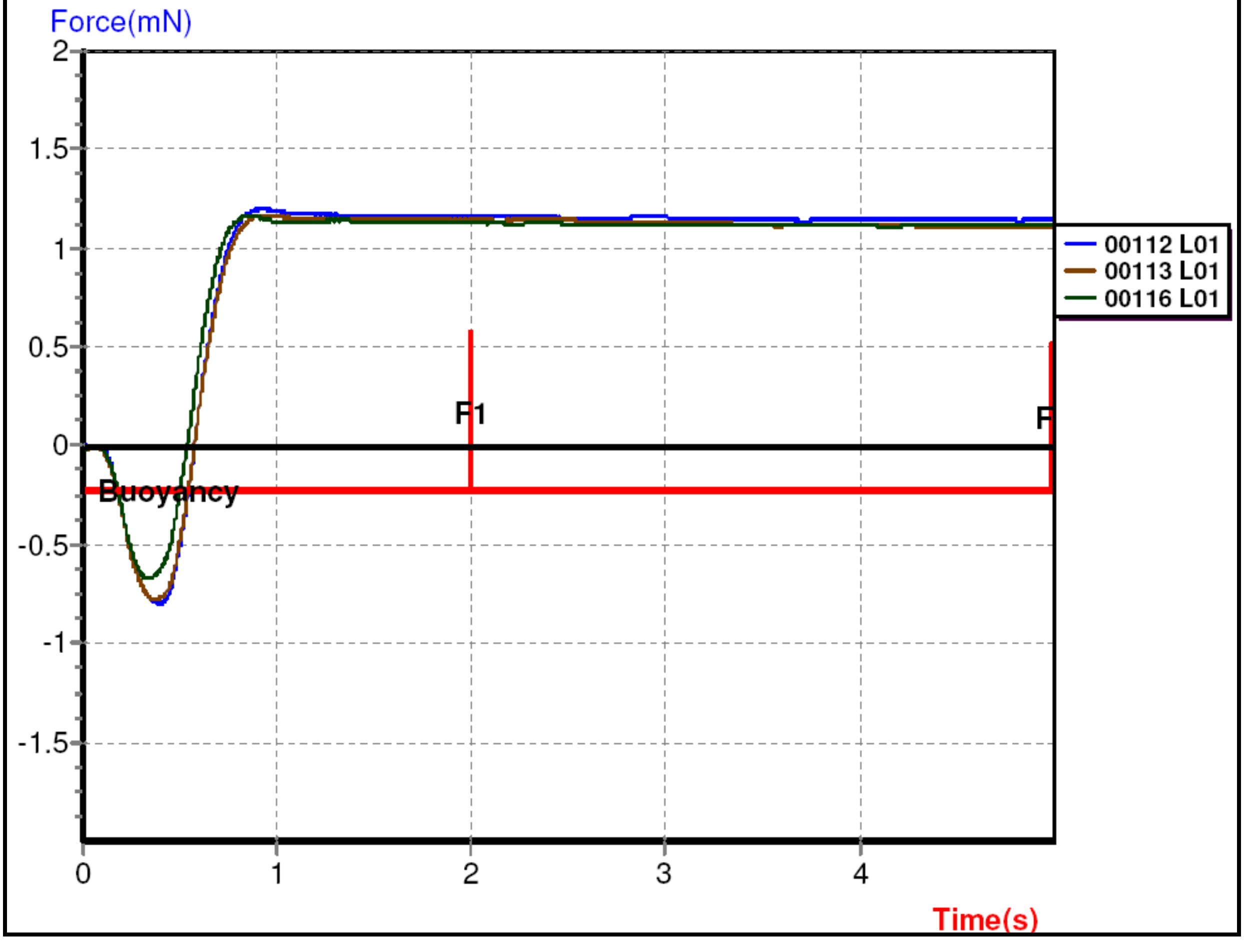
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00112 L01	0.543	0.573	0.696	1.391	1.374	1.202	0.912	Pass
SN100C Alloy	00113 L01	0.540	0.573	0.696	1.374	1.333	1.167	0.918	Pass
SN100C Alloy	00116 L01	0.501	0.534	0.654	1.364	1.350	1.167	0.849	Pass
	Standard Dev	0.023	0.023	0.024	0.014	0.021	0.020	0.038	
	Mean	0.528	0.560	0.682	1.376	1.352	1.179	0.893	
	Max	0.543	0.573	0.696	1.391	1.374	1.202	0.918	
	Min	0.501	0.534	0.654	1.364	1.333	1.167	0.849	

Number of Tests : 003 Passing rate : 100.0 %



RUN 25

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

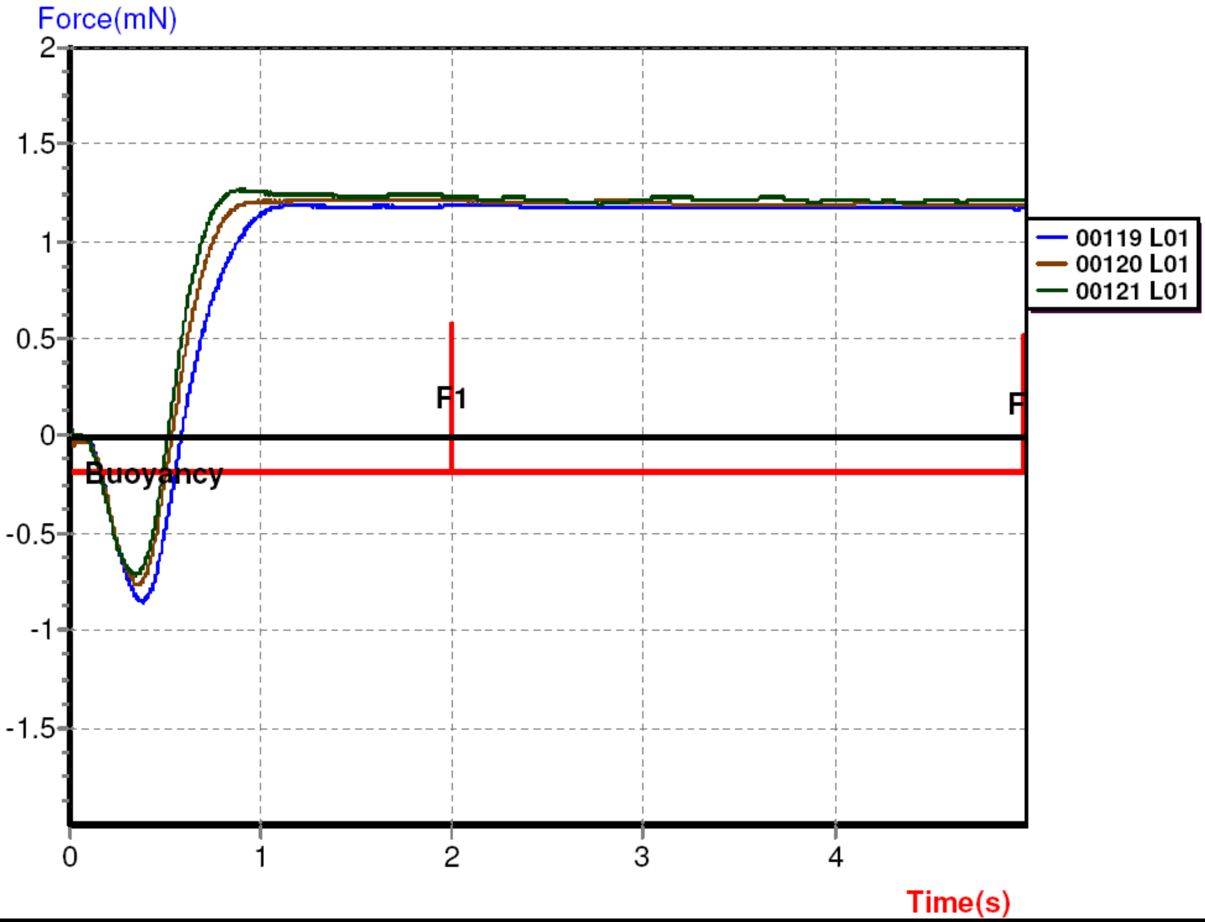
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00119 L01	0.552	0.582	0.777	1.369	1.355	1.191	1.164	Pass
SN100C Alloy	00120 L01	0.504	0.534	0.684	1.397	1.373	1.222	1.254	Pass
SN100C Alloy	00121 L01	0.486	0.513	0.645	1.417	1.400	1.267	0.870	Pass
	Standard Dev	0.034	0.035	0.068	0.024	0.023	0.038	0.201	
	Mean	0.514	0.543	0.702	1.394	1.376	1.227	1.096	
	Max	0.552	0.582	0.777	1.417	1.400	1.267	1.254	
	Min	0.486	0.513	0.645	1.369	1.355	1.191	0.870	

Number of Tests : 003 Passing rate : 100.0 %



RUN 26

Test Details

Component : SN100C Alloy

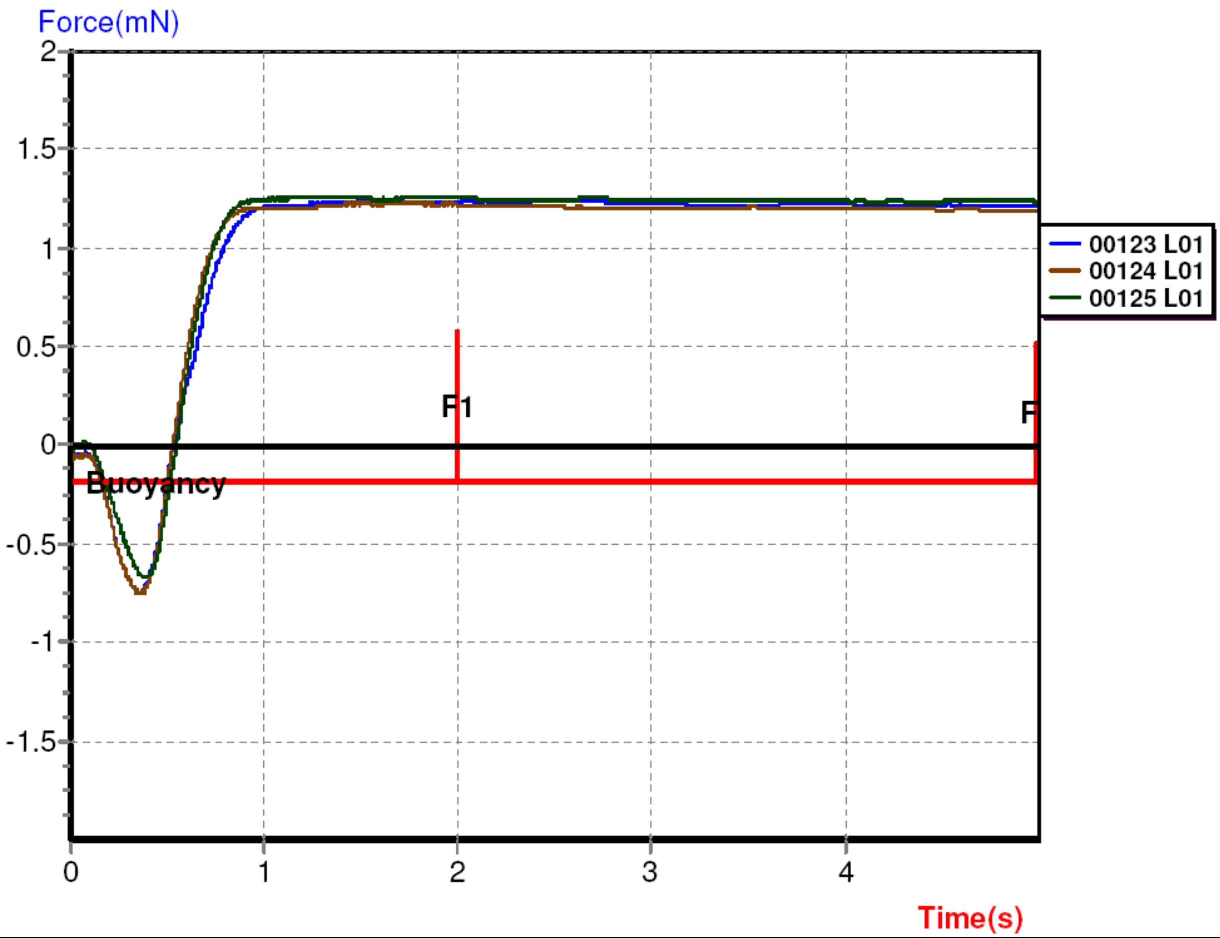
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00123 L01	0.501	0.531	0.726	1.421	1.400	1.246	1.596	Pass
SN100C Alloy	00124 L01	0.501	0.528	0.672	1.407	1.373	1.229	1.707	Pass
SN100C Alloy	00125 L01	0.516	0.543	0.693	1.441	1.421	1.264	1.203	Pass
	Standard Dev	0.009	0.008	0.027	0.017	0.024	0.017	0.265	
	Mean	0.506	0.534	0.697	1.423	1.398	1.246	1.502	
	Max	0.516	0.543	0.726	1.441	1.421	1.264	1.707	
	Min	0.501	0.528	0.672	1.407	1.373	1.229	1.203	

Number of Tests : 003   Passing rate : 100.0 %



RUN 27

Test Details

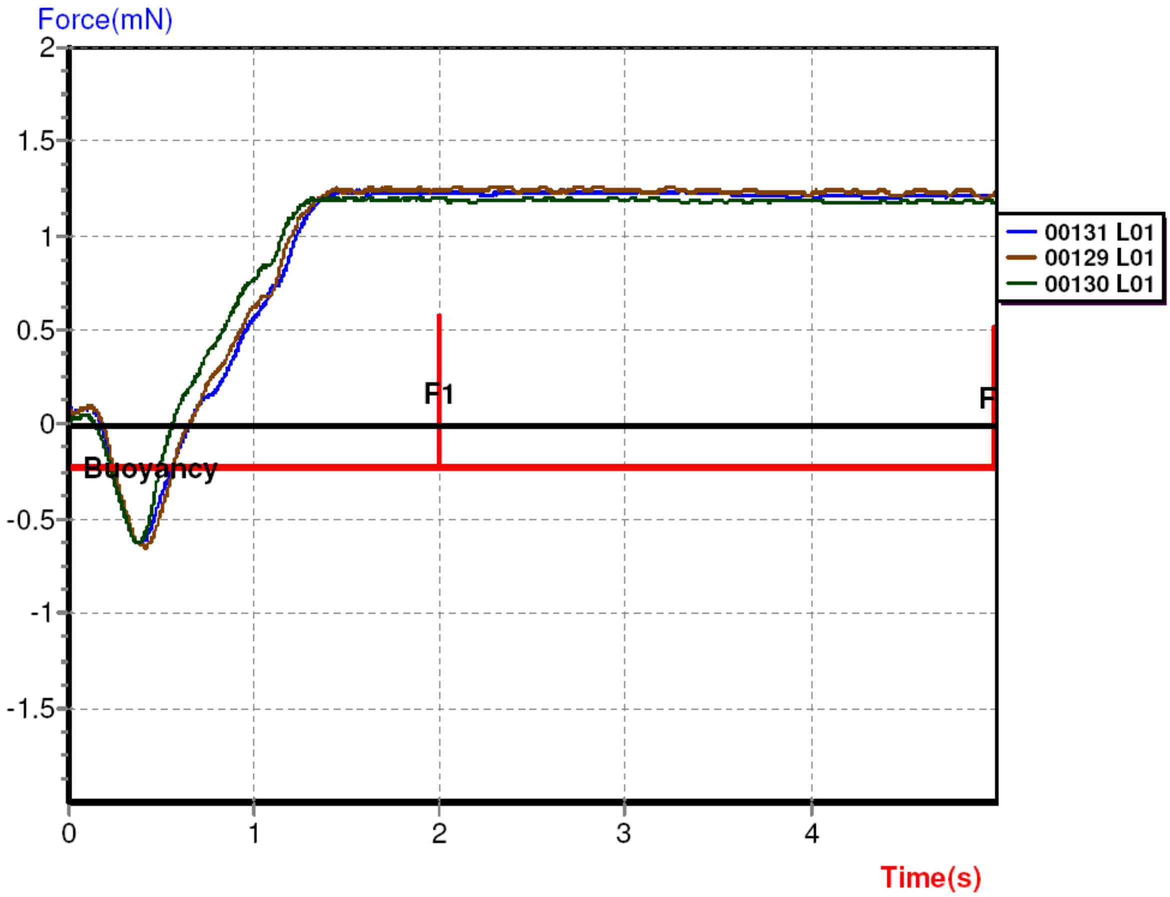
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00131 L01	0.555	0.648	1.167	1.460	1.446	1.243	1.479	Fail
SN100C Alloy	00129 L01	0.561	0.648	1.140	1.474	1.457	1.264	2.370	Fail
SN100C Alloy	00130 L01	0.492	0.555	1.023	1.436	1.408	1.209	1.977	Fail
	Standard Dev	0.038	0.054	0.077	0.019	0.025	0.028	0.447	
	Mean	0.536	0.617	1.110	1.457	1.437	1.238	1.942	
	Max	0.561	0.648	1.167	1.474	1.457	1.264	2.370	
	Min	0.492	0.555	1.023	1.436	1.408	1.209	1.479	

Number of Tests : 003 Passing rate : 0.0 %



RUN 28

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

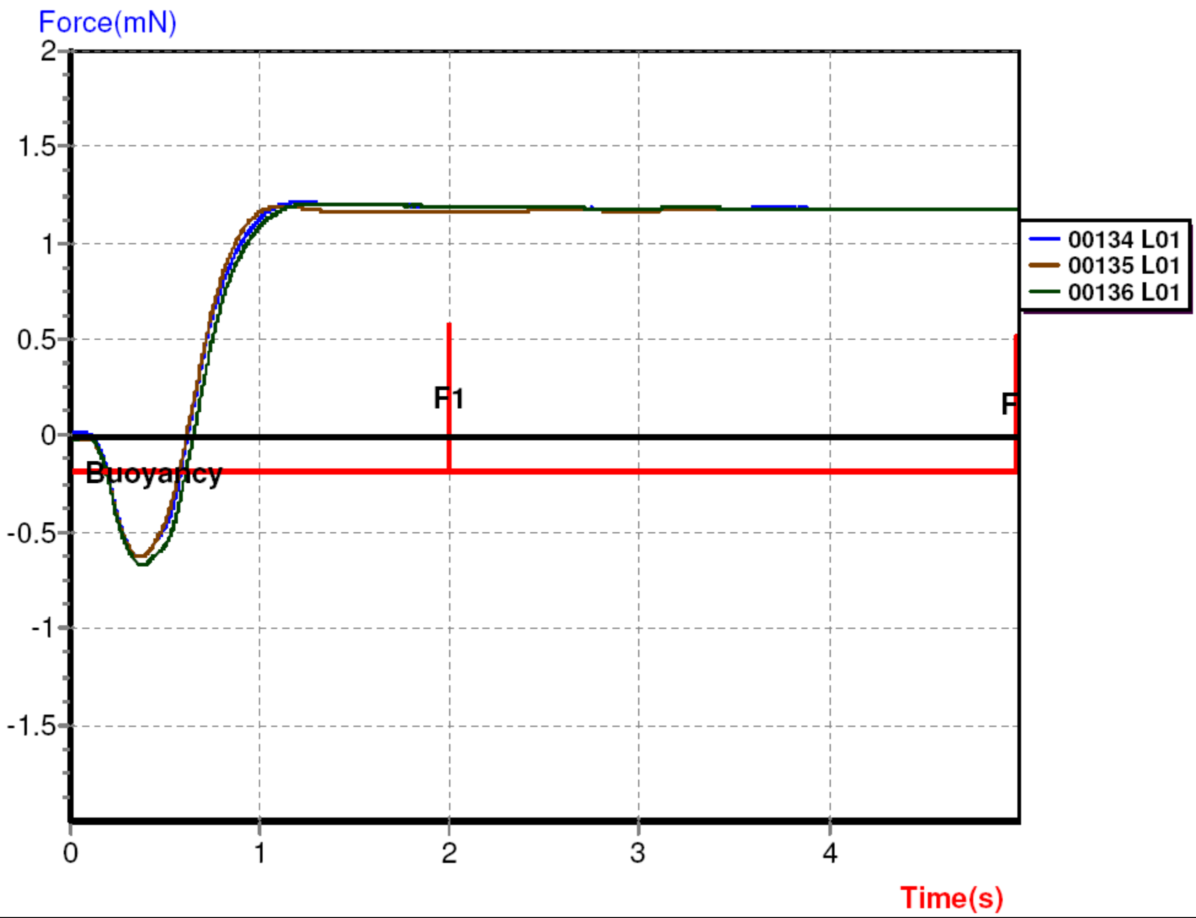
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00134 L01	0.582	0.621	0.807	1.373	1.359	1.215	1.188	Pass
SN100C Alloy	00135 L01	0.573	0.615	0.786	1.345	1.359	1.191	1.095	Pass
SN100C Alloy	00136 L01	0.612	0.648	0.834	1.376	1.366	1.209	1.389	Fail
	Standard Dev	0.020	0.018	0.024	0.017	0.004	0.012	0.150	
	Mean	0.589	0.628	0.809	1.365	1.361	1.205	1.224	
	Max	0.612	0.648	0.834	1.376	1.366	1.215	1.389	
	Min	0.573	0.615	0.786	1.345	1.359	1.191	1.095	

Number of Tests : 003 Passing rate : 66.7 %



RUN 29

Test Details

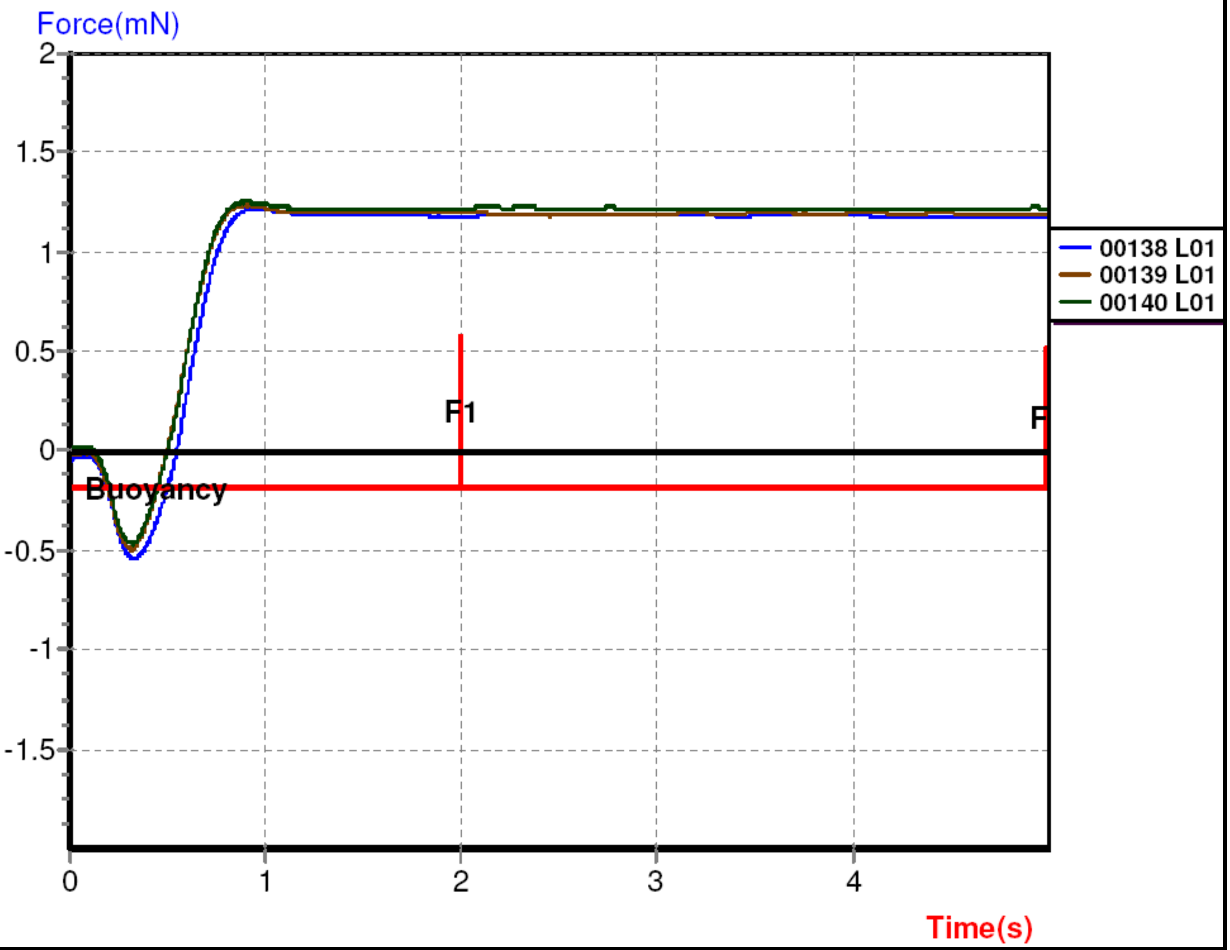
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00138 L01	0.501	0.546	0.699	1.366	1.359	1.219	0.918	Pass
SN100C Alloy	00139 L01	0.444	0.498	0.666	1.386	1.369	1.240	0.894	Pass
SN100C Alloy	00140 L01	0.444	0.501	0.666	1.407	1.407	1.253	0.873	Pass
	Standard Dev	0.033	0.027	0.019	0.021	0.025	0.017	0.023	
	Mean	0.463	0.515	0.677	1.386	1.378	1.237	0.895	
	Max	0.501	0.546	0.699	1.407	1.407	1.253	0.918	
	Min	0.444	0.498	0.666	1.366	1.359	1.219	0.873	

Number of Tests : 003 Passing rate : 100.0 %



RUN 30

Test Details

Component : SN100C Alloy

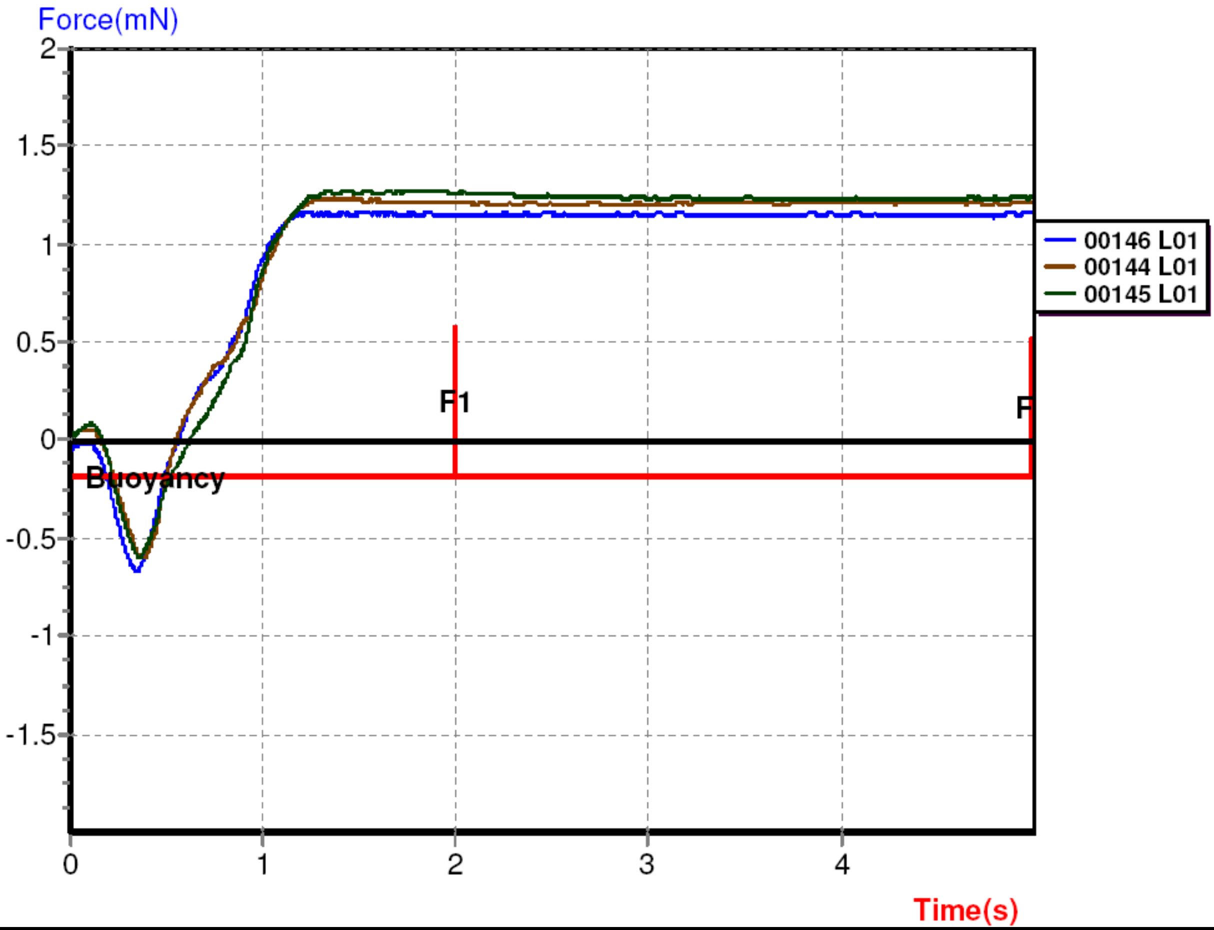
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00146 L01	0.492	0.558	0.942	1.331	1.342	1.167	1.233	Pass
SN100C Alloy	00144 L01	0.501	0.546	0.993	1.400	1.400	1.240	1.371	Pass
SN100C Alloy	00145 L01	0.522	0.621	0.993	1.445	1.424	1.277	1.914	Pass
	Standard Dev	0.015	0.040	0.029	0.057	0.042	0.056	0.360	
	Mean	0.505	0.575	0.976	1.392	1.389	1.228	1.506	
	Max	0.522	0.621	0.993	1.445	1.424	1.277	1.914	
	Min	0.492	0.546	0.942	1.331	1.342	1.167	1.233	

Number of Tests : 003   Passing rate : 100.0 %



RUN 31

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

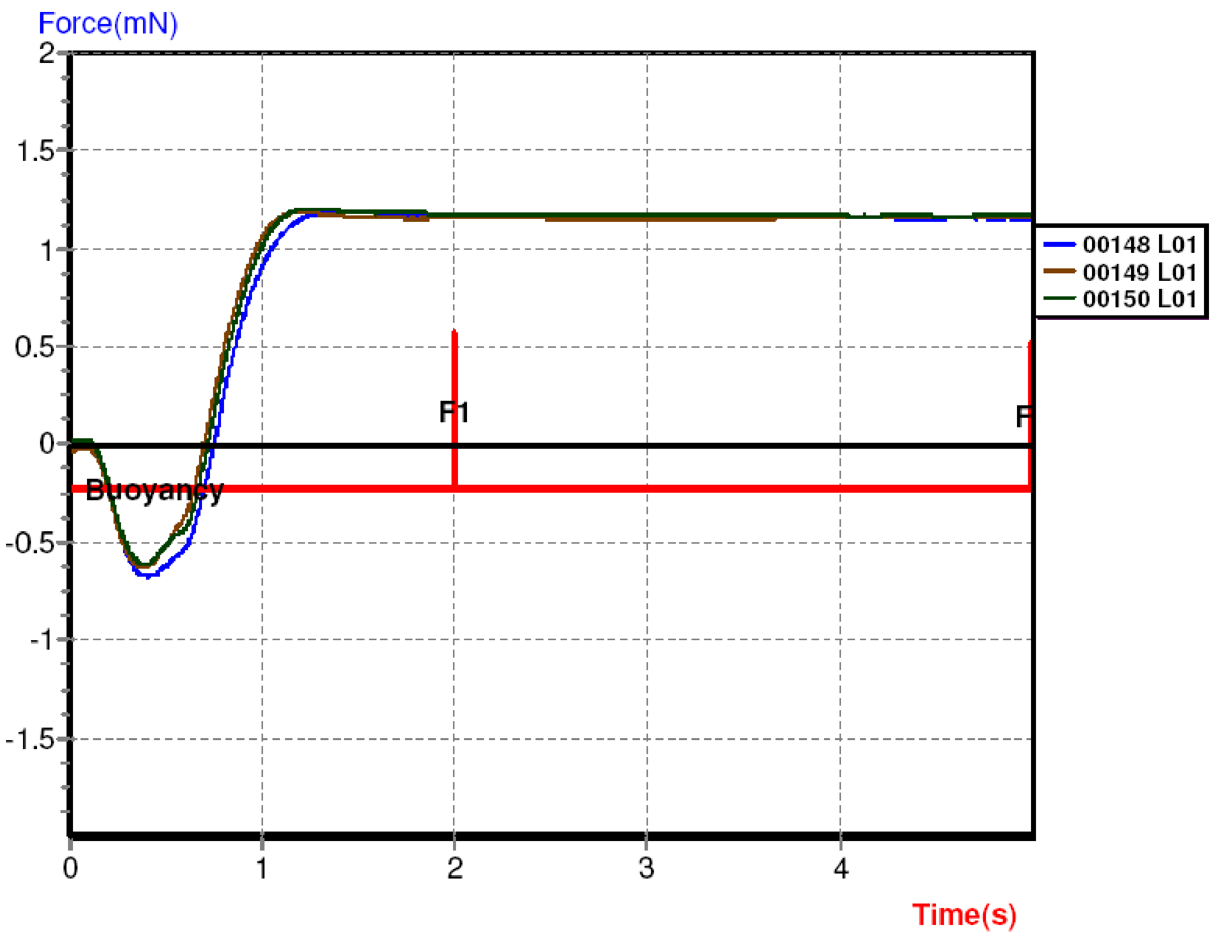
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00148 L01	0.699	0.750	0.945	1.412	1.384	1.188	1.323	Fail
SN100C Alloy	00149 L01	0.645	0.696	0.882	1.388	1.391	1.188	1.182	Fail
SN100C Alloy	00150 L01	0.666	0.717	0.909	1.408	1.402	1.209	1.233	Fail
	Standard Dev	0.027	0.027	0.032	0.013	0.009	0.012	0.071	
	Mean	0.670	0.722	0.912	1.403	1.392	1.195	1.246	
	Max	0.699	0.750	0.945	1.412	1.402	1.209	1.323	
	Min	0.645	0.696	0.882	1.388	1.384	1.188	1.182	

Number of Tests : 003 Passing rate : 0.0 %



RUN 32

Test Details

Component : SN100C Alloy

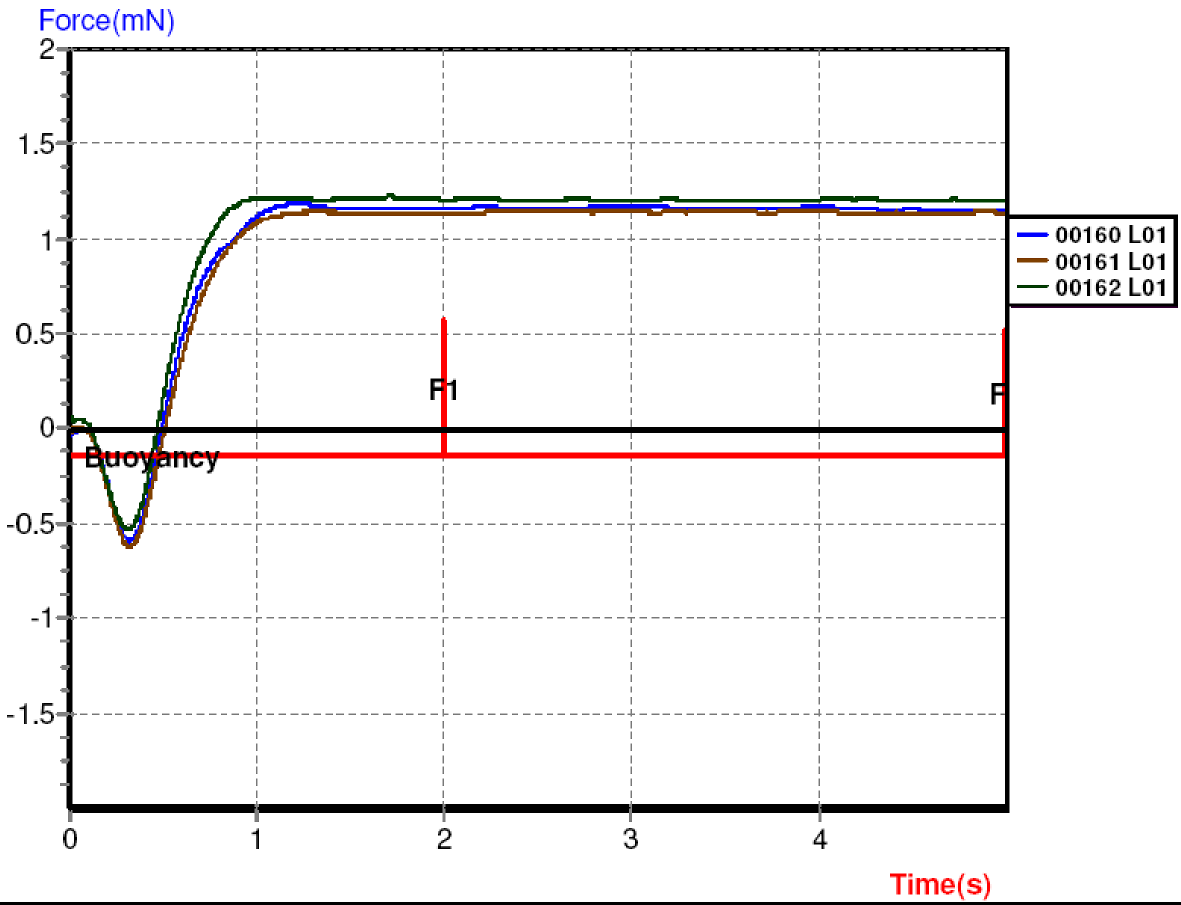
Test parameter filename : Bath Parameters.vts | Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00160 L01	0.465	0.495	0.711	1.306	1.289	1.188	1.188	Pass
SN100C Alloy	00161 L01	0.477	0.507	0.735	1.278	1.278	1.150	3.957	Pass
SN100C Alloy	00162 L01	0.444	0.471	0.663	1.347	1.344	1.226	1.695	Pass
	Standard Dev	0.017	0.018	0.037	0.035	0.035	0.038	1.474	
	Mean	0.462	0.491	0.703	1.310	1.303	1.188	2.280	
	Max	0.477	0.507	0.735	1.347	1.344	1.226	3.957	
	Min	0.444	0.471	0.663	1.278	1.278	1.150	1.188	

Number of Tests : 003 Passing rate : 100.0 %



RUN 33

Test Details

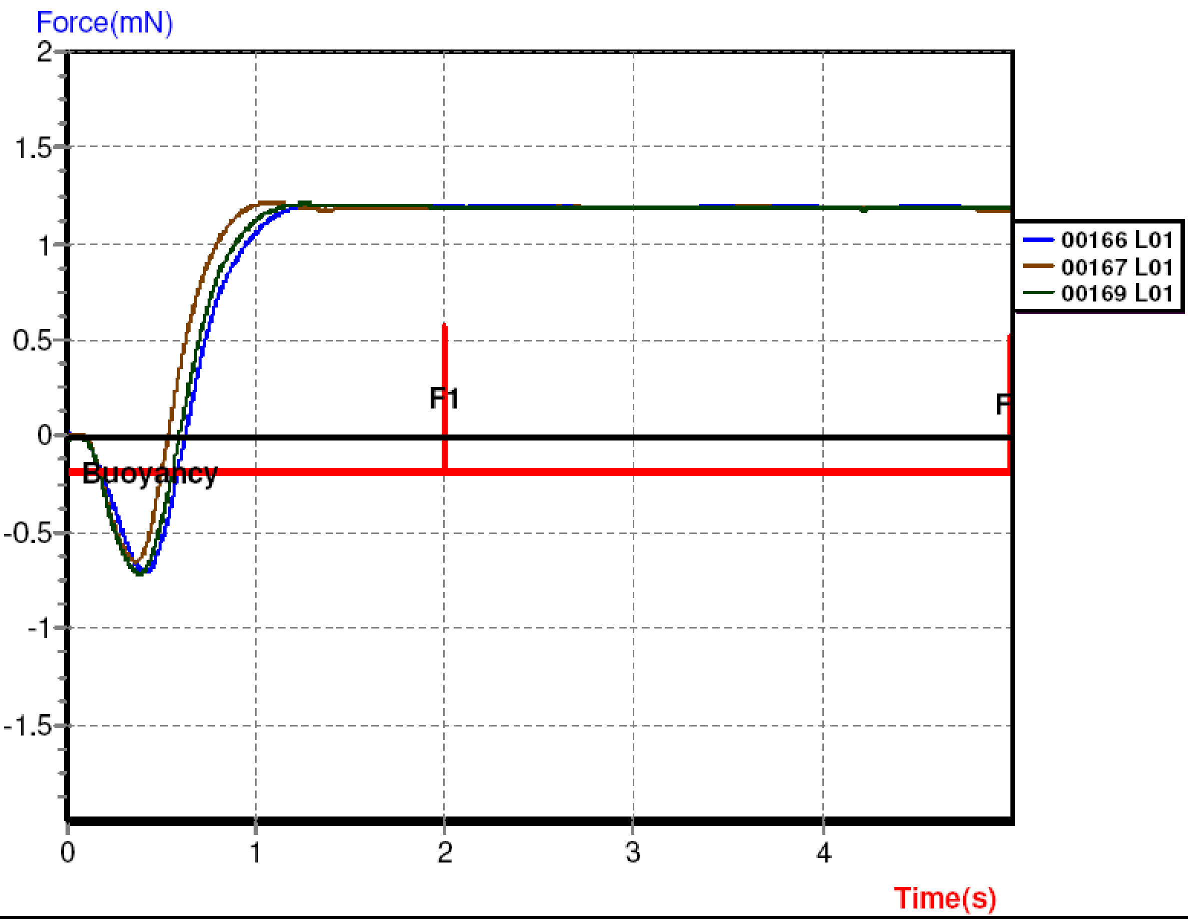
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00166 L01	0.588	0.624	0.831	1.383	1.380	1.205	1.275	Pass
SN100C Alloy	00167 L01	0.504	0.534	0.711	1.369	1.366	1.219	1.050	Pass
SN100C Alloy	00169 L01	0.561	0.594	0.789	1.380	1.376	1.212	1.230	Pass
	Standard Dev	0.043	0.046	0.061	0.007	0.007	0.007	0.119	
	Mean	0.551	0.584	0.777	1.377	1.374	1.212	1.185	
	Max	0.588	0.624	0.831	1.383	1.380	1.219	1.275	
	Min	0.504	0.534	0.711	1.369	1.366	1.205	1.050	

Number of Tests : 003 Passing rate : 100.0 %



RUN 34

Test Details

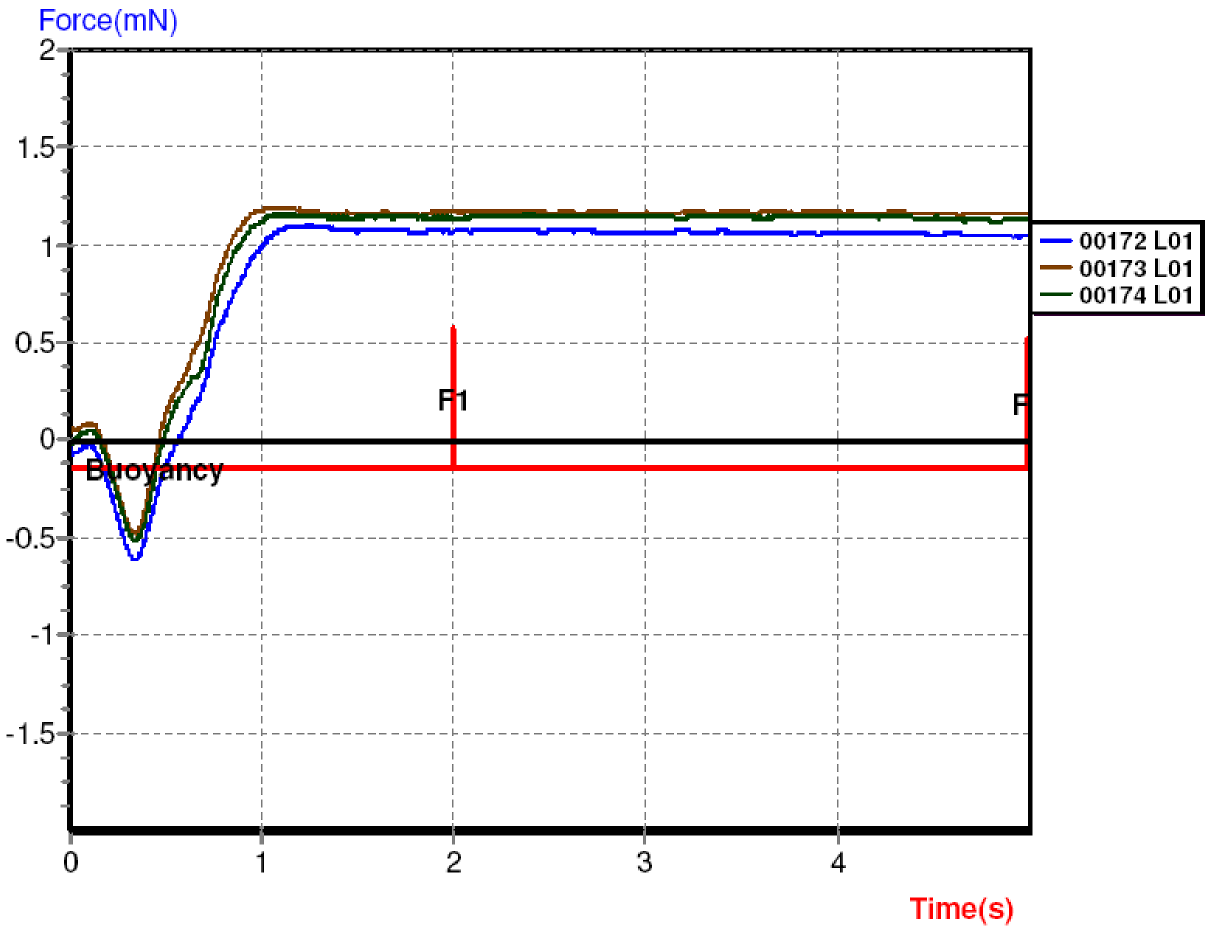
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00172 L01	0.498	0.564	0.843	1.209	1.189	1.102	1.233	Pass
SN100C Alloy	00173 L01	0.435	0.465	0.753	1.309	1.299	1.195	1.050	Pass
SN100C Alloy	00174 L01	0.453	0.486	0.780	1.278	1.271	1.160	1.080	Pass
	Standard Dev	0.032	0.052	0.046	0.051	0.057	0.047	0.098	
	Mean	0.462	0.505	0.792	1.266	1.253	1.152	1.121	
	Max	0.498	0.564	0.843	1.309	1.299	1.195	1.233	
	Min	0.435	0.465	0.753	1.209	1.189	1.102	1.050	

Number of Tests : 003 Passing rate : 100.0 %



RUN 35

Test Details

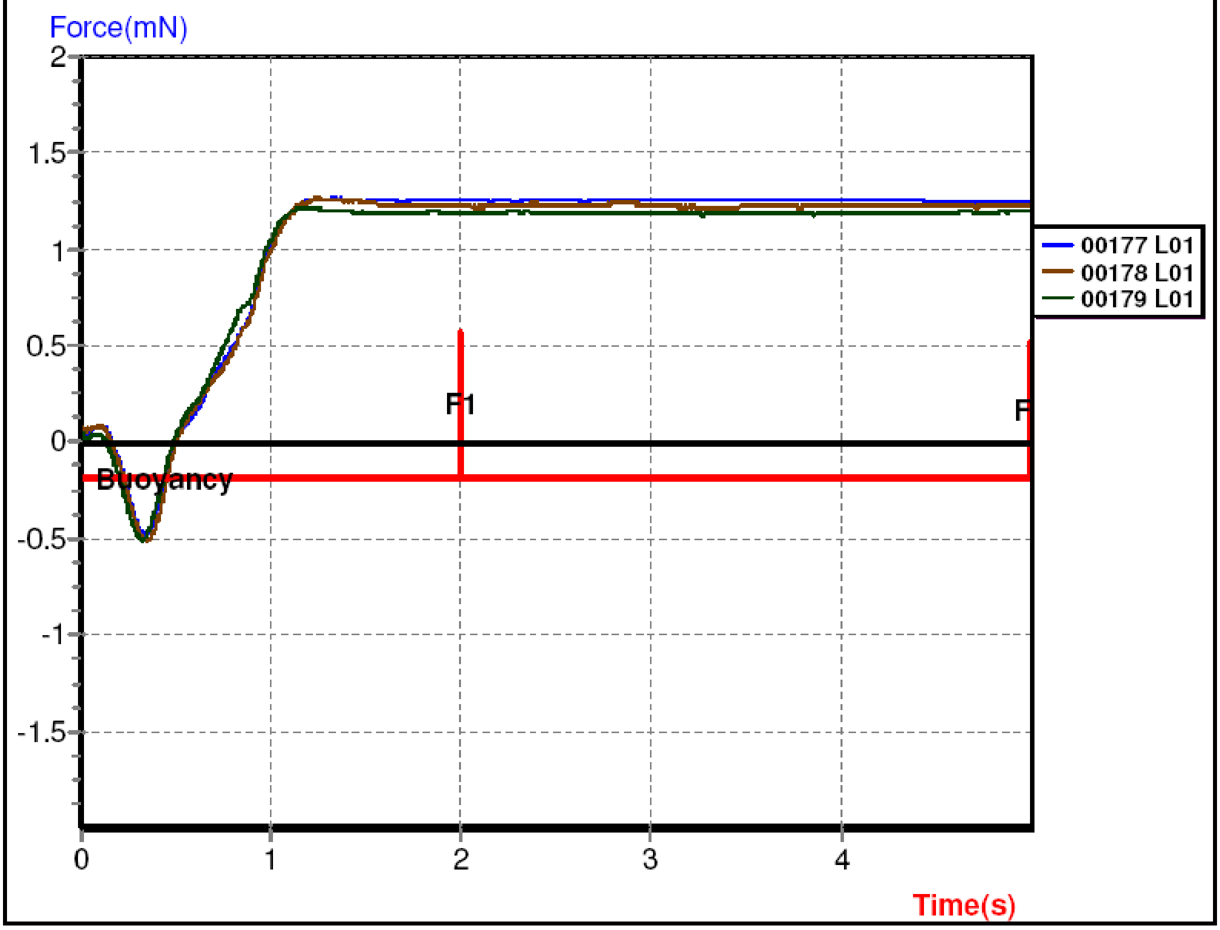
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00177 L01	0.444	0.498	0.936	1.438	1.435	1.267	1.233	Pass
SN100C Alloy	00178 L01	0.456	0.507	0.942	1.417	1.417	1.267	1.236	Pass
SN100C Alloy	00179 L01	0.438	0.486	0.918	1.373	1.386	1.222	1.161	Pass
	Standard Dev	0.009	0.011	0.012	0.033	0.024	0.026	0.042	
	Mean	0.446	0.497	0.932	1.409	1.413	1.252	1.210	
	Max	0.456	0.507	0.942	1.438	1.435	1.267	1.236	
	Min	0.438	0.486	0.918	1.373	1.386	1.222	1.161	

Number of Tests : 003 Passing rate : 100.0 %



RUN 36

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

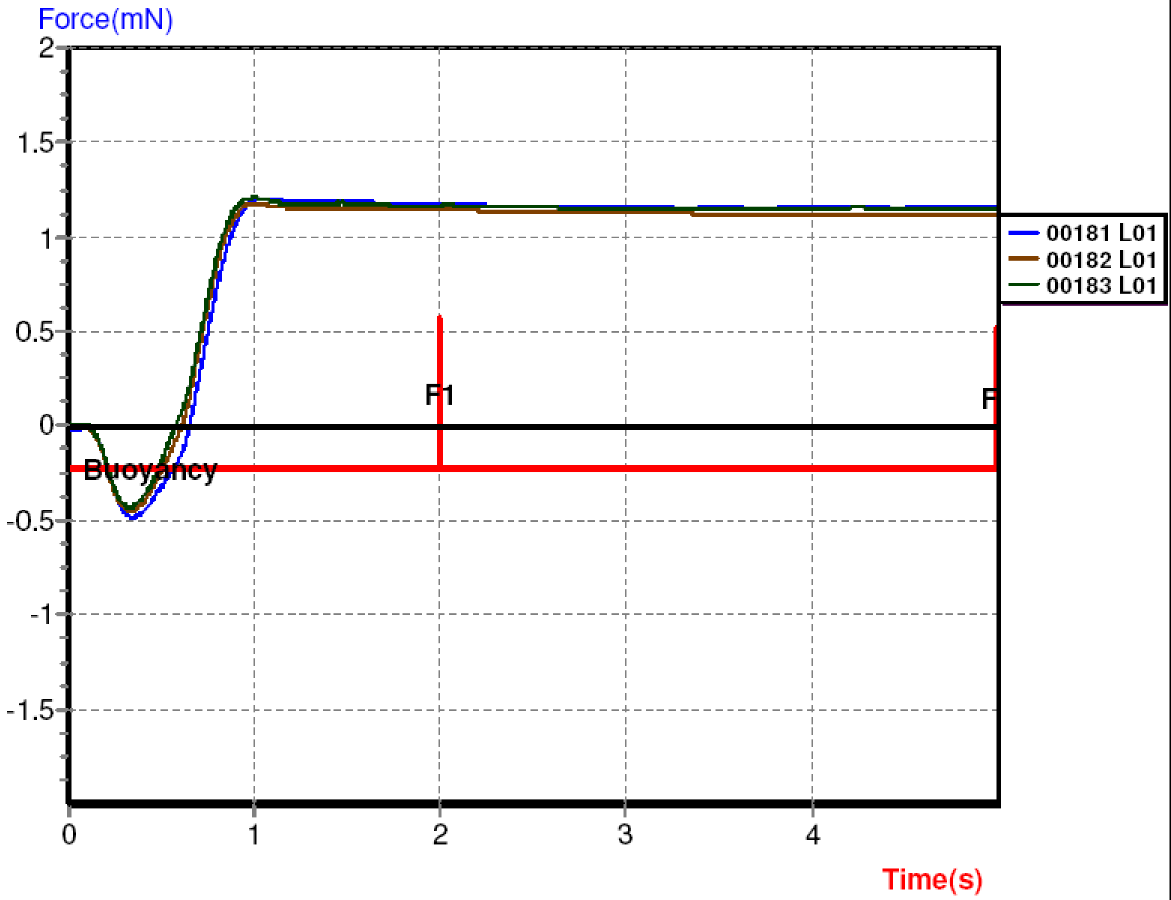
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00181 L01	0.558	0.651	0.813	1.412	1.388	1.209	1.035	Pass
SN100C Alloy	00182 L01	0.504	0.609	0.780	1.374	1.353	1.178	0.975	Pass
SN100C Alloy	00183 L01	0.483	0.576	0.774	1.398	1.384	1.212	0.984	Pass
	Standard Dev	0.039	0.038	0.021	0.019	0.019	0.019	0.032	
	Mean	0.515	0.612	0.789	1.395	1.375	1.199	0.998	
	Max	0.558	0.651	0.813	1.412	1.388	1.212	1.035	
	Min	0.483	0.576	0.774	1.374	1.353	1.178	0.975	

Number of Tests : 003 Passing rate : 100.0 %



RUN 37

Test Details

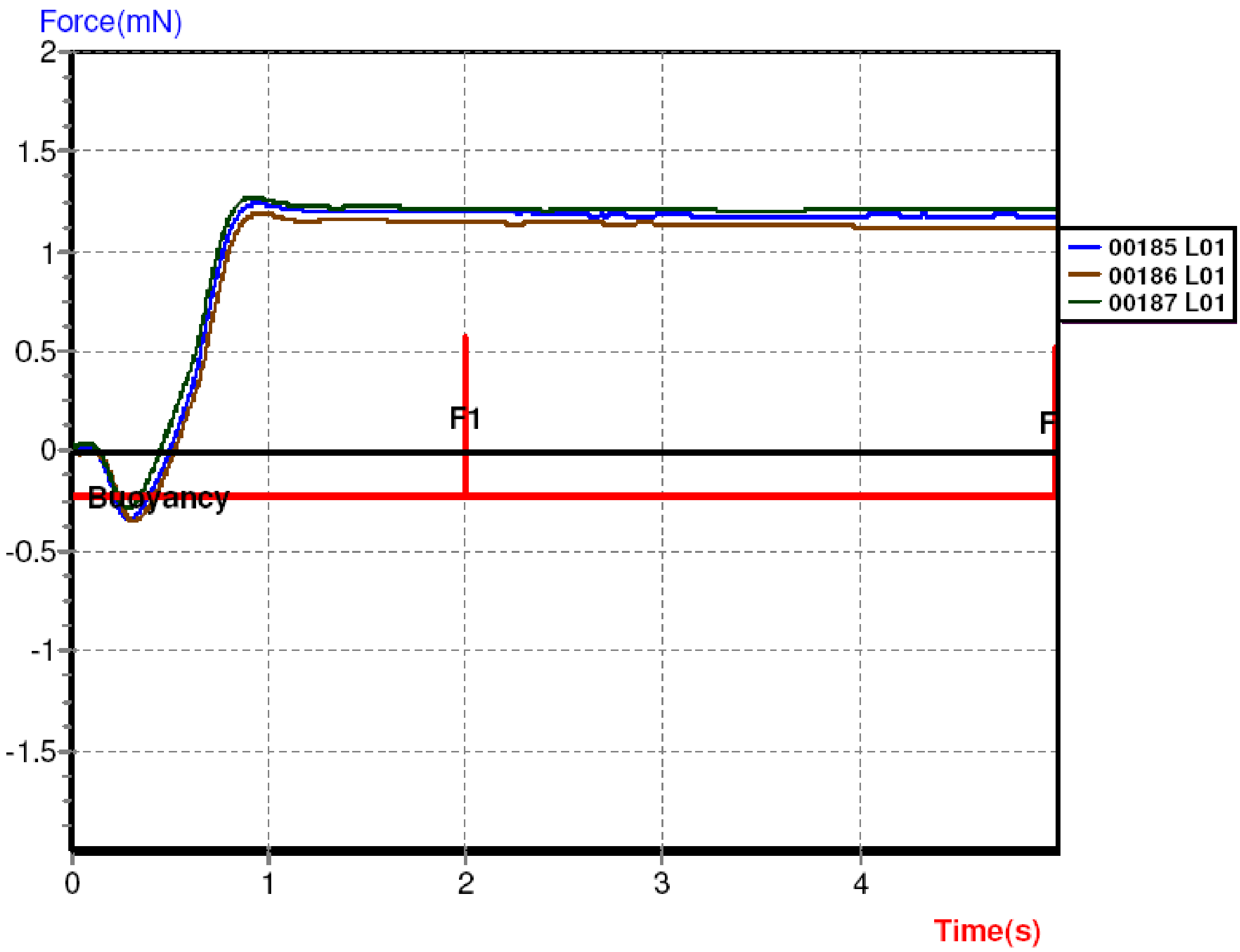
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00185 L01	0.387	0.498	0.723	1.433	1.405	1.243	0.927	Pass
SN100C Alloy	00186 L01	0.417	0.522	0.741	1.381	1.350	1.191	0.945	Pass
SN100C Alloy	00187 L01	0.345	0.447	0.702	1.443	1.443	1.271	0.894	Pass
	Standard Dev	0.036	0.039	0.020	0.033	0.047	0.040	0.026	
	Mean	0.383	0.490	0.722	1.419	1.399	1.235	0.922	
	Max	0.417	0.522	0.741	1.443	1.443	1.271	0.945	
	Min	0.345	0.447	0.702	1.381	1.350	1.191	0.894	

Number of Tests : 003 Passing rate : 100.0 %



RUN 38

Test Details

Component : SN100C Alloy

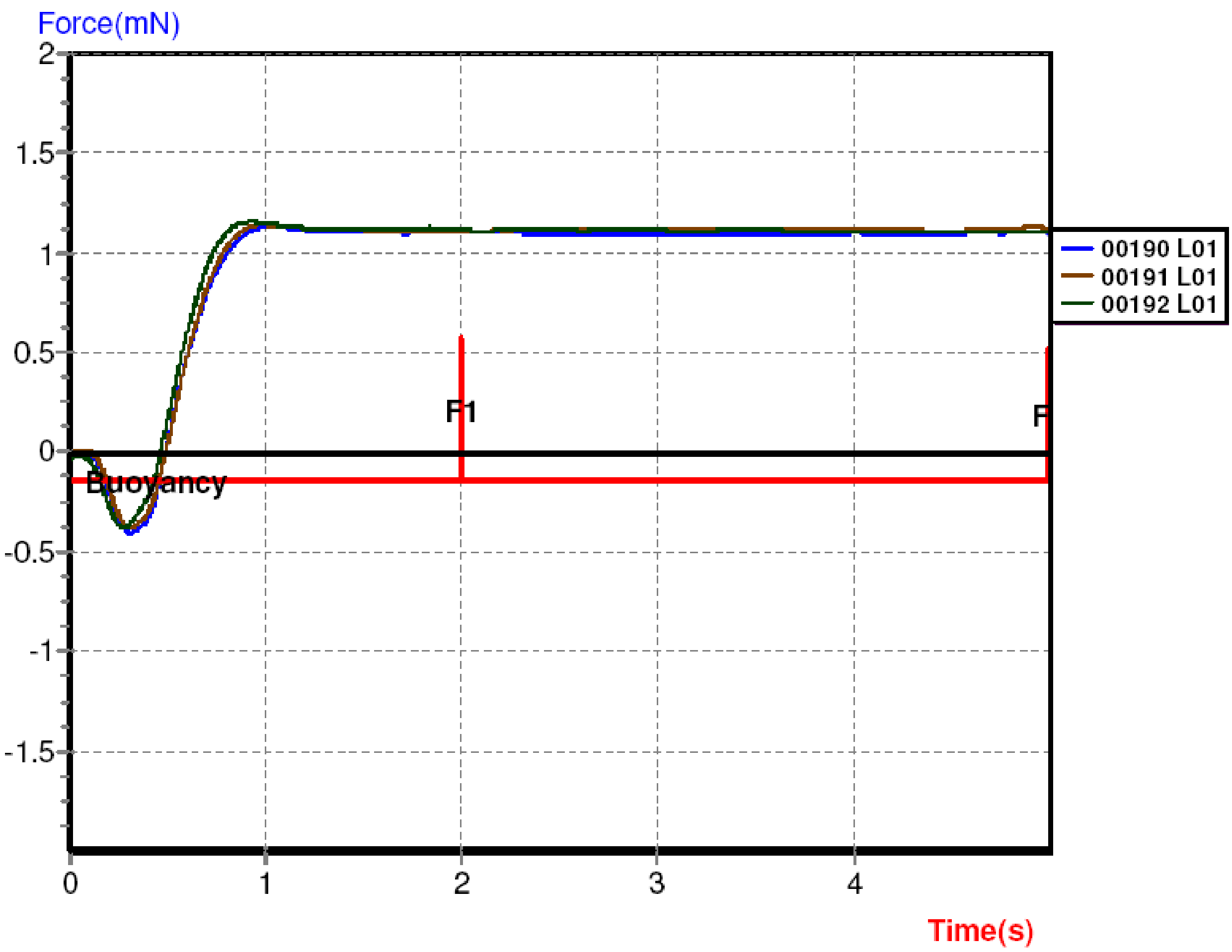
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00190 L01	0.459	0.489	0.681	1.247	1.237	1.133	0.984	Pass
SN100C Alloy	00191 L01	0.456	0.492	0.675	1.247	1.264	1.143	0.954	Pass
SN100C Alloy	00192 L01	0.429	0.462	0.642	1.254	1.240	1.157	0.906	Pass
	Standard Dev	0.017	0.017	0.021	0.004	0.015	0.012	0.039	
	Mean	0.448	0.481	0.666	1.250	1.247	1.144	0.948	
	Max	0.459	0.492	0.681	1.254	1.264	1.157	0.984	
	Min	0.429	0.462	0.642	1.247	1.237	1.133	0.906	

Number of Tests : 003   Passing rate : 100.0 %



RUN 39

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

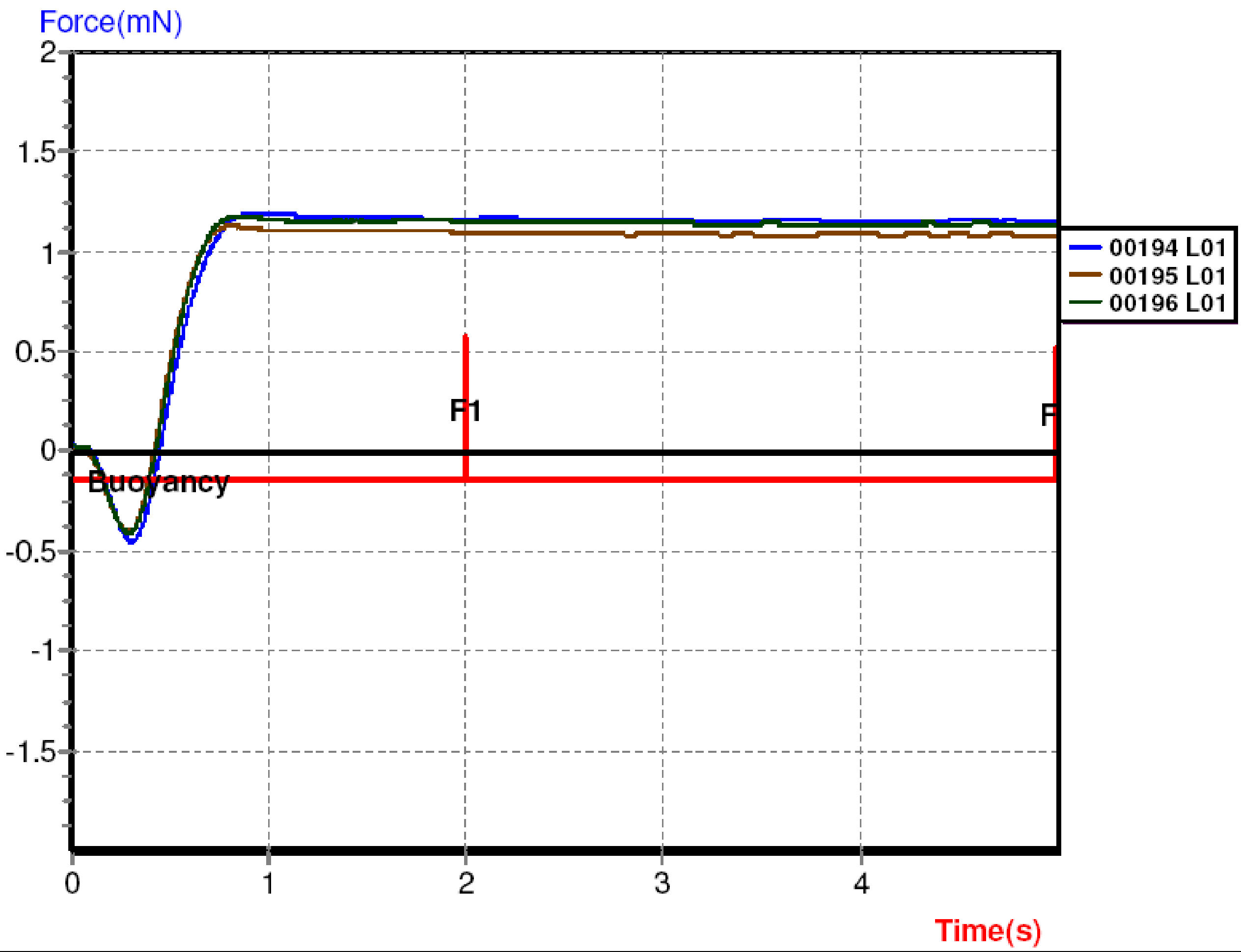
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00194 L01	0.417	0.444	0.618	1.306	1.285	1.195	0.954	Pass
SN100C Alloy	00195 L01	0.390	0.417	0.570	1.233	1.216	1.133	0.801	Pass
SN100C Alloy	00196 L01	0.396	0.423	0.585	1.292	1.275	1.181	0.828	Pass
	Standard Dev	0.014	0.014	0.025	0.038	0.037	0.033	0.082	
	Mean	0.401	0.429	0.591	1.277	1.259	1.170	0.861	
	Max	0.417	0.444	0.618	1.306	1.285	1.195	0.954	
	Min	0.390	0.417	0.570	1.233	1.216	1.133	0.801	

Number of Tests : 003 Passing rate : 100.0 %



RUN 40

Test Details

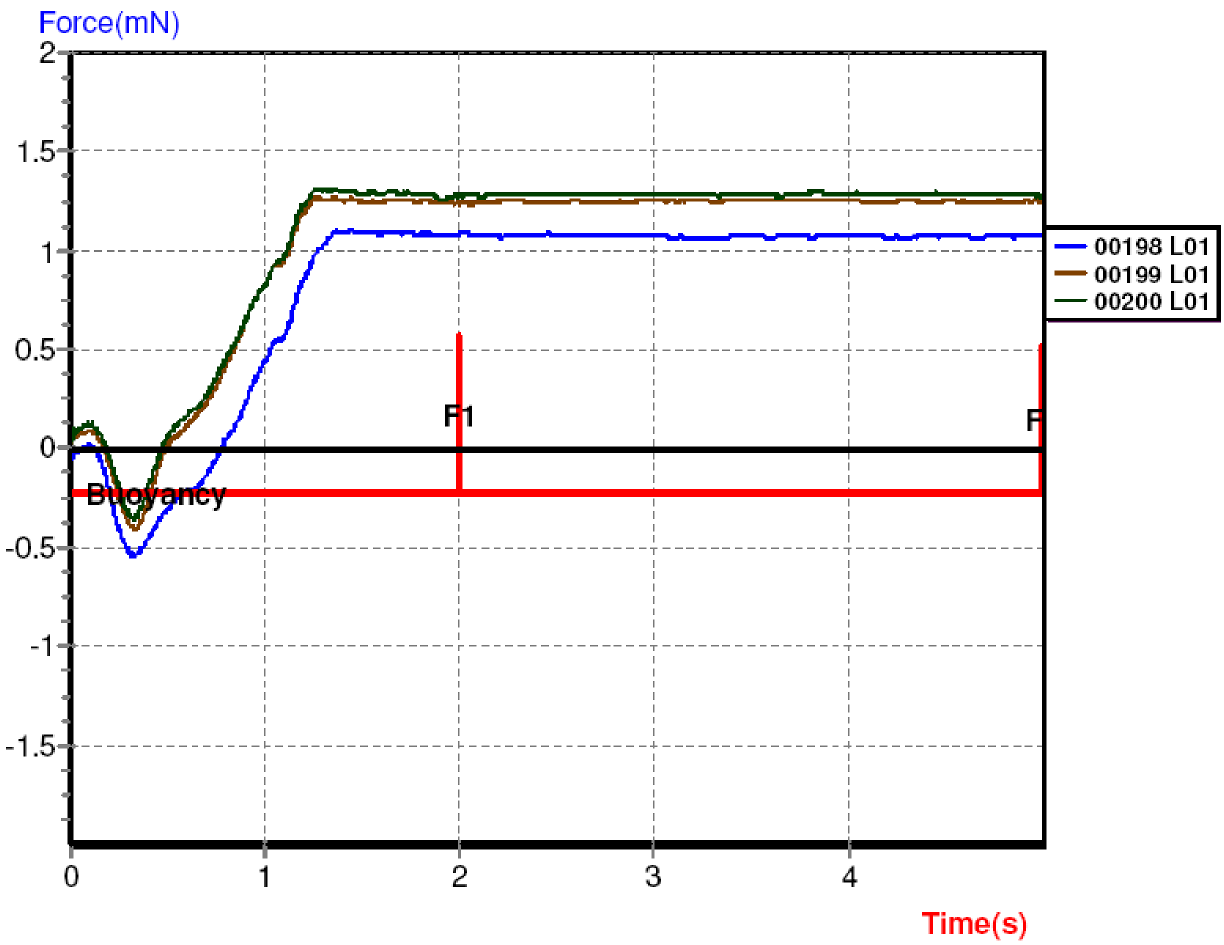
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00198 L01	0.564	0.774	1.155	1.319	1.309	1.105	1.434	Fail
SN100C Alloy	00199 L01	0.408	0.489	1.008	1.470	1.481	1.274	1.260	Fail
SN100C Alloy	00200 L01	0.390	0.468	1.023	1.512	1.508	1.315	1.260	Fail
	Standard Dev	0.096	0.171	0.081	0.102	0.108	0.111	0.100	
	Mean	0.454	0.577	1.062	1.434	1.433	1.232	1.318	
	Max	0.564	0.774	1.155	1.512	1.508	1.315	1.434	
	Min	0.390	0.468	1.008	1.319	1.309	1.105	1.260	

Number of Tests : 003   Passing rate : 0.0 %



RUN 41

Test Details

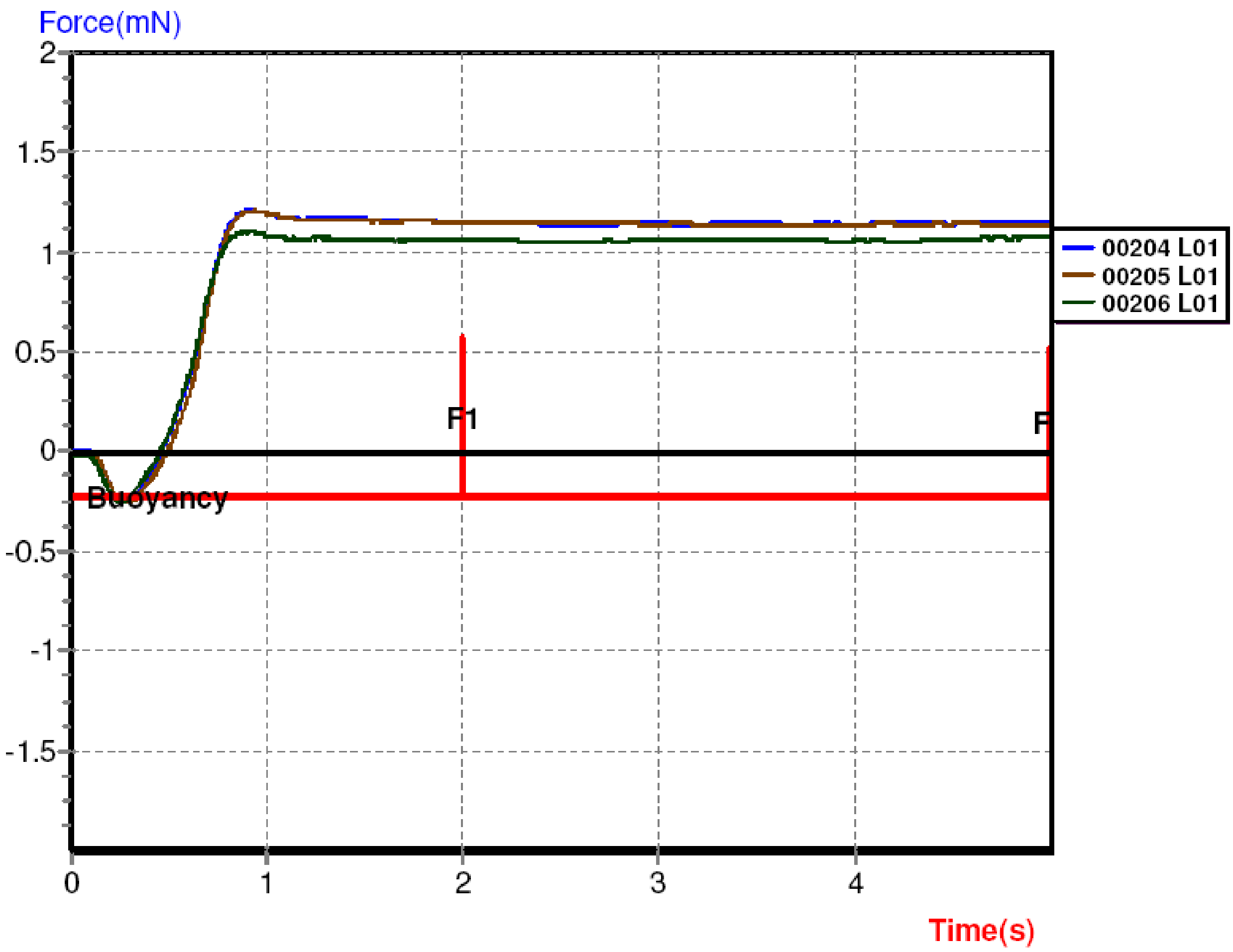
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00204 L01	0.312	0.465	0.705	1.377	1.374	1.212	0.885	Pass
SN100C Alloy	00205 L01	0.330	0.492	0.714	1.377	1.371	1.212	0.933	Pass
SN100C Alloy	00206 L01	0.294	0.456	0.684	1.291	1.309	1.102	0.864	Pass
	Standard Dev	0.018	0.019	0.015	0.050	0.037	0.064	0.035	
	Mean	0.312	0.471	0.701	1.349	1.351	1.175	0.894	
	Max	0.330	0.492	0.714	1.377	1.374	1.212	0.933	
	Min	0.294	0.456	0.684	1.291	1.309	1.102	0.864	

Number of Tests : 003 Passing rate : 100.0 %



RUN 42

Test Details

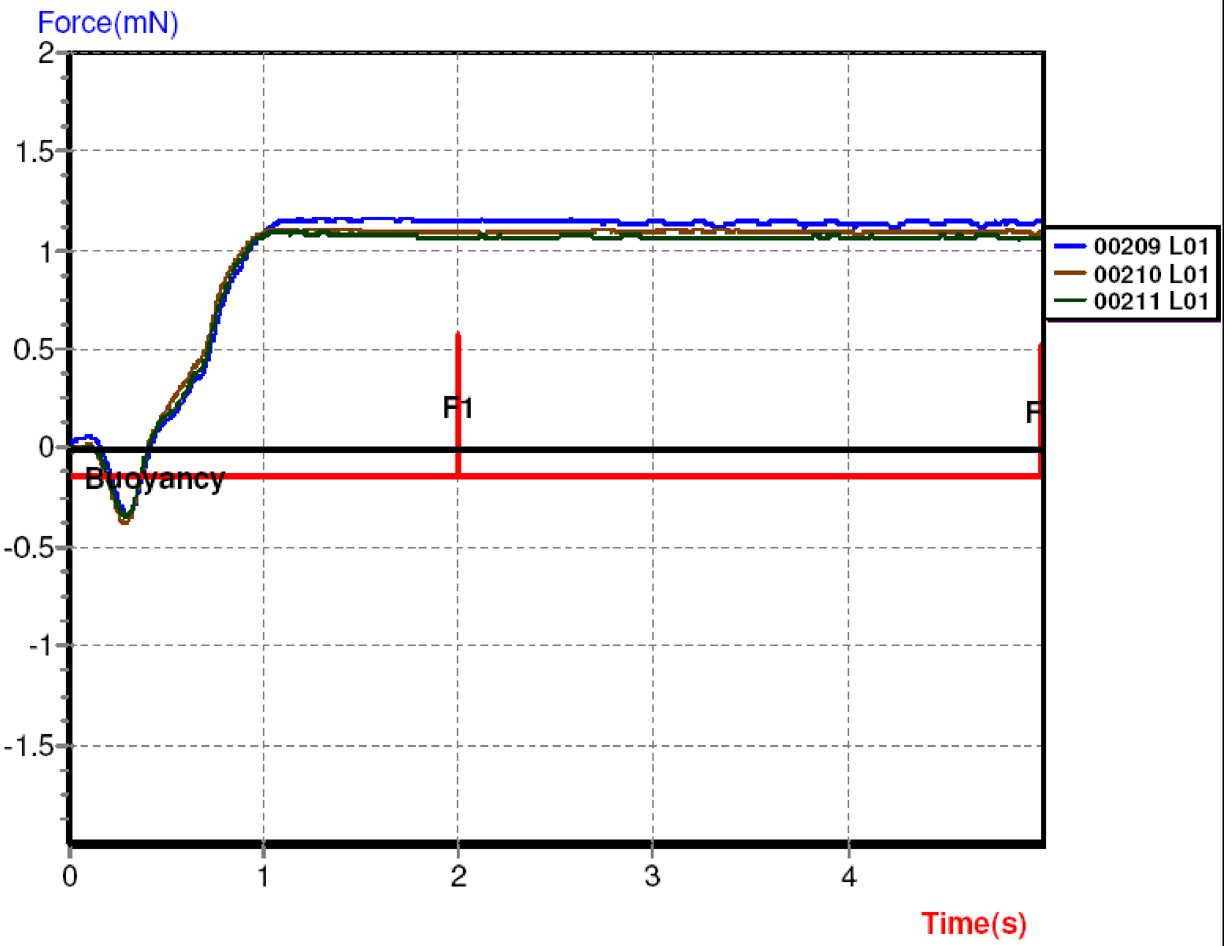
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00209 L01	0.375	0.417	0.804	1.289	1.282	1.164	1.617	Pass
SN100C Alloy	00210 L01	0.369	0.405	0.756	1.233	1.227	1.112	1.119	Pass
SN100C Alloy	00211 L01	0.366	0.405	0.771	1.206	1.199	1.095	1.032	Pass
	Standard Dev	0.005	0.007	0.025	0.042	0.042	0.036	0.316	
	Mean	0.370	0.409	0.777	1.243	1.236	1.124	1.256	
	Max	0.375	0.417	0.804	1.289	1.282	1.164	1.617	
	Min	0.366	0.405	0.756	1.206	1.199	1.095	1.032	

Number of Tests : 003 Passing rate : 100.0 %



RUN 43

Test Details

Component : SN100C Alloy

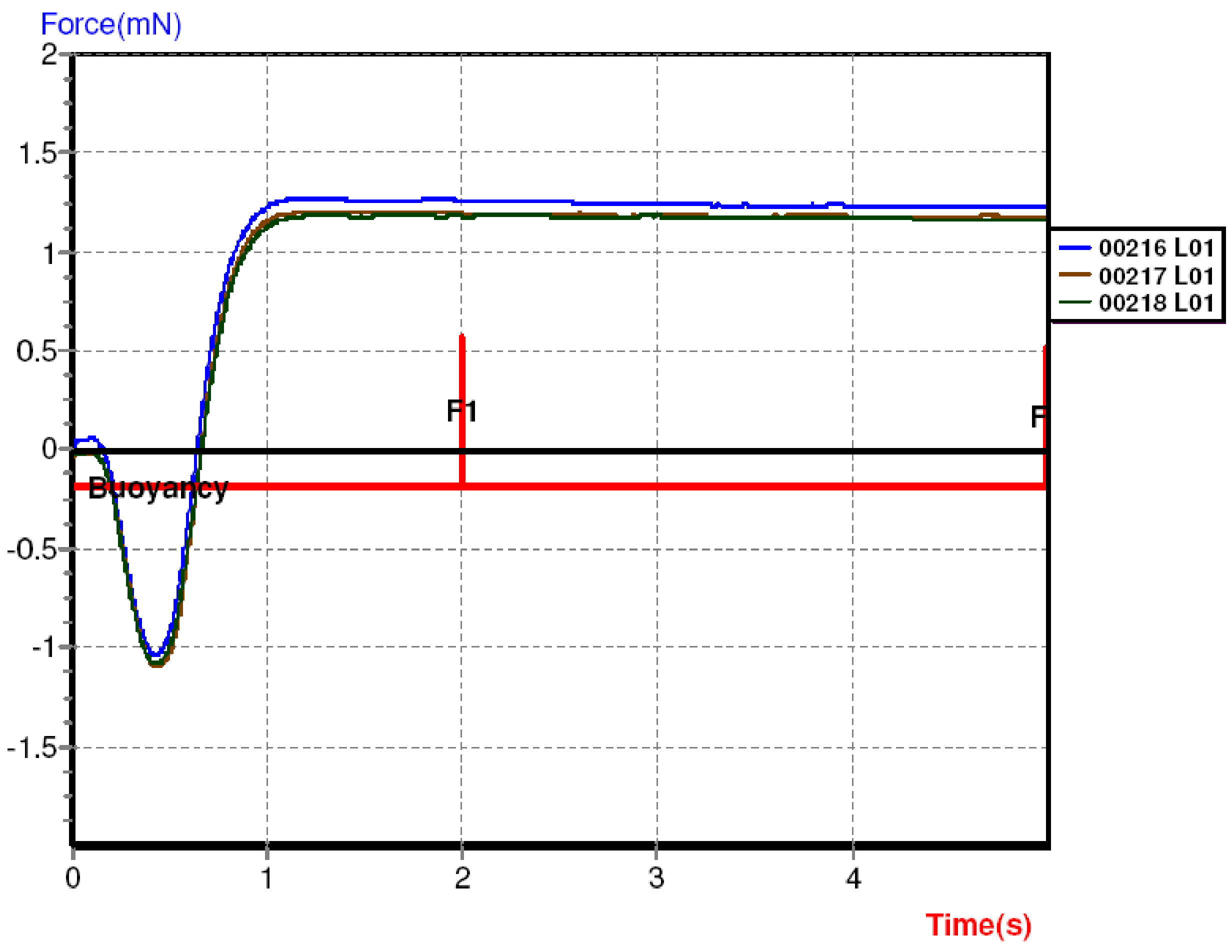
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00216 L01	0.615	0.639	0.780	1.445	1.410	1.271	1.110	Fail
SN100C Alloy	00217 L01	0.639	0.660	0.795	1.380	1.355	1.202	1.638	Fail
SN100C Alloy	00218 L01	0.636	0.663	0.804	1.366	1.345	1.191	1.254	Fail
	Standard Dev	0.013	0.013	0.012	0.042	0.035	0.043	0.273	
	Mean	0.630	0.654	0.793	1.397	1.370	1.221	1.334	
	Max	0.639	0.663	0.804	1.445	1.410	1.271	1.638	
	Min	0.615	0.639	0.780	1.366	1.345	1.191	1.110	

Number of Tests : 003   Passing rate : 0.0 %



RUN 44

Test Details

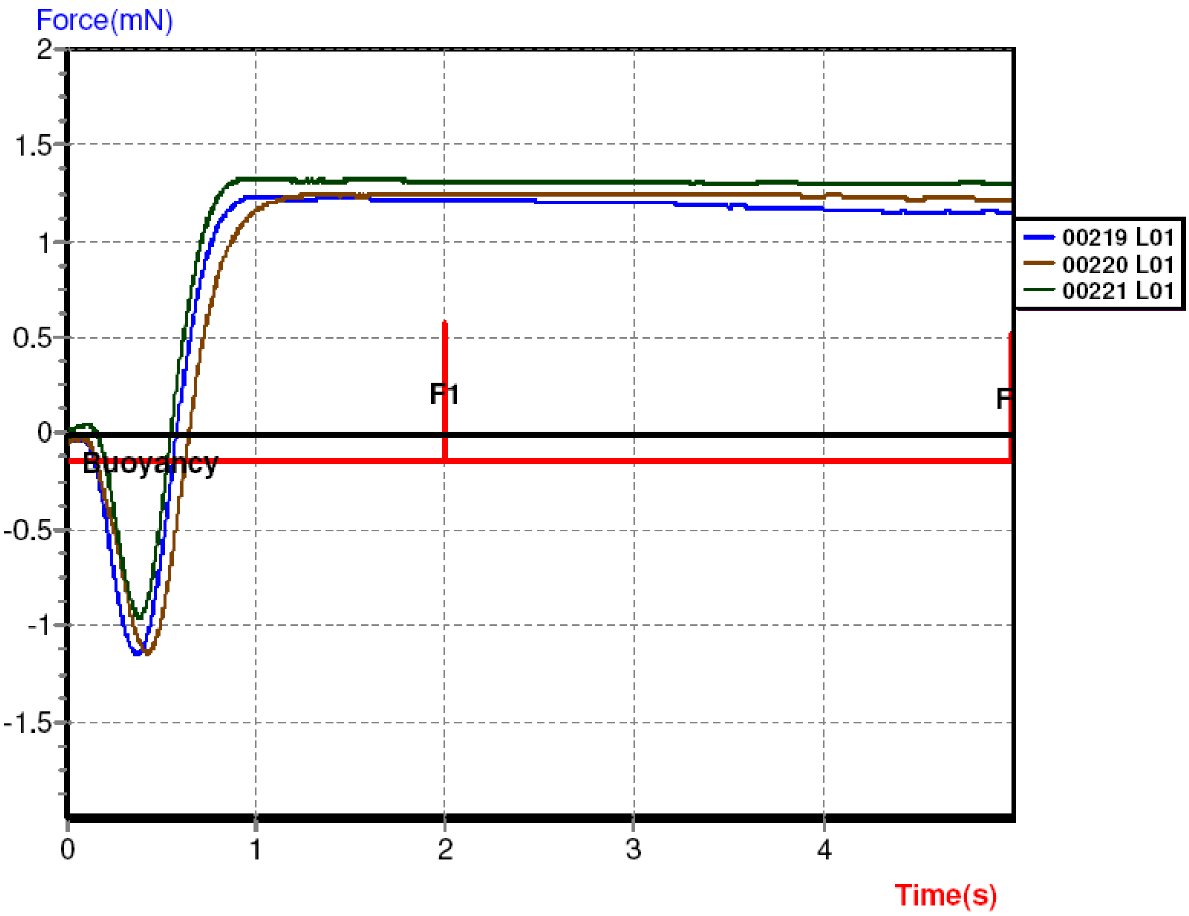
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00219 L01	0.564	0.579	0.711	1.354	1.285	1.236	0.981	Pass
SN100C Alloy	00220 L01	0.624	0.642	0.801	1.388	1.357	1.250	1.770	Fail
SN100C Alloy	00221 L01	0.534	0.549	0.681	1.450	1.440	1.333	0.945	Pass
	Standard Dev	0.046	0.047	0.062	0.049	0.078	0.052	0.466	
	Mean	0.574	0.590	0.731	1.398	1.361	1.273	1.232	
	Max	0.624	0.642	0.801	1.450	1.440	1.333	1.770	
	Min	0.534	0.549	0.681	1.354	1.285	1.236	0.945	

Number of Tests : 003 Passing rate : 66.7 %



RUN 45

Test Details

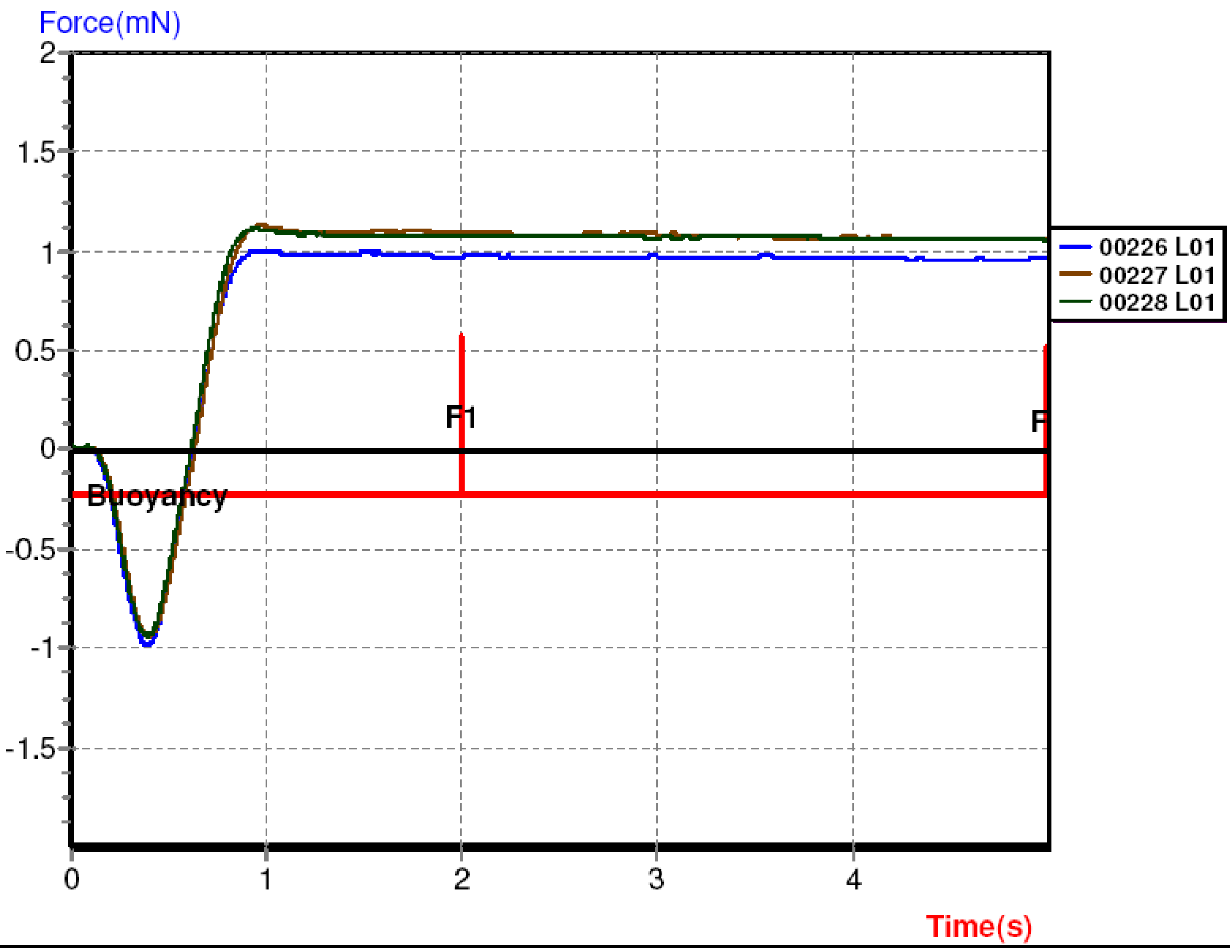
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00226 L01	0.576	0.624	0.753	1.205	1.195	1.002	0.939	Pass
SN100C Alloy	00227 L01	0.588	0.633	0.771	1.329	1.302	1.129	0.951	Pass
SN100C Alloy	00228 L01	0.567	0.615	0.744	1.312	1.288	1.116	0.924	Pass
	Standard Dev	0.011	0.009	0.014	0.067	0.058	0.070	0.014	
	Mean	0.577	0.624	0.756	1.282	1.262	1.082	0.938	
	Max	0.588	0.633	0.771	1.329	1.302	1.129	0.951	
	Min	0.567	0.615	0.744	1.205	1.195	1.002	0.924	

Number of Tests : 003   Passing rate : 100.0 %



RUN 46

Test Details

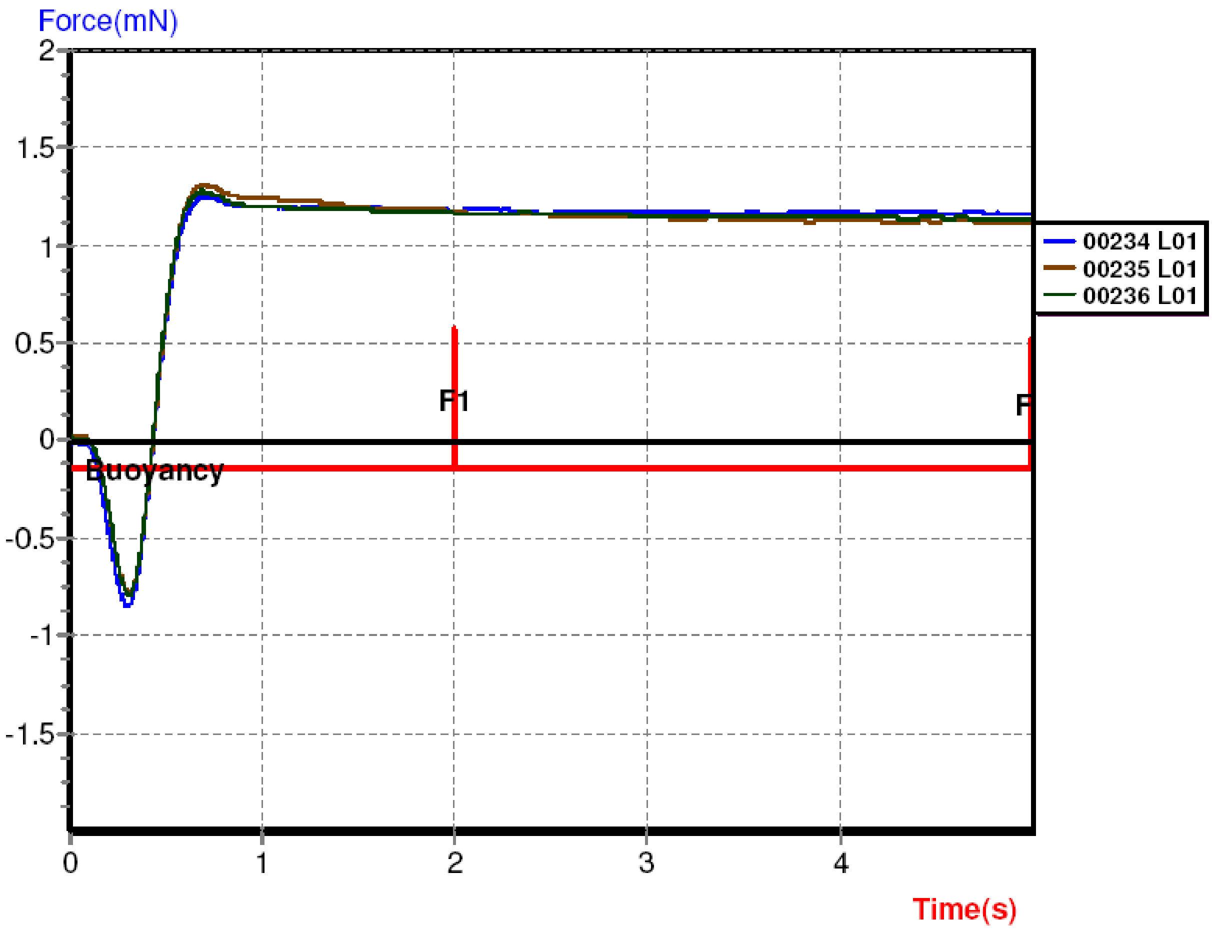
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00234 L01	0.420	0.432	0.531	1.320	1.302	1.253	0.708	Pass
SN100C Alloy	00235 L01	0.417	0.432	0.528	1.309	1.258	1.312	0.690	Pass
SN100C Alloy	00236 L01	0.414	0.429	0.525	1.306	1.278	1.281	0.684	Pass
	Standard Dev	0.003	0.002	0.003	0.007	0.022	0.029	0.012	
	Mean	0.417	0.431	0.528	1.312	1.279	1.282	0.694	
	Max	0.420	0.432	0.531	1.320	1.302	1.312	0.708	
	Min	0.414	0.429	0.525	1.306	1.258	1.253	0.684	

Number of Tests : 003   Passing rate : 100.0 %



RUN 47

Test Details

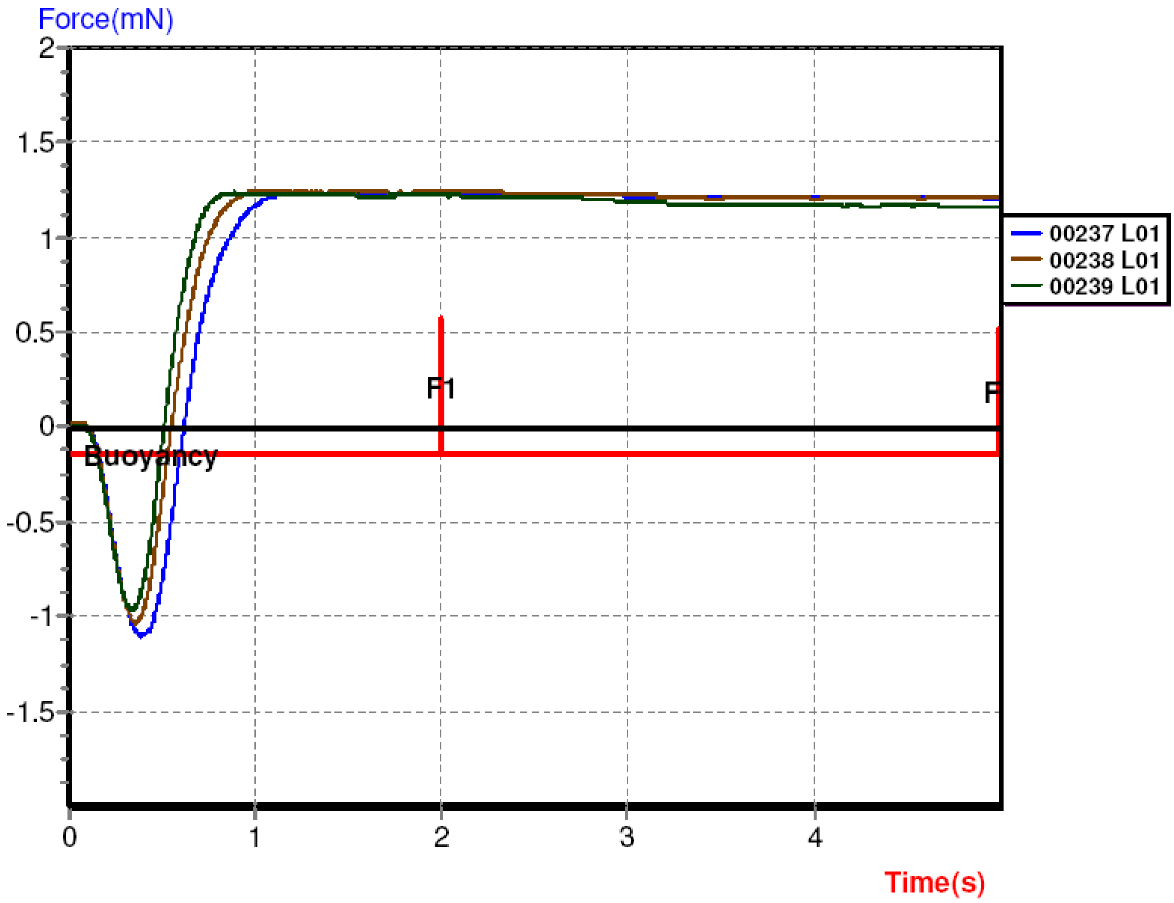
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00237 L01	0.597	0.618	0.786	1.378	1.347	1.240	1.929	Pass
SN100C Alloy	00238 L01	0.531	0.549	0.693	1.382	1.354	1.246	1.029	Pass
SN100C Alloy	00239 L01	0.495	0.510	0.630	1.364	1.299	1.240	0.891	Pass
	Standard Dev	0.052	0.055	0.078	0.009	0.030	0.004	0.564	
	Mean	0.541	0.559	0.703	1.375	1.333	1.242	1.283	
	Max	0.597	0.618	0.786	1.382	1.354	1.246	1.929	
	Min	0.495	0.510	0.630	1.364	1.299	1.240	0.891	

Number of Tests : 003 Passing rate : 100.0 %



RUN 48

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

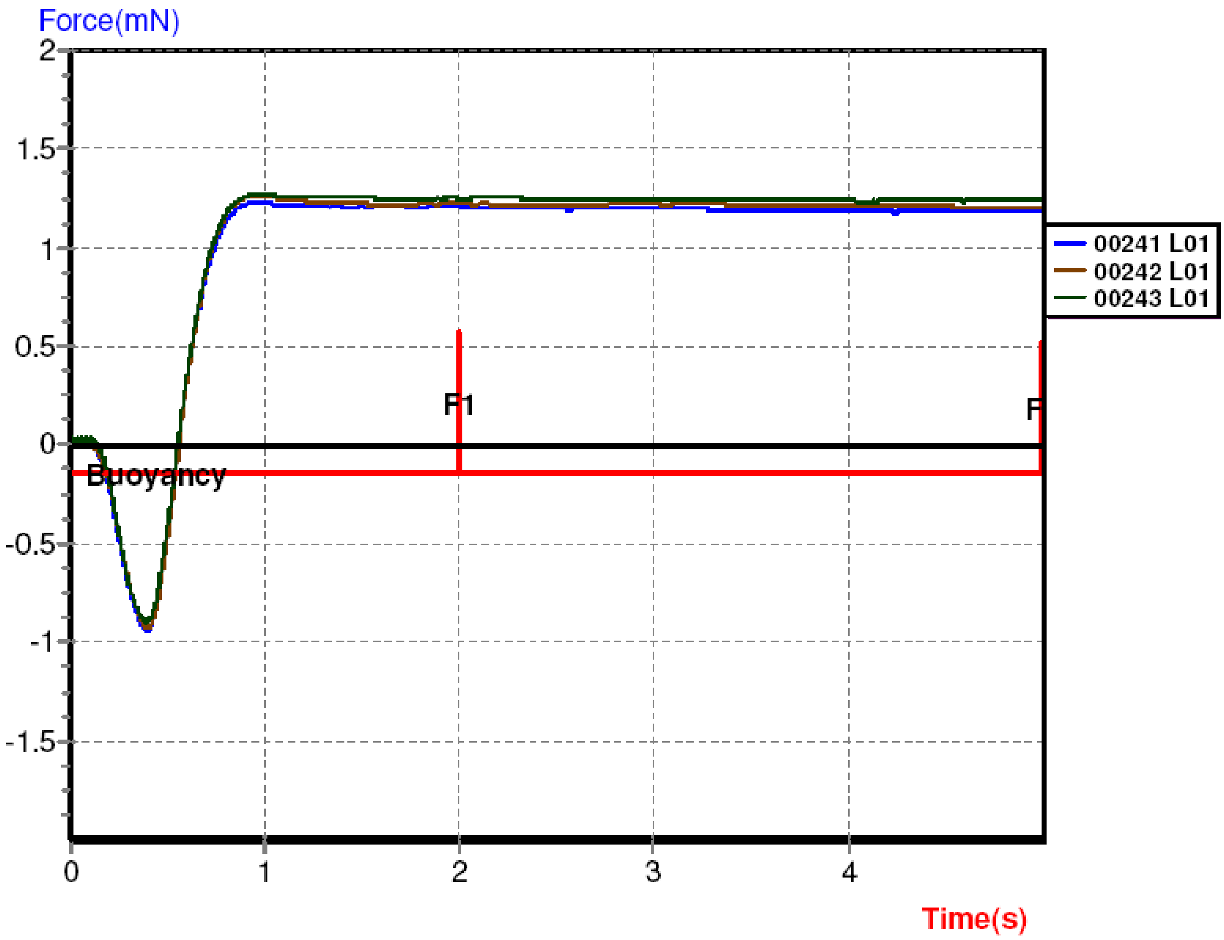
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00241 L01	0.537	0.555	0.684	1.351	1.330	1.229	0.924	Pass
SN100C Alloy	00242 L01	0.543	0.558	0.687	1.364	1.344	1.264	0.921	Pass
SN100C Alloy	00243 L01	0.534	0.552	0.684	1.388	1.378	1.271	0.927	Pass
	Standard Dev	0.005	0.003	0.002	0.019	0.025	0.022	0.003	
	Mean	0.538	0.555	0.685	1.368	1.351	1.255	0.924	
	Max	0.543	0.558	0.687	1.388	1.378	1.271	0.927	
	Min	0.534	0.552	0.684	1.351	1.330	1.229	0.921	

Number of Tests : 003 Passing rate : 100.0 %



RUN 49

Test Details

Component : SN100C Alloy

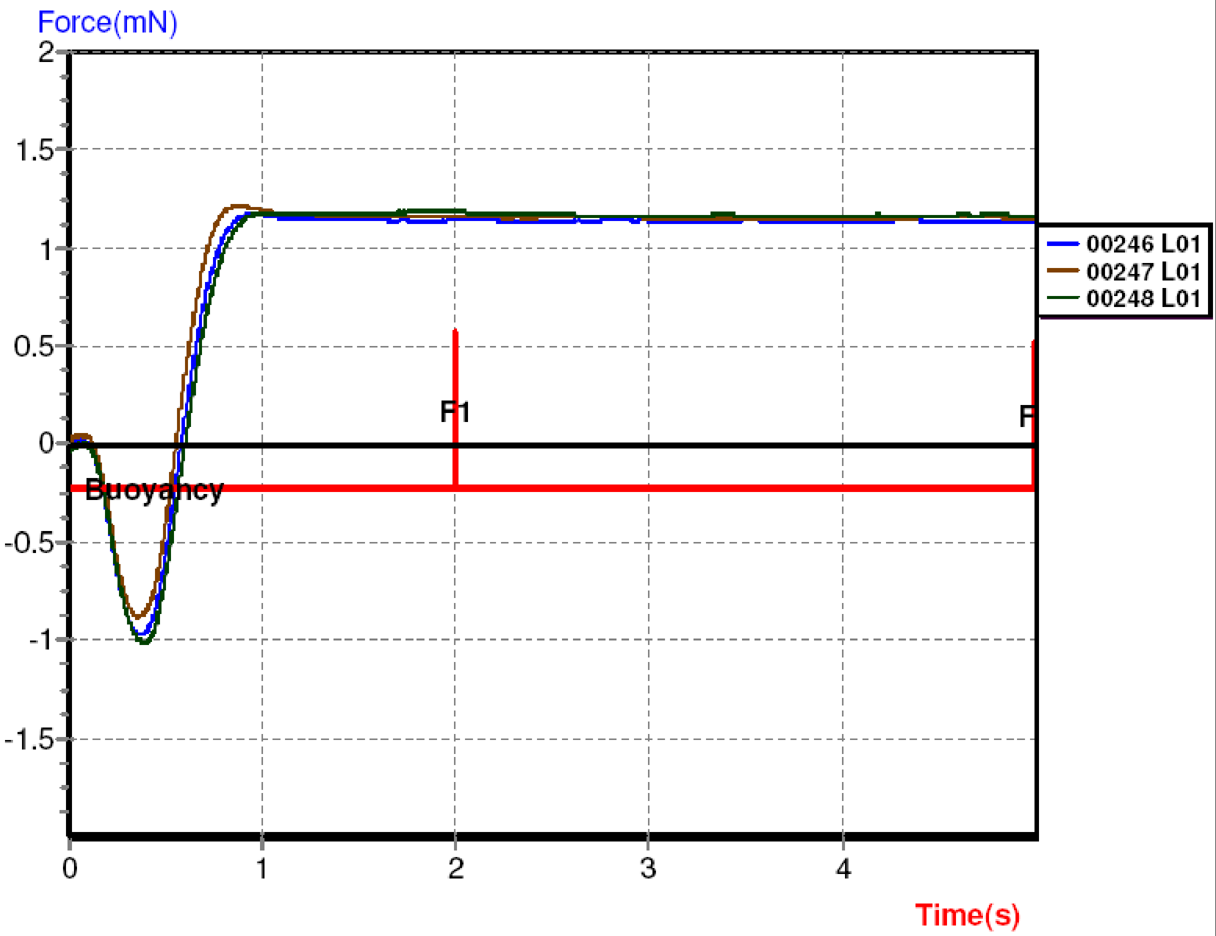
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00246 L01	0.549	0.582	0.708	1.374	1.367	1.178	0.933	Pass
SN100C Alloy	00247 L01	0.525	0.552	0.672	1.391	1.381	1.219	0.867	Pass
SN100C Alloy	00248 L01	0.567	0.600	0.741	1.419	1.398	1.191	1.821	Pass
	Standard Dev	0.021	0.024	0.035	0.023	0.016	0.021	0.533	
	Mean	0.547	0.578	0.707	1.395	1.382	1.196	1.207	
	Max	0.567	0.600	0.741	1.419	1.398	1.219	1.821	
	Min	0.525	0.552	0.672	1.374	1.367	1.178	0.867	

Number of Tests : 003   Passing rate : 100.0 %



RUN 50

Test Details

Component : SN100C Alloy

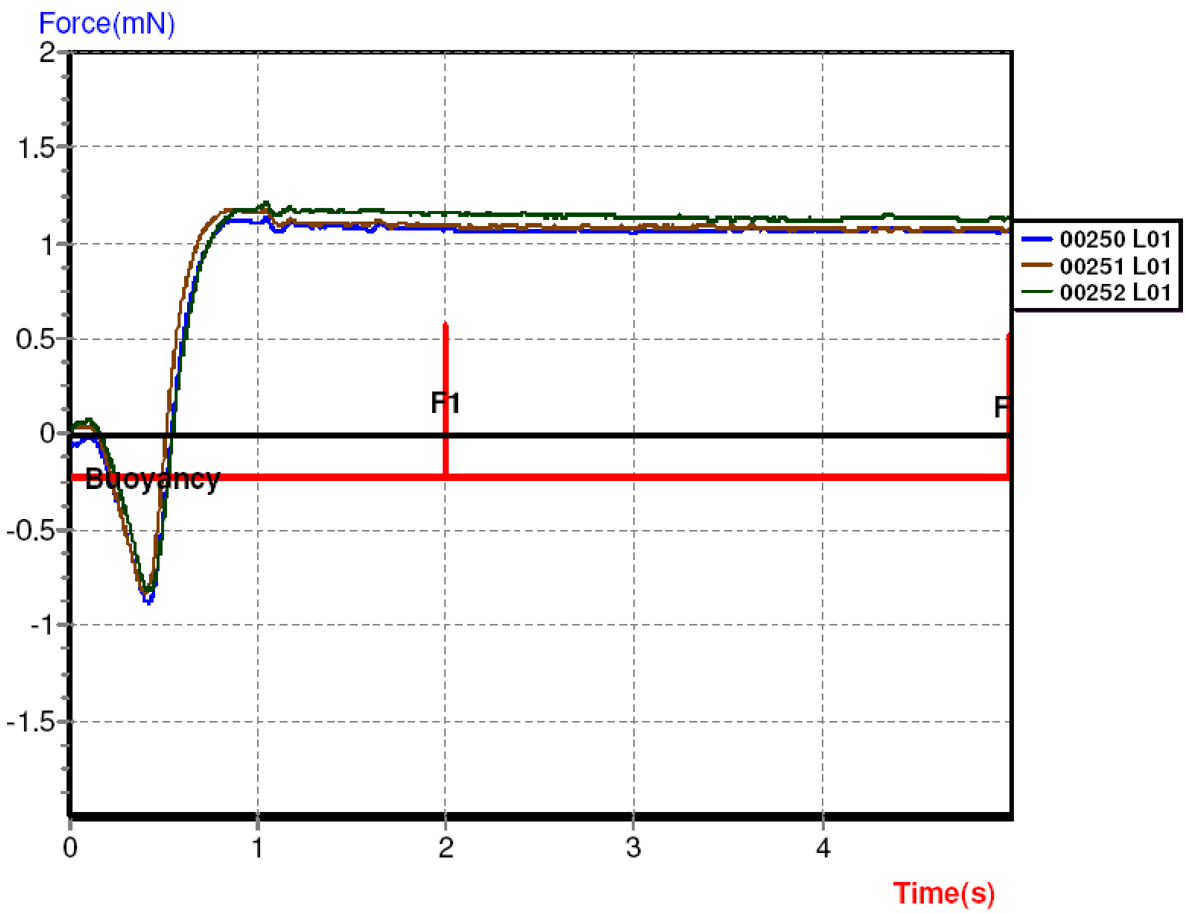
Test parameter filename : Bath Parameters.vts — Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00250 L01	0.519	0.543	0.648	1.309	1.295	1.136	1.041	Pass
SN100C Alloy	00251 L01	0.492	0.513	0.612	1.326	1.305	1.181	0.870	Pass
SN100C Alloy	00252 L01	0.525	0.549	0.672	1.388	1.364	1.212	1.038	Pass
	Standard Dev	0.018	0.019	0.030	0.042	0.037	0.038	0.098	
	Mean	0.512	0.535	0.644	1.341	1.321	1.176	0.983	
	Max	0.525	0.549	0.672	1.388	1.364	1.212	1.041	
	Min	0.492	0.513	0.612	1.309	1.295	1.136	0.870	

Number of Tests : 003 — Passing rate : 100.0 %



RUN 51

Test Details

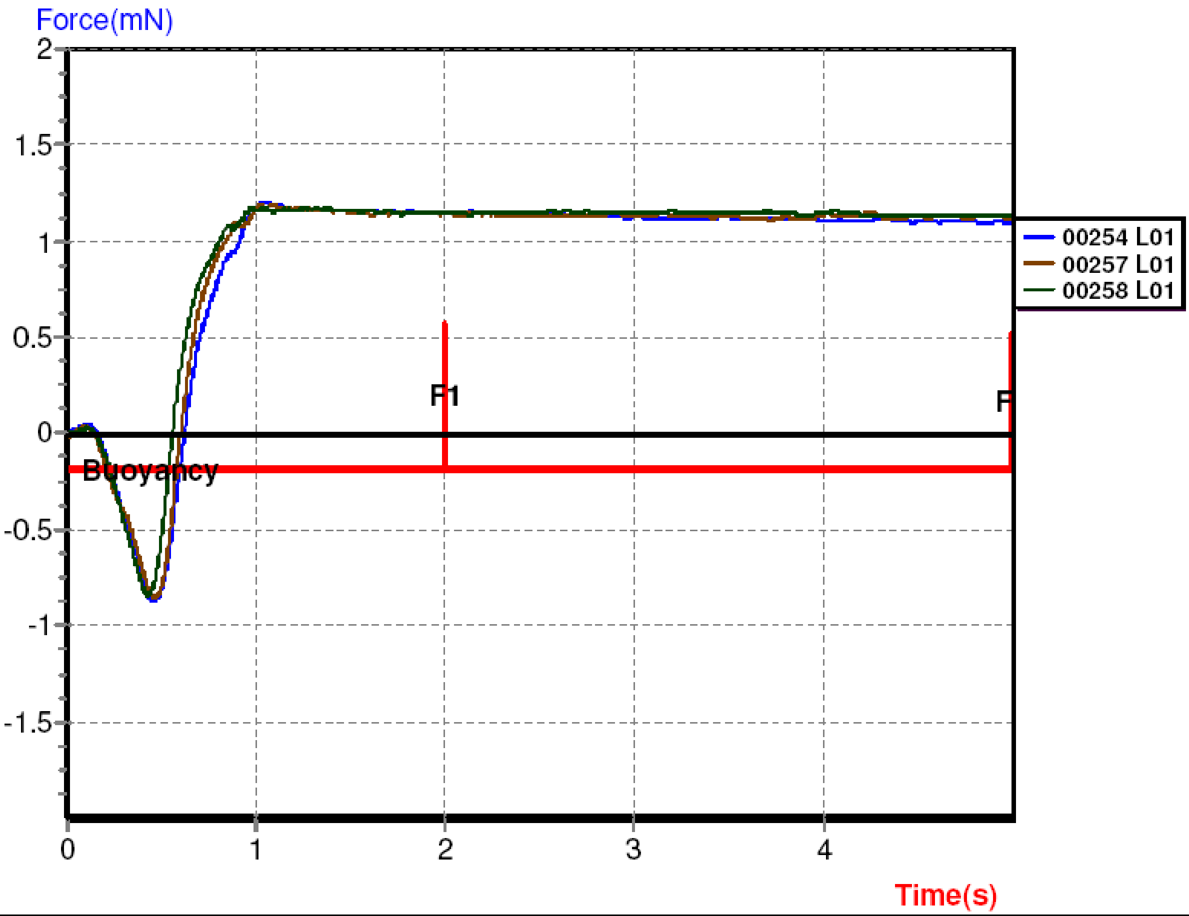
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00254 L01	0.597	0.618	0.798	1.335	1.280	1.202	1.029	Pass
SN100C Alloy	00257 L01	0.582	0.600	0.738	1.331	1.311	1.191	1.074	Pass
SN100C Alloy	00258 L01	0.540	0.558	0.696	1.335	1.318	1.178	1.035	Pass
	Standard Dev	0.030	0.031	0.051	0.002	0.020	0.012	0.024	
	Mean	0.573	0.592	0.744	1.334	1.303	1.190	1.046	
	Max	0.597	0.618	0.798	1.335	1.318	1.202	1.074	
	Min	0.540	0.558	0.696	1.331	1.280	1.178	1.029	

Number of Tests : 003 Passing rate : 100.0 %



RUN 52

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

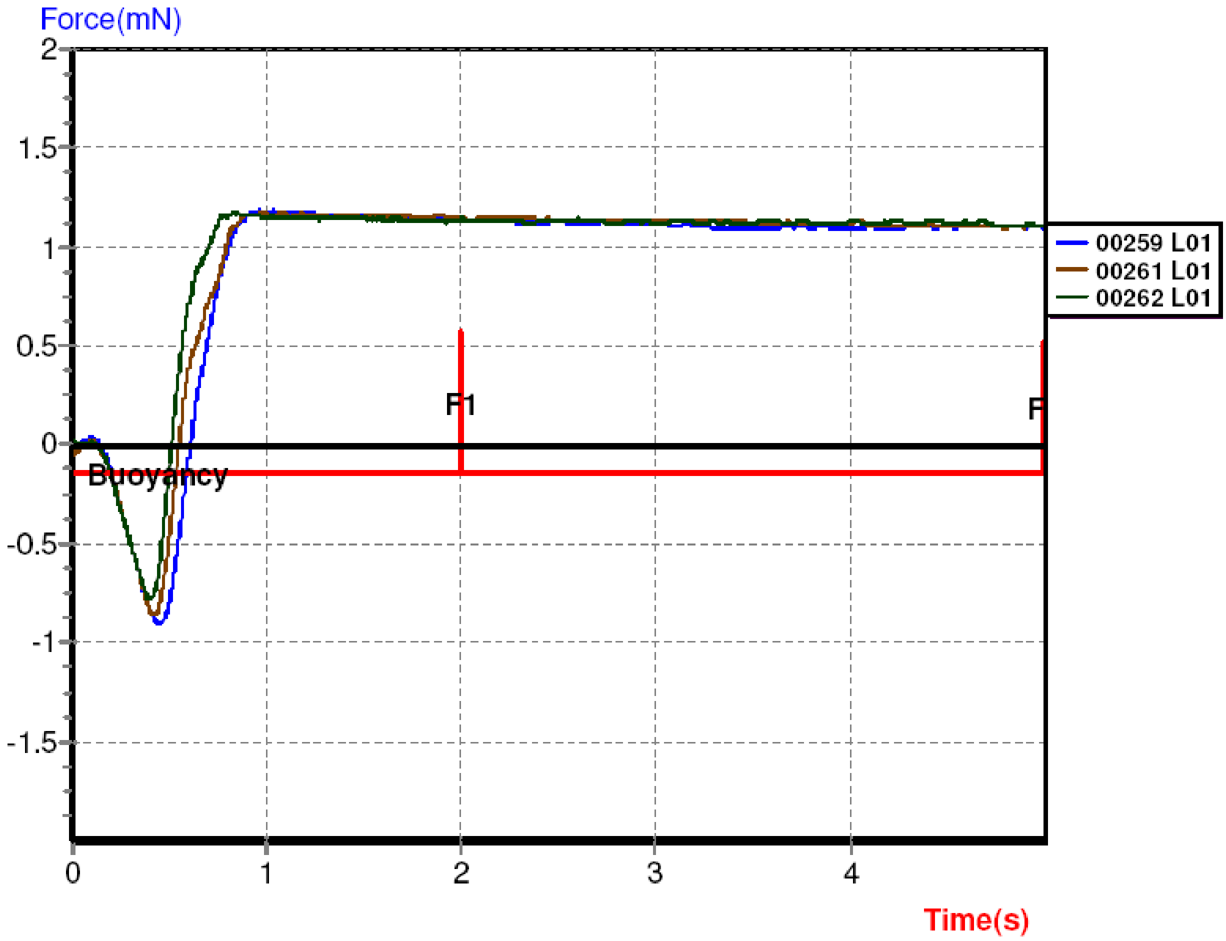
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00259 L01	0.591	0.609	0.744	1.275	1.237	1.185	0.963	Pass
SN100C Alloy	00261 L01	0.534	0.549	0.726	1.285	1.244	1.174	1.077	Pass
SN100C Alloy	00262 L01	0.498	0.510	0.615	1.282	1.251	1.174	0.825	Pass
	Standard Dev	0.047	0.050	0.070	0.005	0.007	0.006	0.126	
	Mean	0.541	0.556	0.695	1.281	1.244	1.178	0.955	
	Max	0.591	0.609	0.744	1.285	1.251	1.185	1.077	
	Min	0.498	0.510	0.615	1.275	1.237	1.174	0.825	

Number of Tests : 003 Passing rate : 100.0 %



RUN 53

Test Details

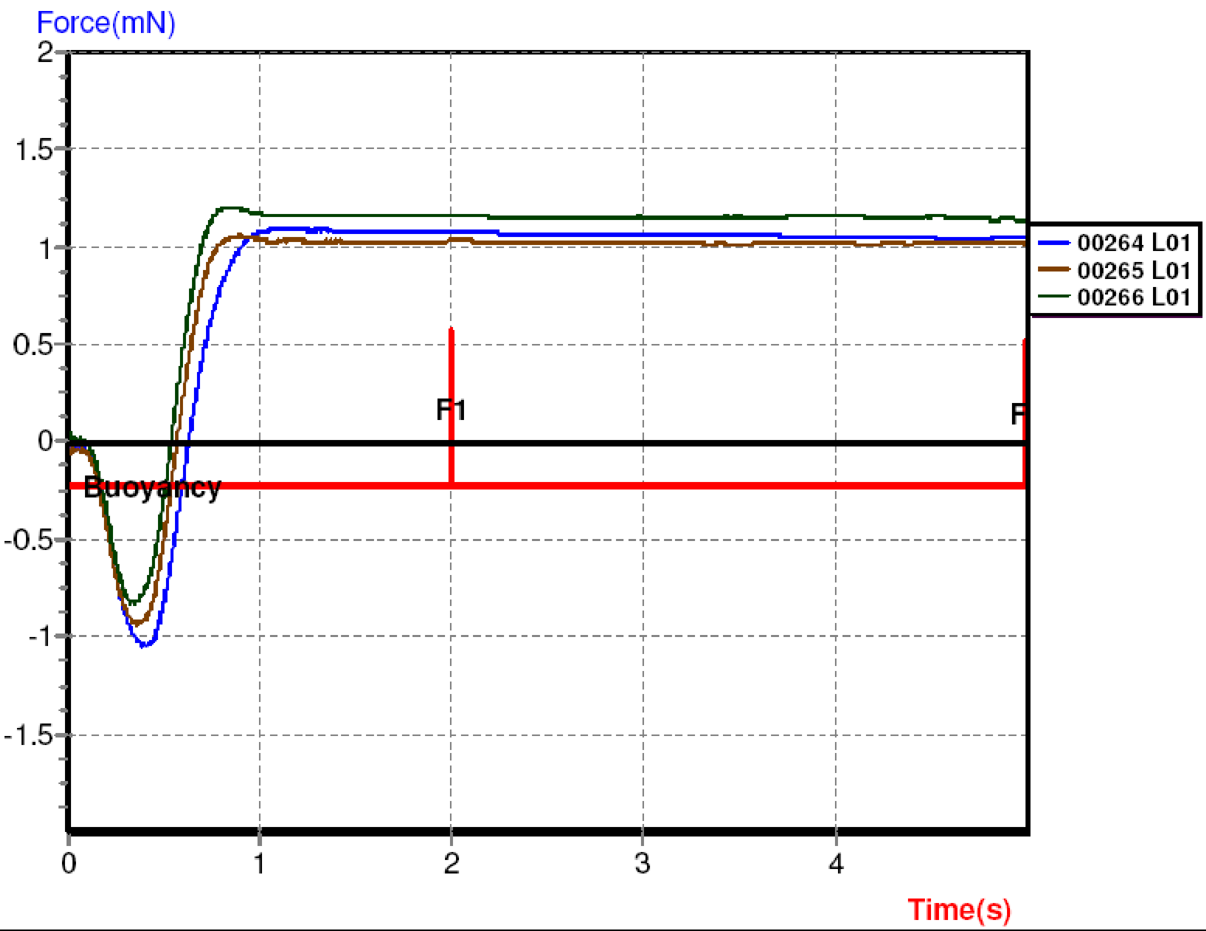
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00264 L01	0.594	0.627	0.774	1.312	1.281	1.098	1.119	Pass
SN100C Alloy	00265 L01	0.537	0.570	0.678	1.264	1.247	1.061	0.891	Pass
SN100C Alloy	00266 L01	0.507	0.537	0.648	1.391	1.371	1.205	0.825	Pass
	Standard Dev	0.044	0.046	0.066	0.064	0.064	0.075	0.154	
	Mean	0.546	0.578	0.700	1.322	1.299	1.121	0.945	
	Max	0.594	0.627	0.774	1.391	1.371	1.205	1.119	
	Min	0.507	0.537	0.648	1.264	1.247	1.061	0.825	

Number of Tests : 003 Passing rate : 100.0 %



RUN 54

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

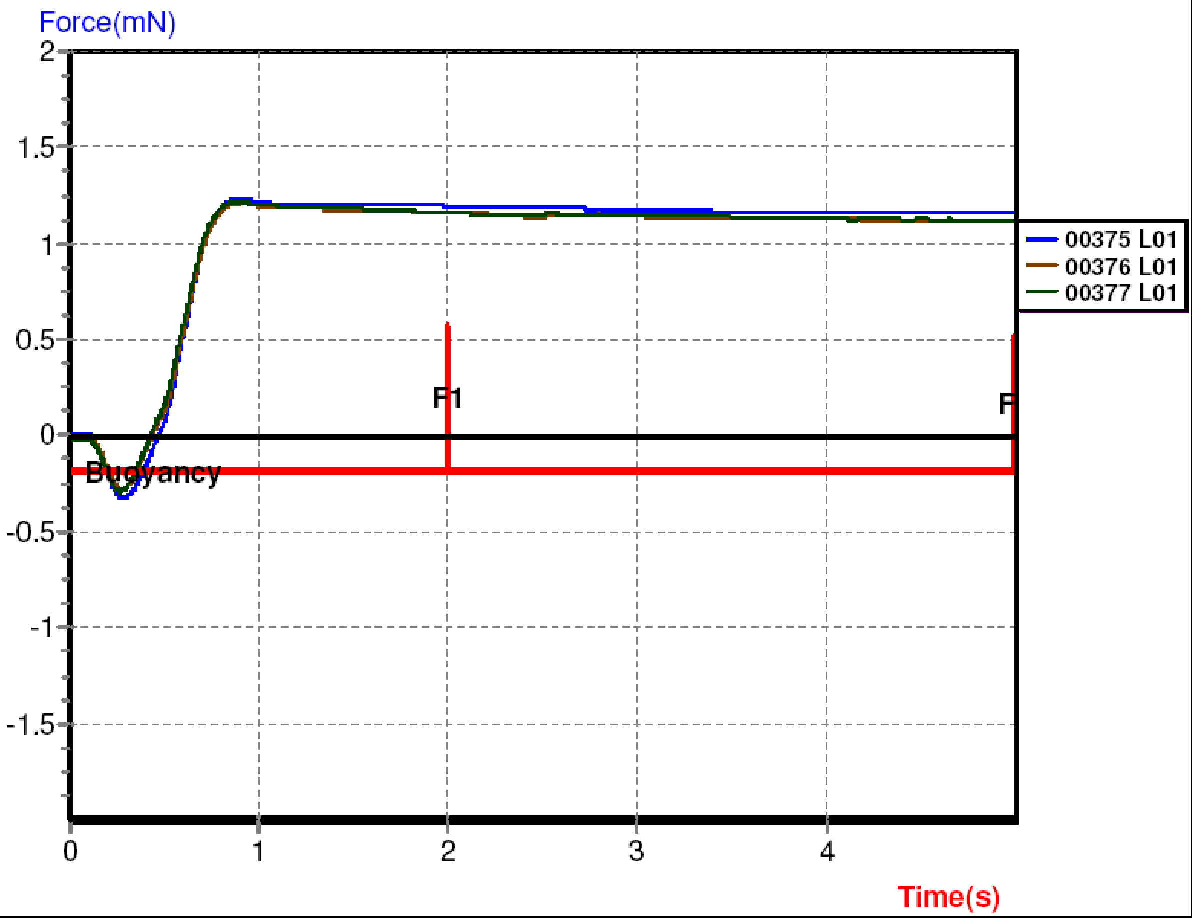
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00375 L01	0.390	0.468	0.663	1.380	1.342	1.233	0.894	Pass
SN100C Alloy	00376 L01	0.354	0.435	0.657	1.345	1.304	1.215	0.921	Pass
SN100C Alloy	00377 L01	0.348	0.426	0.648	1.345	1.311	1.215	0.870	Pass
	Standard Dev	0.023	0.022	0.008	0.020	0.020	0.010	0.026	
	Mean	0.364	0.443	0.656	1.357	1.319	1.221	0.895	
	Max	0.390	0.468	0.663	1.380	1.342	1.233	0.921	
	Min	0.348	0.426	0.648	1.345	1.304	1.215	0.870	

Number of Tests : 003 Passing rate : 100.0 %



RUN 55

Test Details

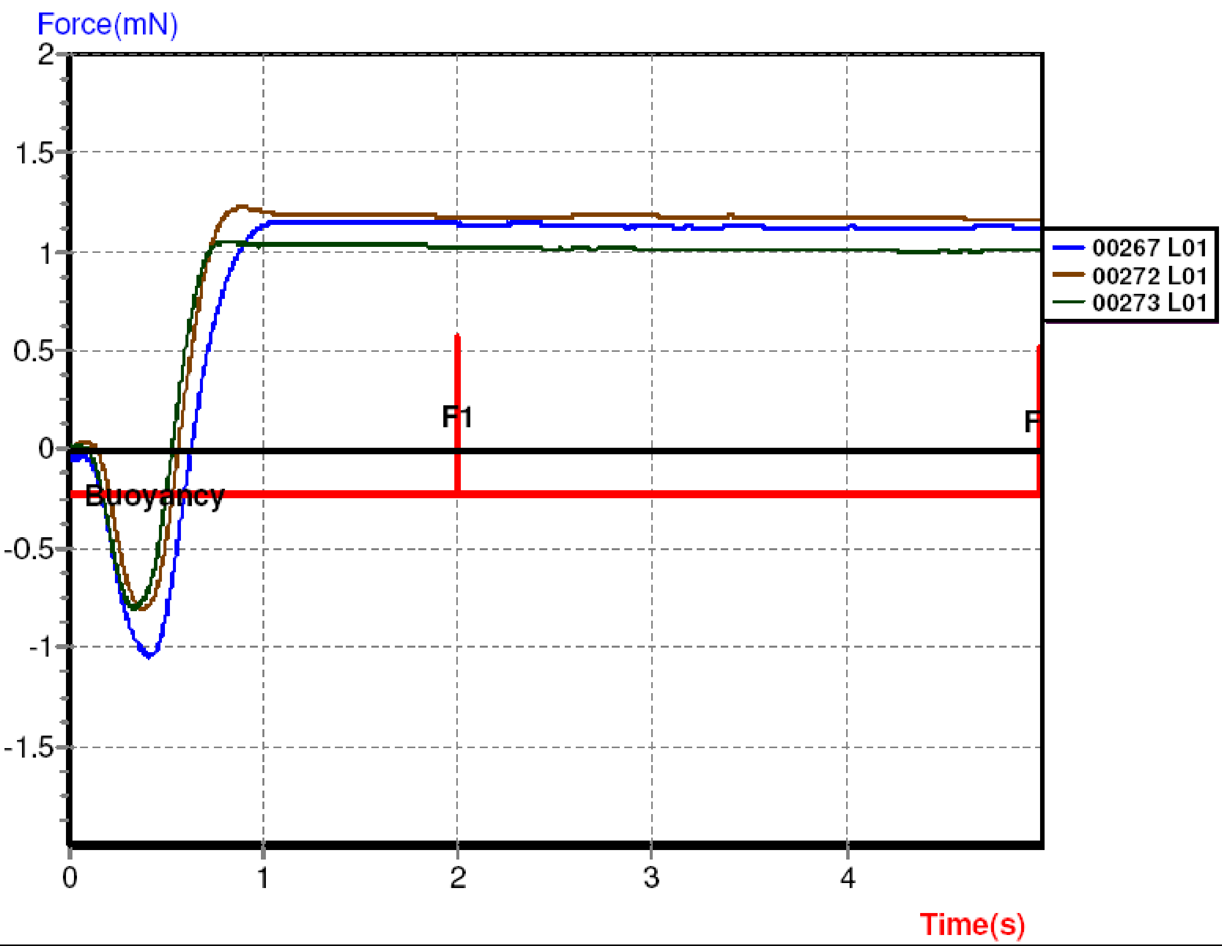
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00267 L01	0.594	0.627	0.780	1.371	1.353	1.154	1.122	Pass
SN100C Alloy	00272 L01	0.531	0.561	0.678	1.408	1.391	1.229	0.867	Pass
SN100C Alloy	00273 L01	0.501	0.531	0.630	1.254	1.240	1.057	0.801	Pass
	Standard Dev	0.047	0.049	0.077	0.081	0.079	0.086	0.170	
	Mean	0.542	0.573	0.696	1.344	1.328	1.147	0.930	
	Max	0.594	0.627	0.780	1.408	1.391	1.229	1.122	
	Min	0.501	0.531	0.630	1.254	1.240	1.057	0.801	

Number of Tests : 003 Passing rate : 100.0 %



RUN 56

Test Details

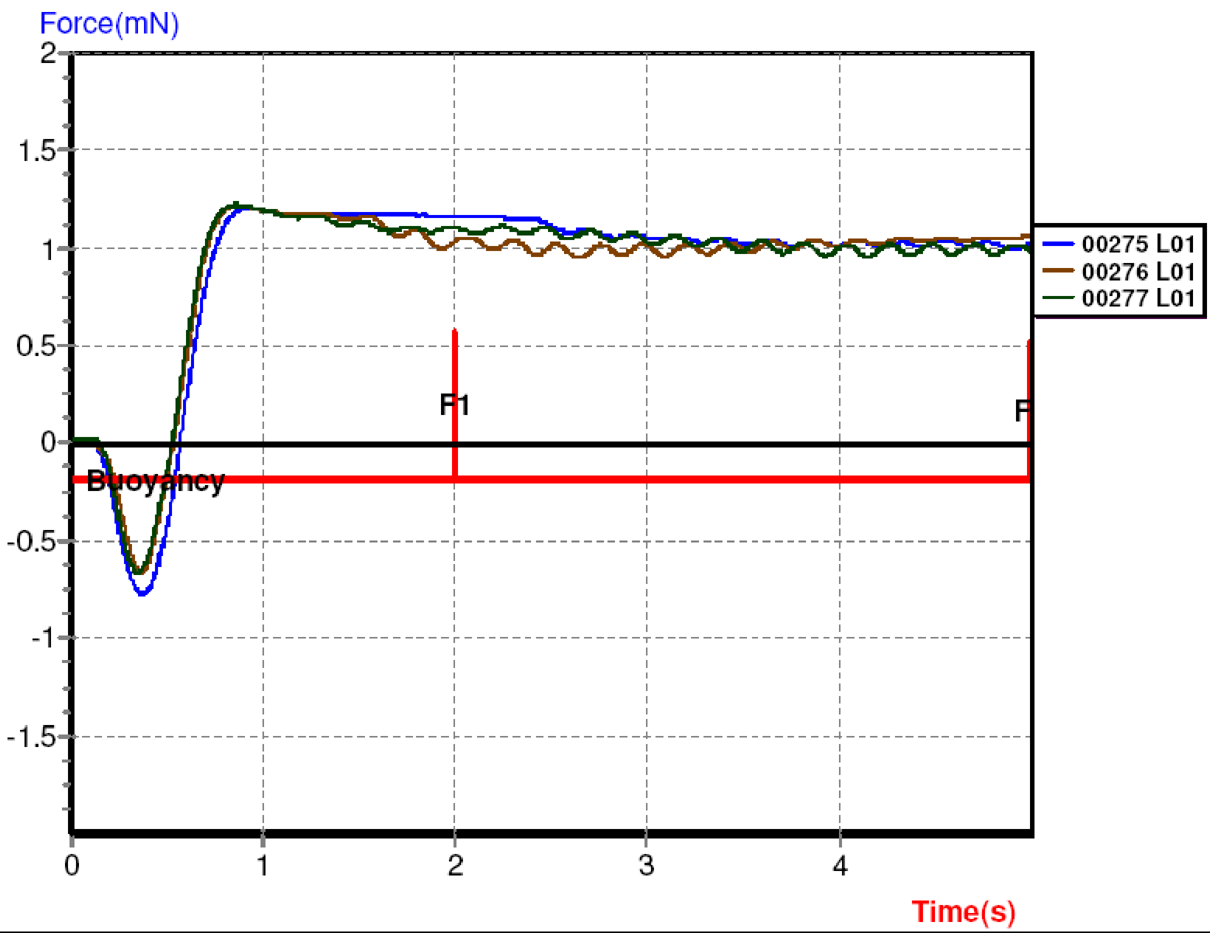
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00275 L01	0.543	0.567	0.696	1.345	1.207	1.209	0.924	Pass
SN100C Alloy	00276 L01	0.498	0.534	0.663	1.225	1.245	1.219	0.855	Pass
SN100C Alloy	00277 L01	0.492	0.525	0.651	1.293	1.169	1.226	0.849	Pass
	Standard Dev	0.028	0.022	0.023	0.060	0.038	0.009	0.042	
	Mean	0.511	0.542	0.670	1.288	1.207	1.218	0.876	
	Max	0.543	0.567	0.696	1.345	1.245	1.226	0.924	
	Min	0.492	0.525	0.651	1.225	1.169	1.209	0.849	

Number of Tests : 003 Passing rate : 100.0 %



RUN 57

Test Details

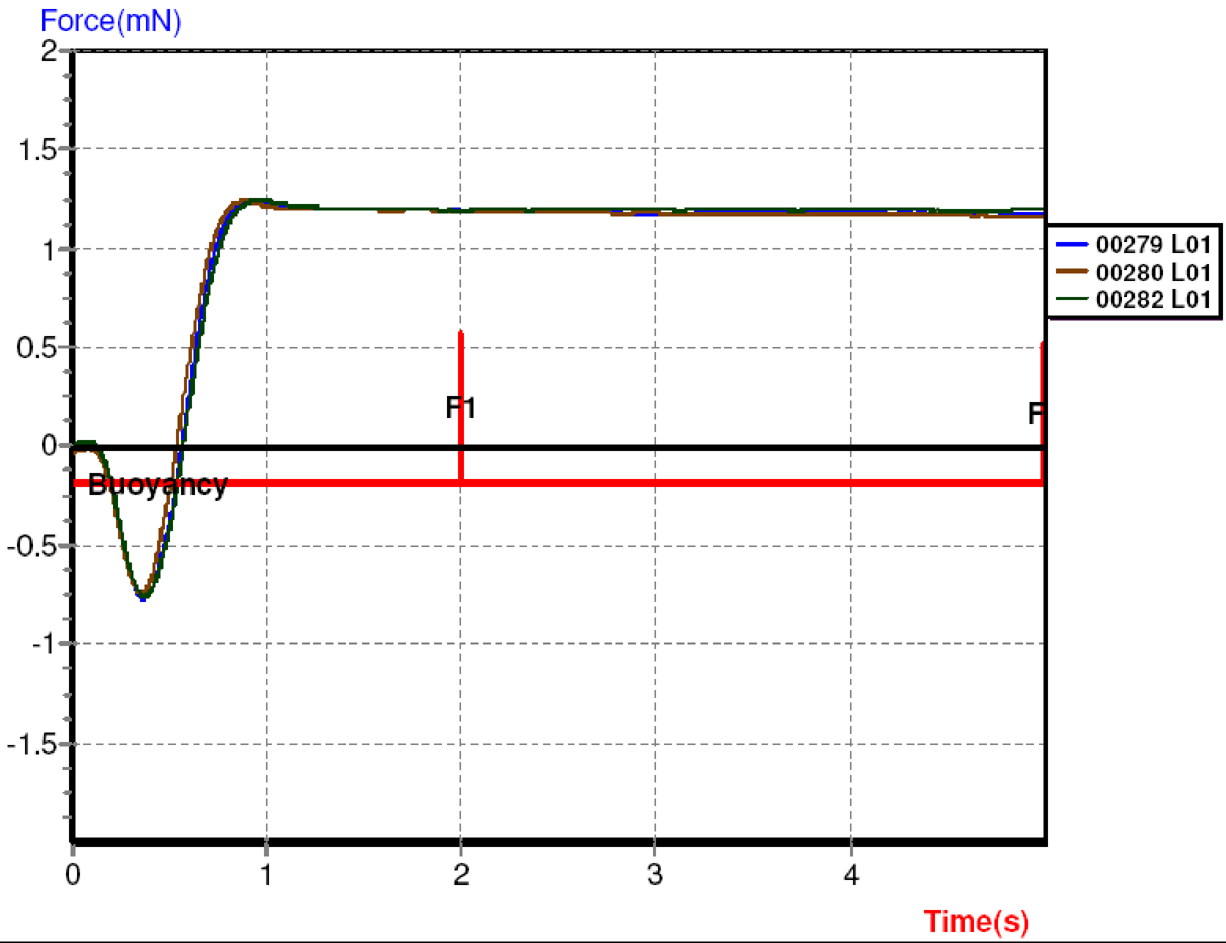
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00279 L01	0.537	0.564	0.690	1.380	1.362	1.236	0.906	Pass
SN100C Alloy	00280 L01	0.507	0.537	0.669	1.373	1.345	1.240	0.864	Pass
SN100C Alloy	00282 L01	0.543	0.573	0.711	1.380	1.383	1.246	0.939	Pass
	Standard Dev	0.019	0.019	0.021	0.004	0.019	0.005	0.038	
	Mean	0.529	0.558	0.690	1.377	1.363	1.241	0.903	
	Max	0.543	0.573	0.711	1.380	1.383	1.246	0.939	
	Min	0.507	0.537	0.669	1.373	1.345	1.236	0.864	

Number of Tests : 003 Passing rate : 100.0 %



RUN 58

Test Details

Component : SN100C Alloy

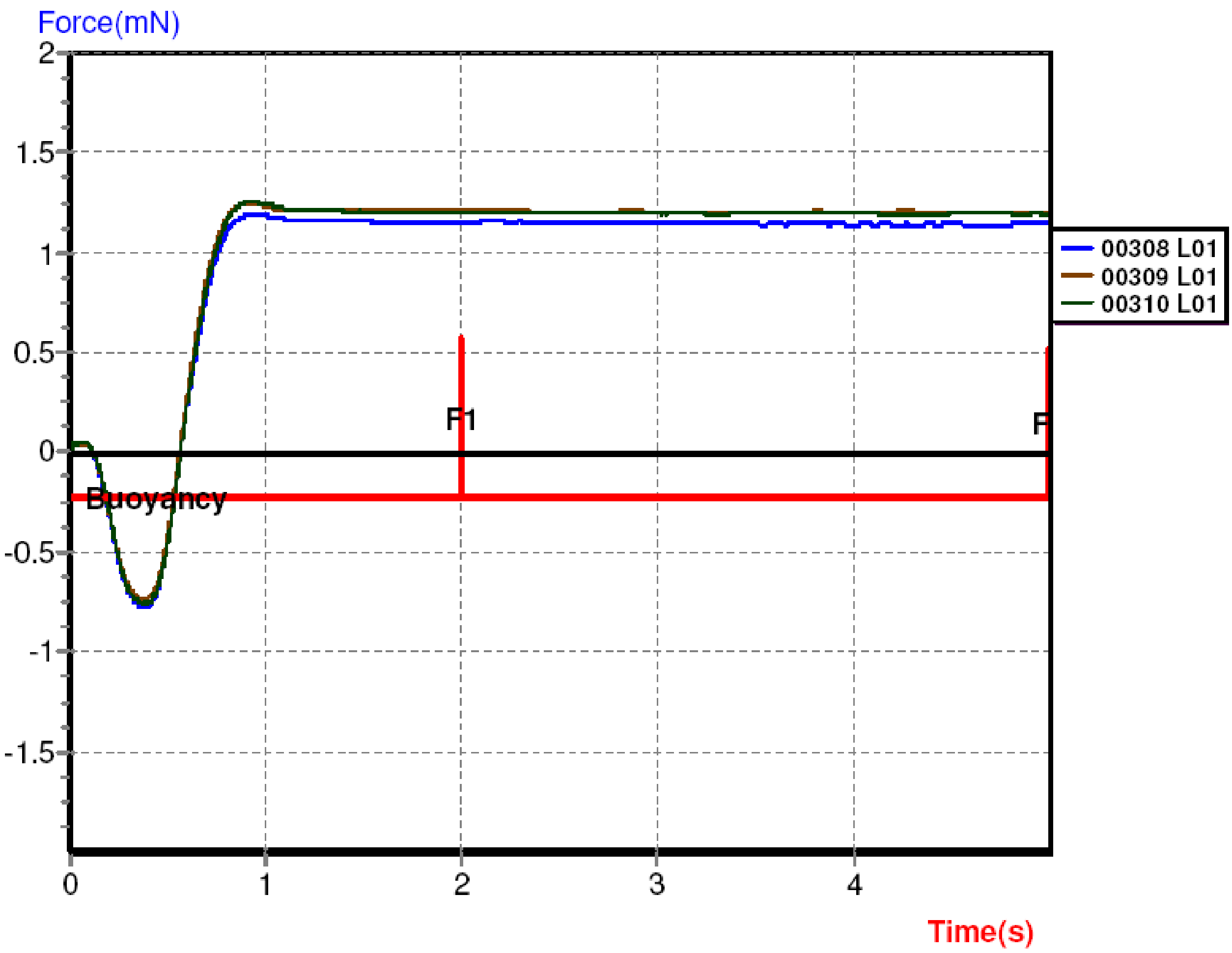
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00308 L01	0.534	0.567	0.696	1.381	1.374	1.191	0.912	Pass
SN100C Alloy	00309 L01	0.528	0.561	0.690	1.443	1.429	1.250	0.909	Pass
SN100C Alloy	00310 L01	0.534	0.567	0.699	1.436	1.426	1.257	0.903	Pass
	Standard Dev	0.003	0.003	0.005	0.034	0.031	0.036	0.005	
	Mean	0.532	0.565	0.695	1.420	1.410	1.233	0.908	
	Max	0.534	0.567	0.699	1.443	1.429	1.257	0.912	
	Min	0.528	0.561	0.690	1.381	1.374	1.191	0.903	

Number of Tests : 003   Passing rate : 100.0 %



RUN 59

Test Details

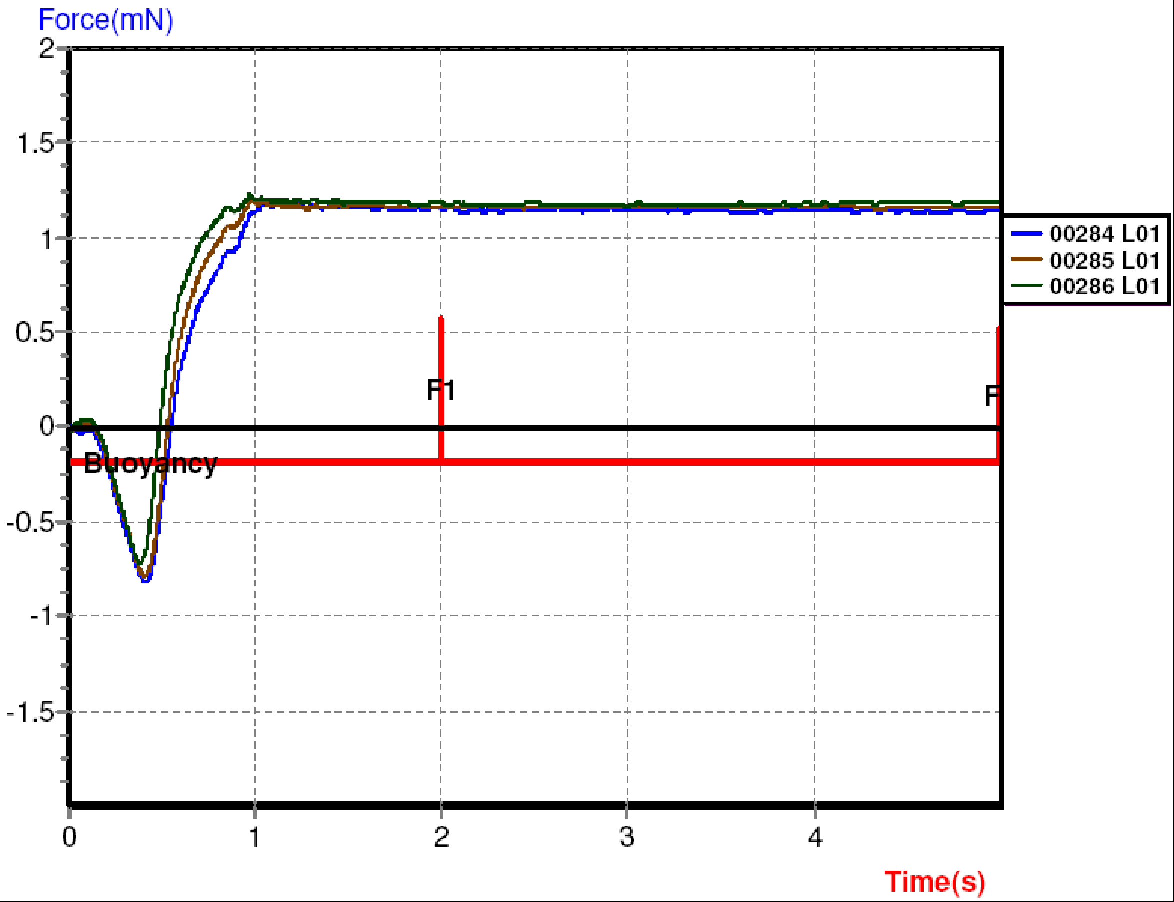
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00284 L01	0.528	0.552	0.774	1.335	1.328	1.188	1.053	Pass
SN100C Alloy	00285 L01	0.510	0.531	0.699	1.352	1.345	1.202	0.984	Pass
SN100C Alloy	00286 L01	0.471	0.489	0.639	1.369	1.369	1.226	0.966	Pass
	Standard Dev	0.029	0.032	0.068	0.017	0.021	0.019	0.046	
	Mean	0.503	0.524	0.704	1.352	1.347	1.205	1.001	
	Max	0.528	0.552	0.774	1.369	1.369	1.226	1.053	
	Min	0.471	0.489	0.639	1.335	1.328	1.188	0.966	

Number of Tests : 003 Passing rate : 100.0 %



RUN 60

Test Details

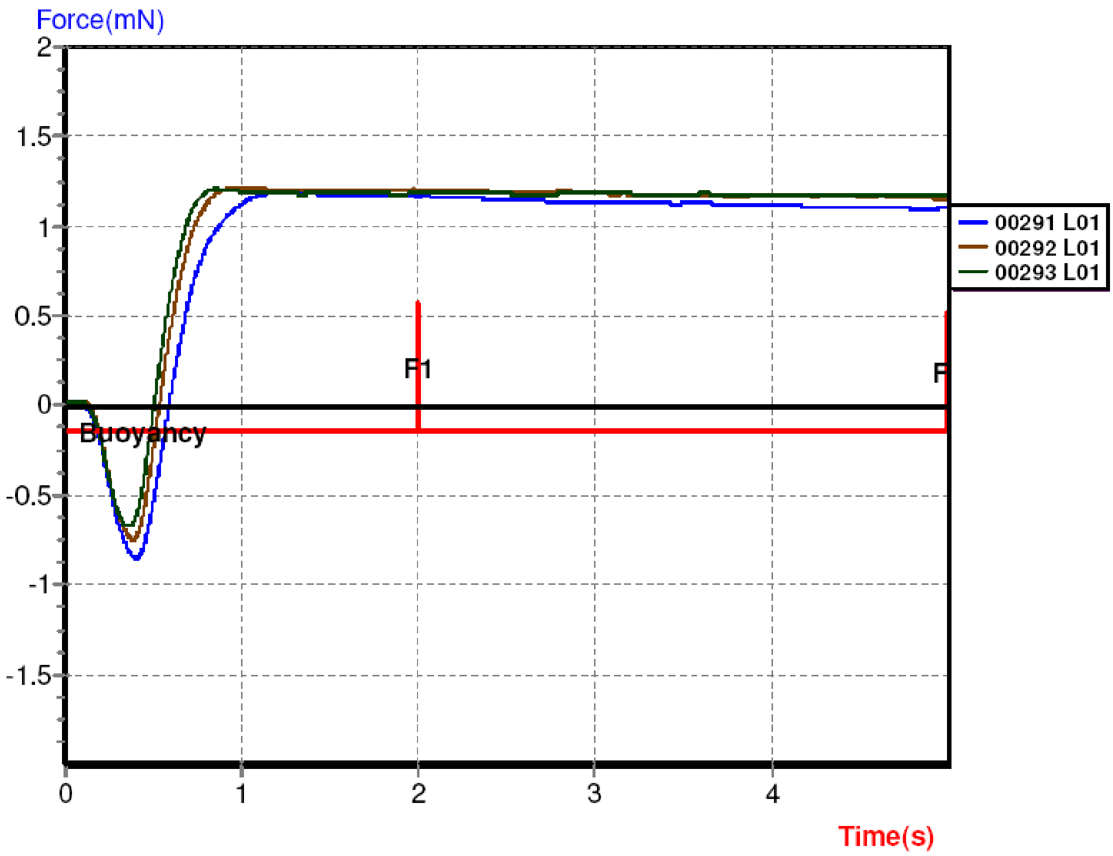
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00291 L01	0.567	0.588	0.762	1.306	1.240	1.195	1.263	Pass
SN100C Alloy	00292 L01	0.516	0.534	0.672	1.347	1.289	1.219	0.933	Pass
SN100C Alloy	00293 L01	0.486	0.504	0.630	1.326	1.309	1.212	0.837	Pass
	Standard Dev	0.041	0.043	0.067	0.021	0.035	0.012	0.223	
	Mean	0.523	0.542	0.688	1.326	1.279	1.209	1.011	
	Max	0.567	0.588	0.762	1.347	1.309	1.219	1.263	
	Min	0.486	0.504	0.630	1.306	1.240	1.195	0.837	

Number of Tests : 003 Passing rate : 100.0 %



RUN 61

Test Details

Component : SN100C Alloy

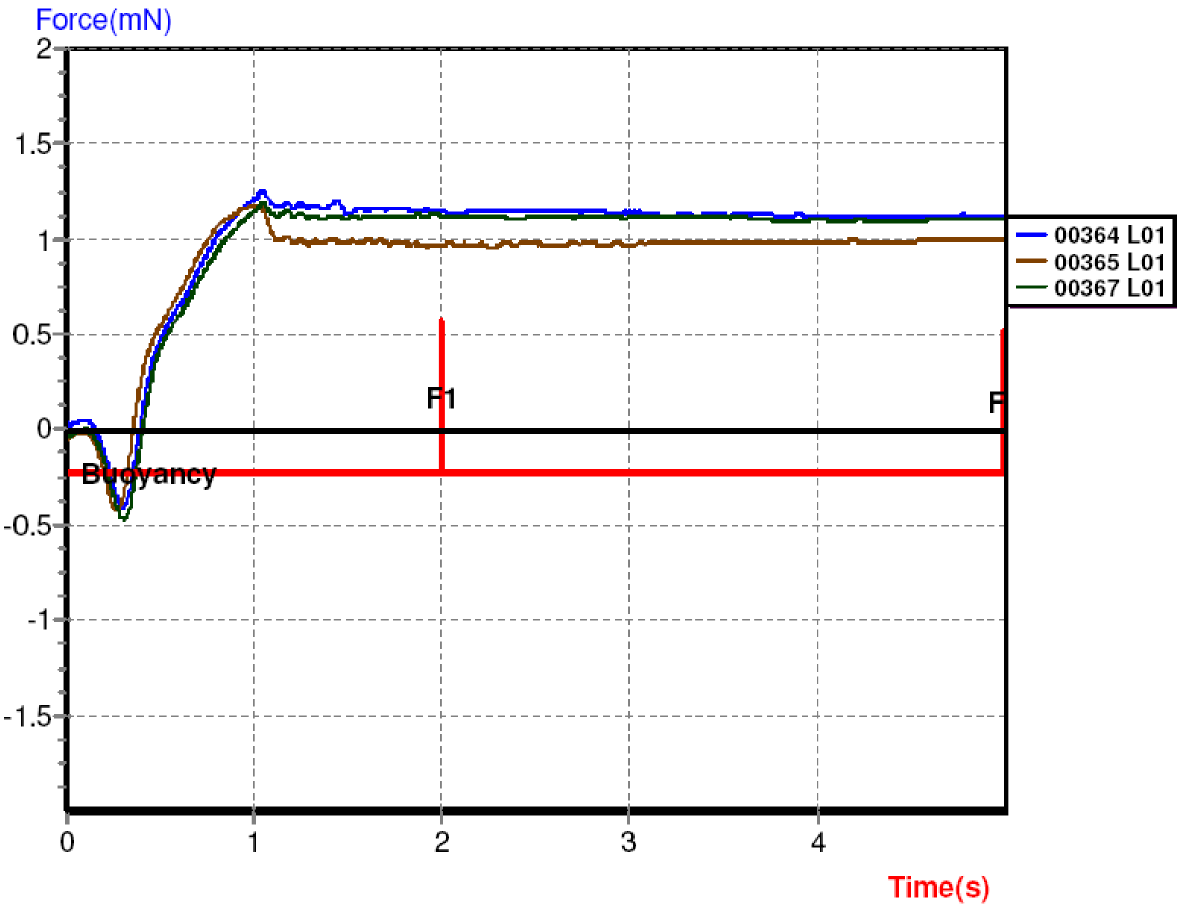
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00364 L01	0.354	0.390	0.702	1.381	1.353	1.257	1.041	Pass
SN100C Alloy	00365 L01	0.324	0.357	0.633	1.205	1.226	1.174	0.978	Pass
SN100C Alloy	00367 L01	0.369	0.405	0.708	1.357	1.340	1.191	1.041	Pass
	Standard Dev	0.023	0.025	0.042	0.095	0.070	0.044	0.036	
	Mean	0.349	0.384	0.681	1.314	1.306	1.207	1.020	
	Max	0.369	0.405	0.708	1.381	1.353	1.257	1.041	
	Min	0.324	0.357	0.633	1.205	1.226	1.174	0.978	

Number of Tests : 003   Passing rate : 100.0 %



RUN 62

Test Details

Component : SN100C Alloy

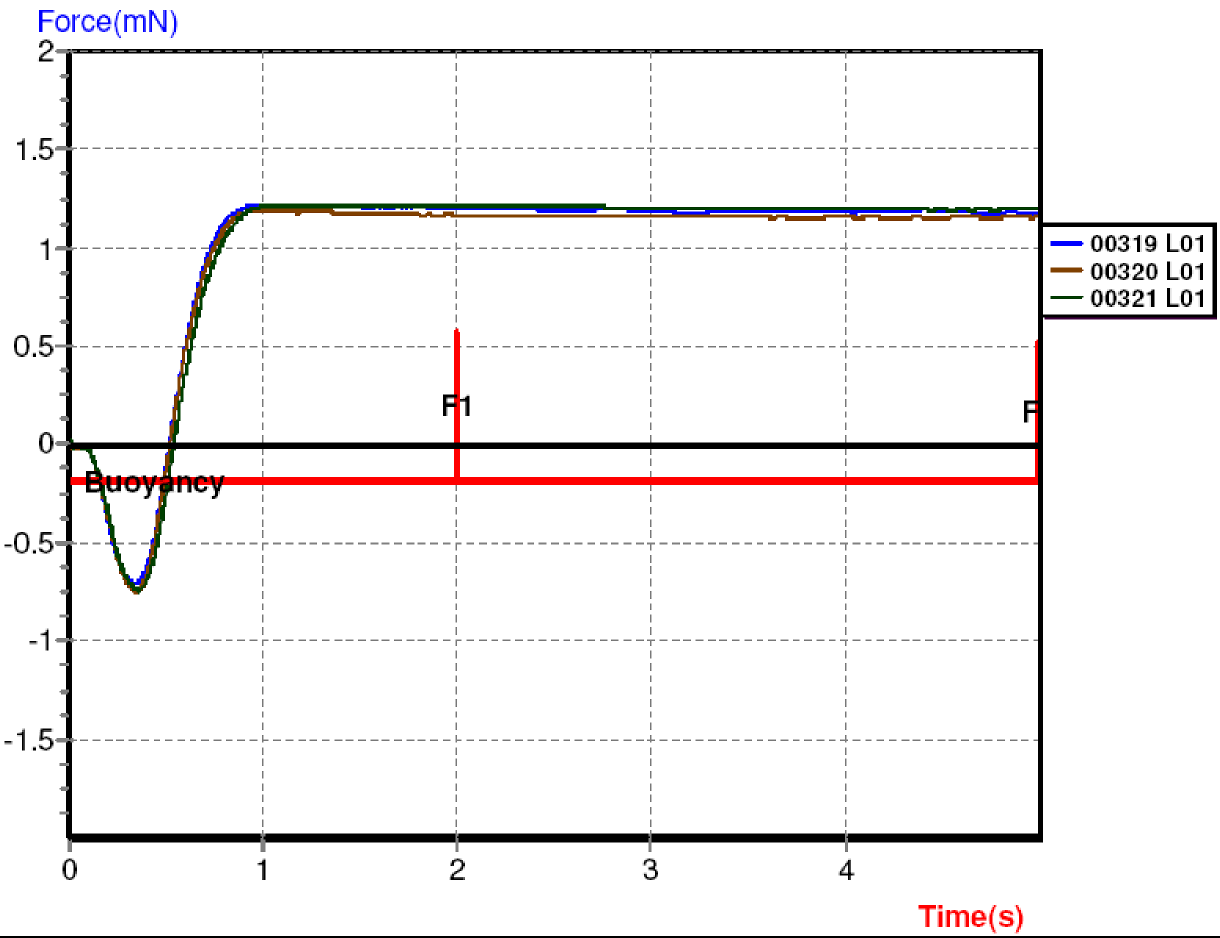
Test parameter filename : Bath Parameters.vts | Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00319 L01	0.489	0.519	0.666	1.390	1.362	1.219	0.954	Pass
SN100C Alloy	00320 L01	0.492	0.522	0.672	1.352	1.342	1.195	0.957	Pass
SN100C Alloy	00321 L01	0.510	0.540	0.705	1.407	1.386	1.222	1.299	Pass
	Standard Dev	0.011	0.011	0.021	0.028	0.022	0.015	0.198	
	Mean	0.497	0.527	0.681	1.383	1.363	1.212	1.070	
	Max	0.510	0.540	0.705	1.407	1.386	1.222	1.299	
	Min	0.489	0.519	0.666	1.352	1.342	1.195	0.954	

Number of Tests : 003 Passing rate : 100.0 %



RUN 63

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

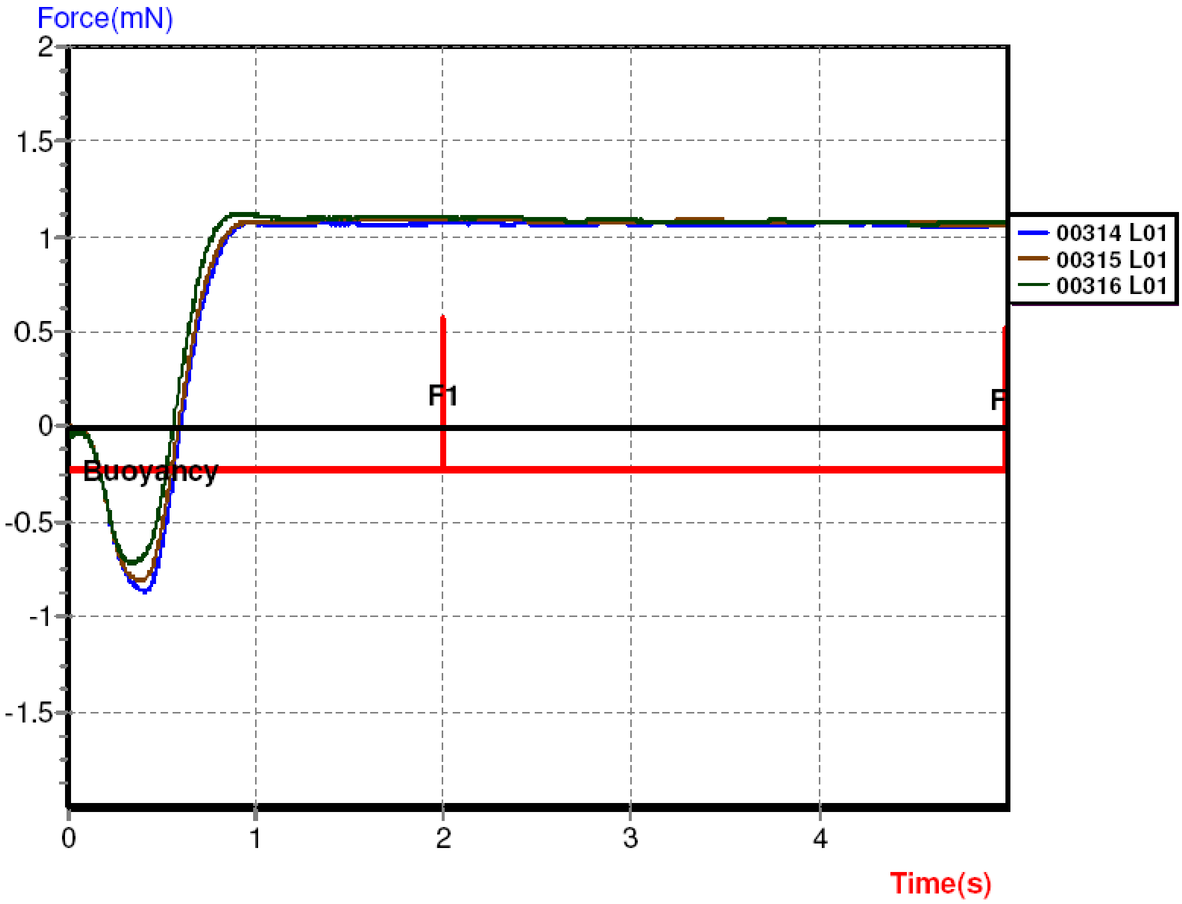
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00314 L01	0.567	0.600	0.735	1.309	1.295	1.081	4.035	Pass
SN100C Alloy	00315 L01	0.552	0.588	0.726	1.326	1.298	1.098	1.800	Pass
SN100C Alloy	00316 L01	0.525	0.561	0.687	1.333	1.315	1.126	0.891	Pass
	Standard Dev	0.021	0.020	0.026	0.012	0.011	0.023	1.618	
	Mean	0.548	0.583	0.716	1.322	1.303	1.102	2.242	
	Max	0.567	0.600	0.735	1.333	1.315	1.126	4.035	
	Min	0.525	0.561	0.687	1.309	1.295	1.081	0.891	

Number of Tests : 003 Passing rate : 100.0 %



RUN 64

Test Details

Component : SN100C Alloy

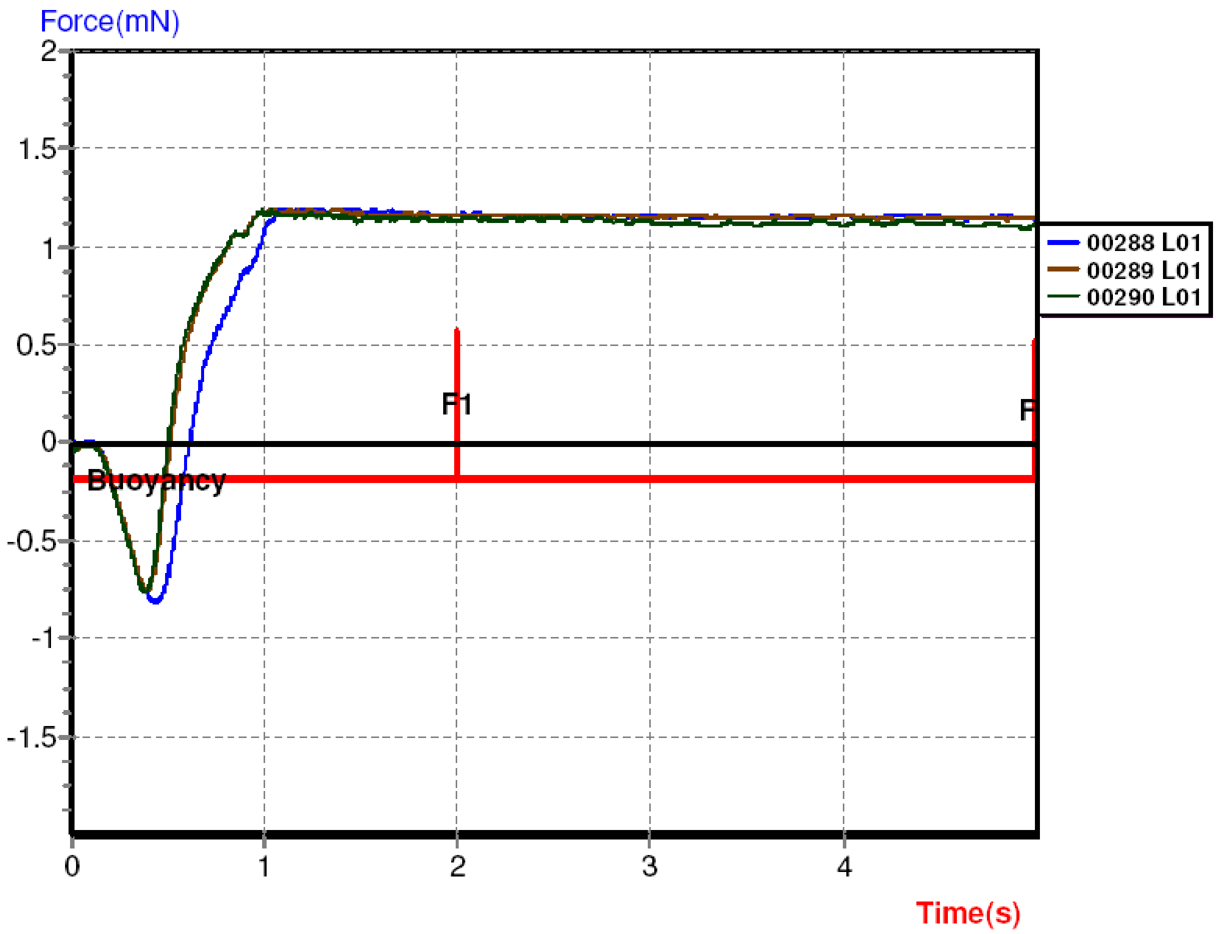
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00288 L01	0.582	0.612	0.858	1.352	1.328	1.195	1.098	Pass
SN100C Alloy	00289 L01	0.492	0.513	0.693	1.345	1.331	1.195	1.362	Pass
SN100C Alloy	00290 L01	0.483	0.501	0.684	1.321	1.300	1.185	0.984	Pass
	Standard Dev	0.055	0.061	0.098	0.016	0.017	0.006	0.194	
	Mean	0.519	0.542	0.745	1.339	1.320	1.191	1.148	
	Max	0.582	0.612	0.858	1.352	1.331	1.195	1.362	
	Min	0.483	0.501	0.684	1.321	1.300	1.185	0.984	

Number of Tests : 003   Passing rate : 100.0 %



RUN 65

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

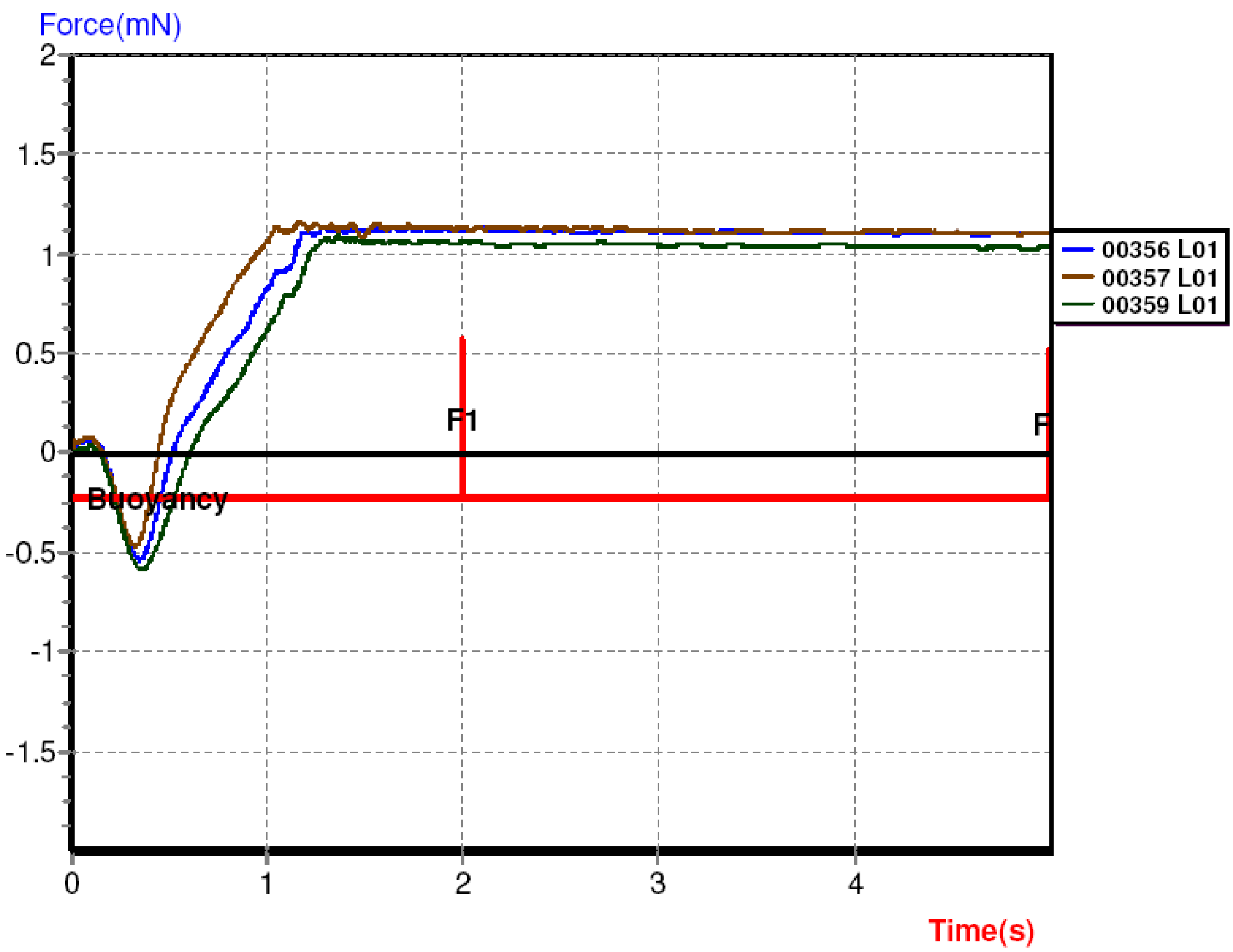
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00356 L01	0.453	0.516	0.954	1.357	1.333	1.133	1.281	Pass
SN100C Alloy	00357 L01	0.402	0.444	0.792	1.367	1.340	1.164	1.170	Pass
SN100C Alloy	00359 L01	0.525	0.606	1.065	1.298	1.267	1.092	1.365	Fail
	Standard Dev	0.062	0.081	0.137	0.037	0.040	0.036	0.098	
	Mean	0.460	0.522	0.937	1.341	1.313	1.129	1.272	
	Max	0.525	0.606	1.065	1.367	1.340	1.164	1.365	
	Min	0.402	0.444	0.792	1.298	1.267	1.092	1.170	

Number of Tests : 003 Passing rate : 66.7 %



RUN 66

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

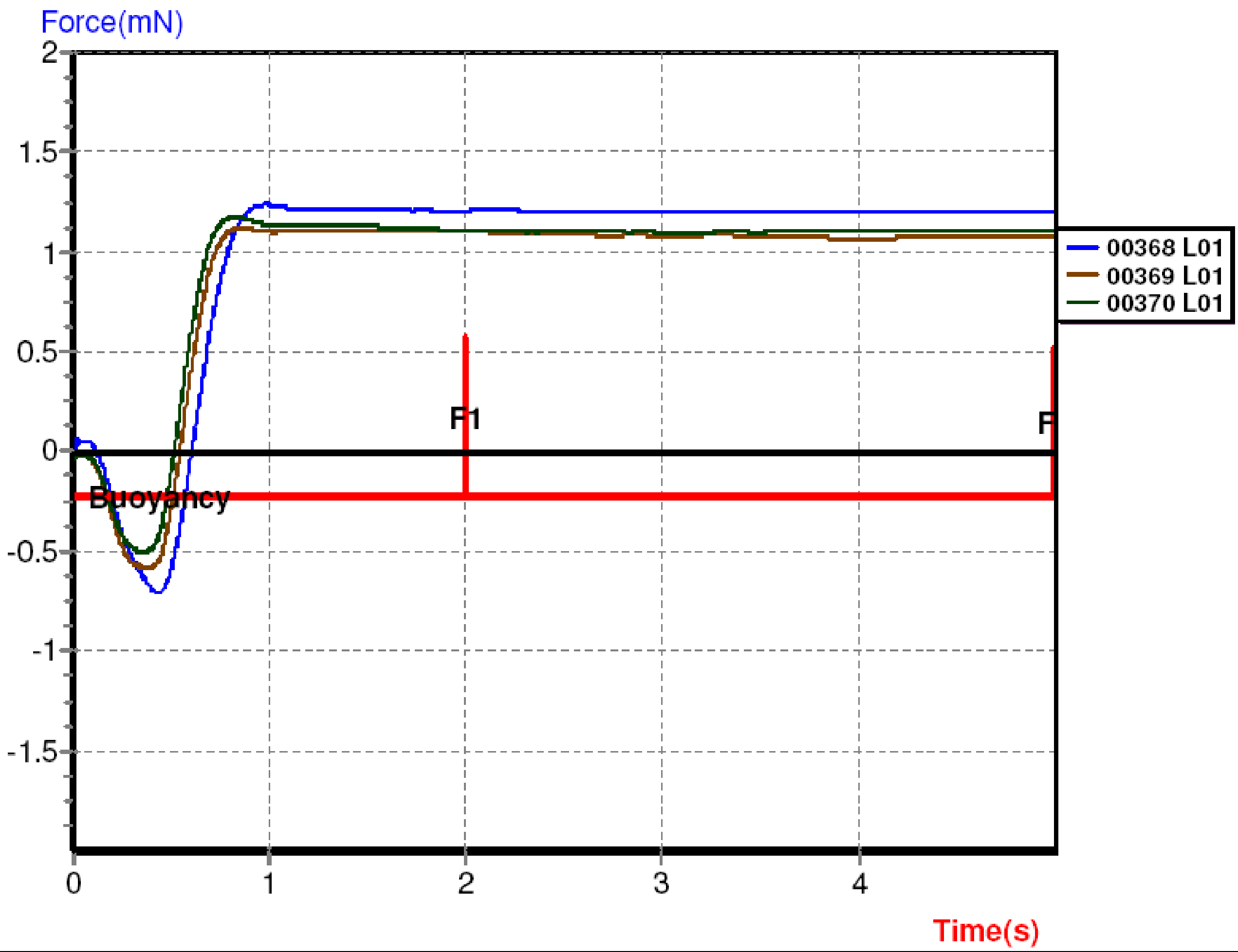
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00368 L01	0.570	0.606	0.741	1.439	1.429	1.240	0.969	Pass
SN100C Alloy	00369 L01	0.510	0.543	0.657	1.340	1.309	1.126	0.825	Pass
SN100C Alloy	00370 L01	0.480	0.516	0.630	1.340	1.336	1.181	0.822	Pass
	Standard Dev	0.046	0.046	0.058	0.058	0.063	0.057	0.084	
	Mean	0.520	0.555	0.676	1.373	1.358	1.182	0.872	
	Max	0.570	0.606	0.741	1.439	1.429	1.240	0.969	
	Min	0.480	0.516	0.630	1.340	1.309	1.126	0.822	

Number of Tests : 003 Passing rate : 100.0 %



RUN 67

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

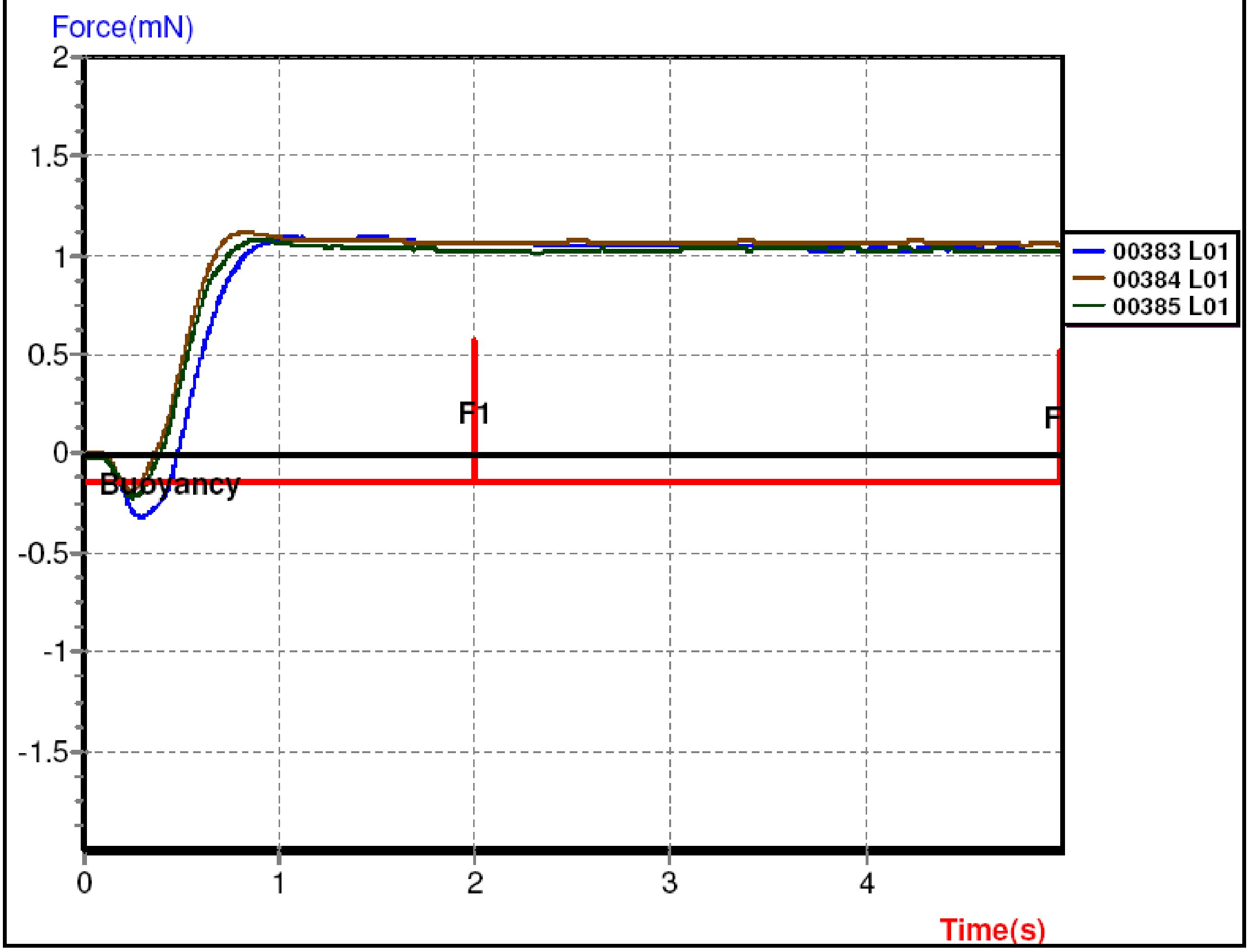
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00383 L01	0.444	0.480	0.672	1.202	1.165	1.092	1.068	Pass
SN100C Alloy	00384 L01	0.297	0.360	0.573	1.206	1.196	1.119	0.813	Pass
SN100C Alloy	00385 L01	0.324	0.390	0.591	1.168	1.161	1.081	0.858	Pass
	Standard Dev	0.078	0.062	0.053	0.021	0.019	0.020	0.136	
	Mean	0.355	0.410	0.612	1.192	1.174	1.097	0.913	
	Max	0.444	0.480	0.672	1.206	1.196	1.119	1.068	
	Min	0.297	0.360	0.573	1.168	1.161	1.081	0.813	

Number of Tests : 003 Passing rate : 100.0 %



RUN 68

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

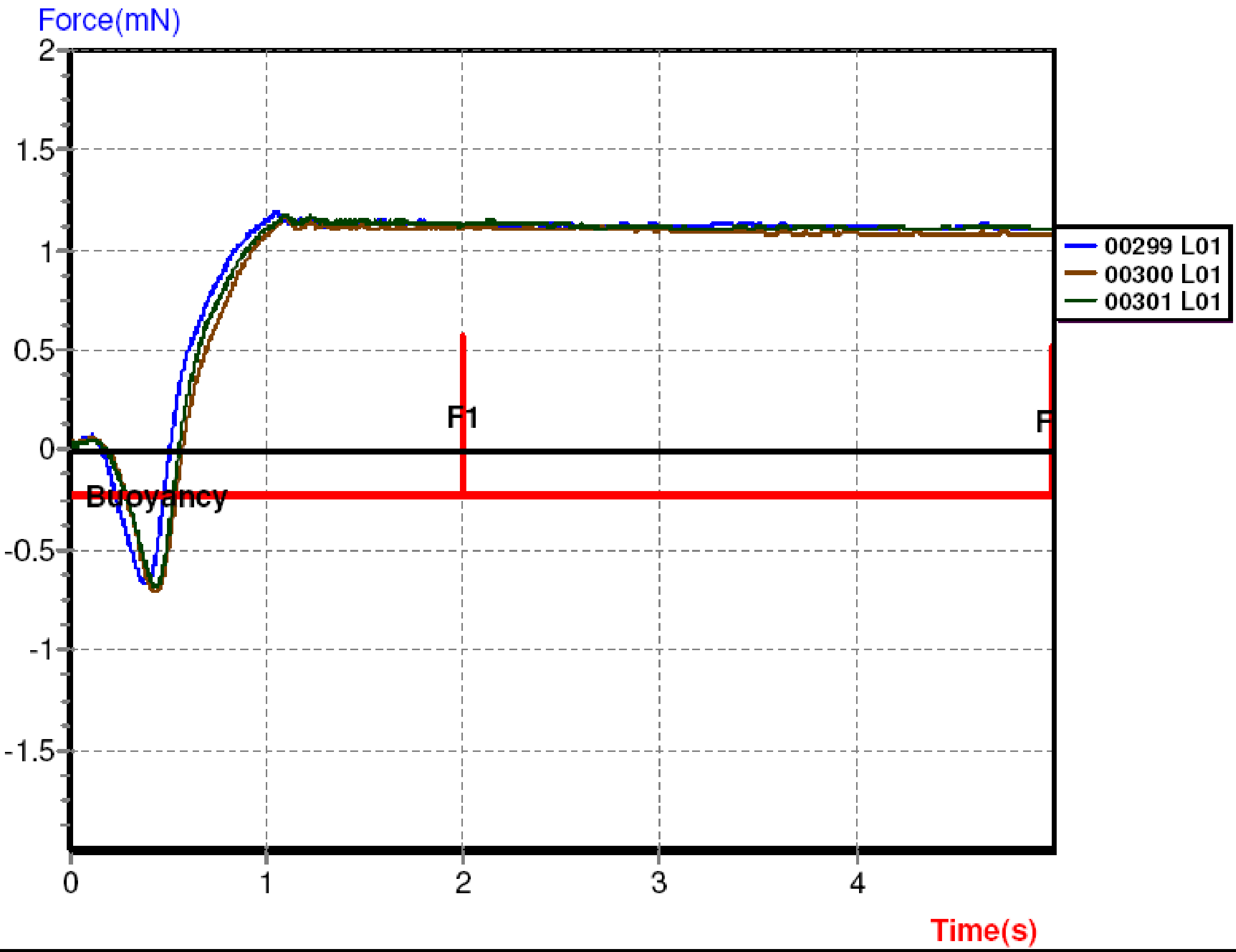
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00299 L01	0.477	0.507	0.720	1.357	1.340	1.191	1.041	Pass
SN100C Alloy	00300 L01	0.537	0.573	0.810	1.343	1.315	1.171	1.086	Pass
SN100C Alloy	00301 L01	0.525	0.555	0.771	1.357	1.336	1.181	1.086	Pass
	Standard Dev	0.032	0.032	0.045	0.008	0.013	0.010	0.026	
	Mean	0.513	0.546	0.767	1.352	1.330	1.181	1.071	
	Max	0.537	0.573	0.810	1.357	1.340	1.191	1.086	
	Min	0.477	0.510	0.720	1.343	1.315	1.171	1.041	

Number of Tests : 003 Passing rate : 100.0 %



RUN 69

Test Details

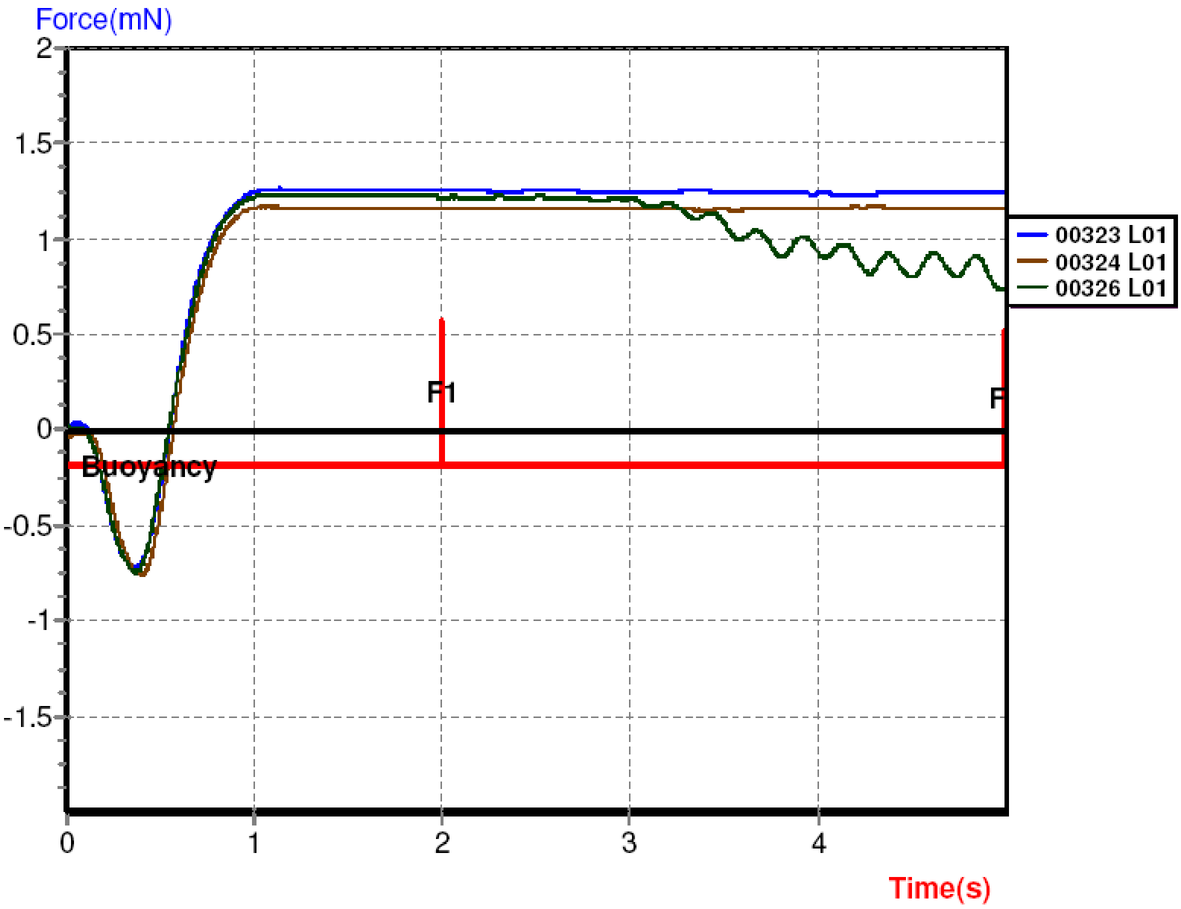
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00323 L01	0.519	0.546	0.714	1.445	1.431	1.267	1.140	Pass
SN100C Alloy	00324 L01	0.540	0.570	0.726	1.352	1.342	1.174	1.044	Pass
SN100C Alloy	00326 L01	0.513	0.543	0.717	1.407	0.925	1.236	1.710	Pass
	Standard Dev	0.014	0.015	0.006	0.047	0.270	0.047	0.360	
	Mean	0.524	0.553	0.719	1.401	1.233	1.226	1.298	
	Max	0.540	0.570	0.726	1.445	1.431	1.267	1.710	
	Min	0.513	0.543	0.714	1.352	0.925	1.174	1.044	

Number of Tests : 003 Passing rate : 100.0 %



RUN 70

Test Details

Component : SN100C Alloy

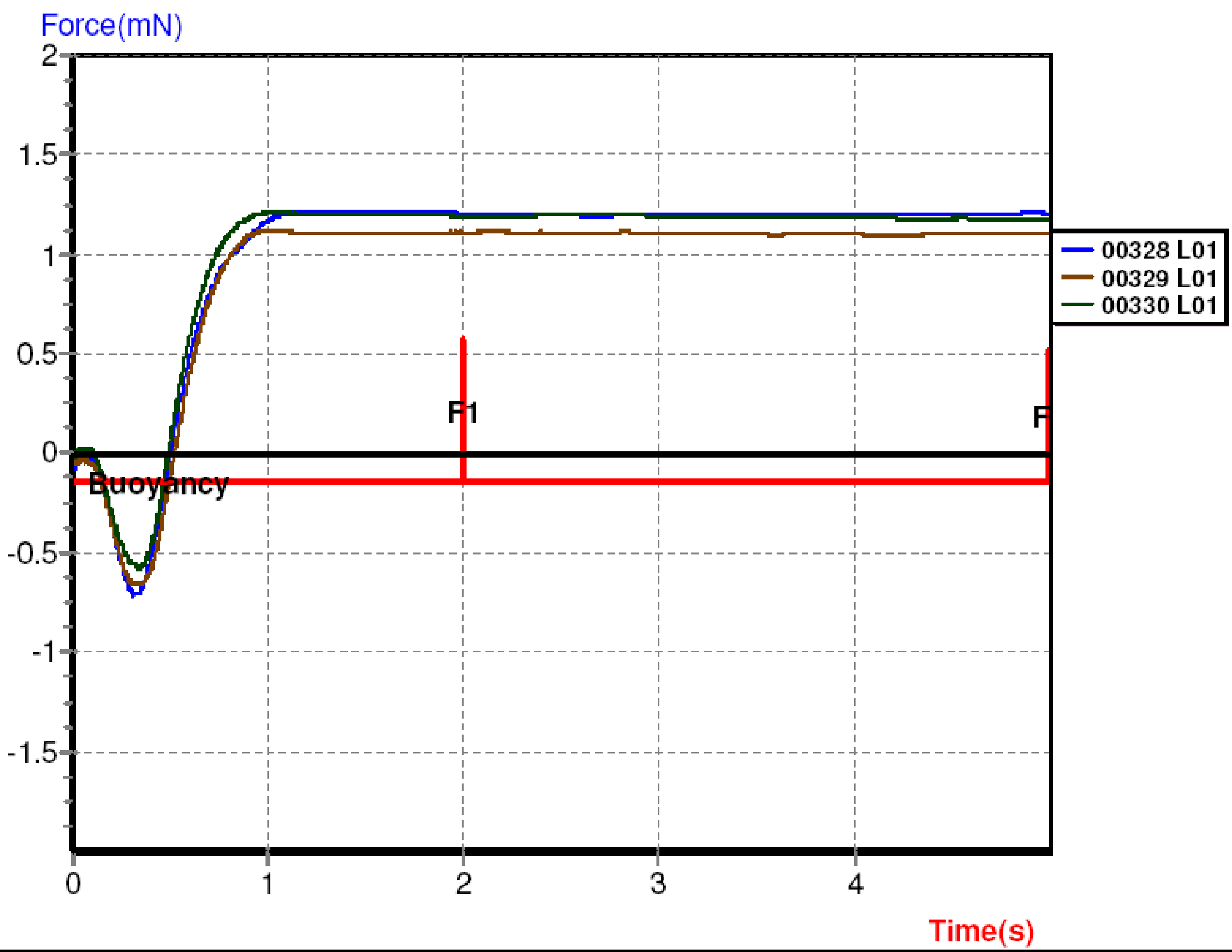
Test parameter filename : Bath Parameters.vts | Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00328 L01	0.477	0.501	0.702	1.347	1.347	1.222	1.317	Pass
SN100C Alloy	00329 L01	0.498	0.522	0.690	1.251	1.244	1.126	1.005	Pass
SN100C Alloy	00330 L01	0.468	0.492	0.657	1.330	1.320	1.215	1.014	Pass
	Standard Dev	0.015	0.015	0.023	0.051	0.053	0.054	0.178	
	Mean	0.481	0.505	0.683	1.309	1.303	1.188	1.112	
	Max	0.498	0.522	0.702	1.347	1.347	1.222	1.317	
	Min	0.468	0.492	0.657	1.251	1.244	1.126	1.005	

Number of Tests : 003 Passing rate : 100.0 %



RUN 71

Test Details

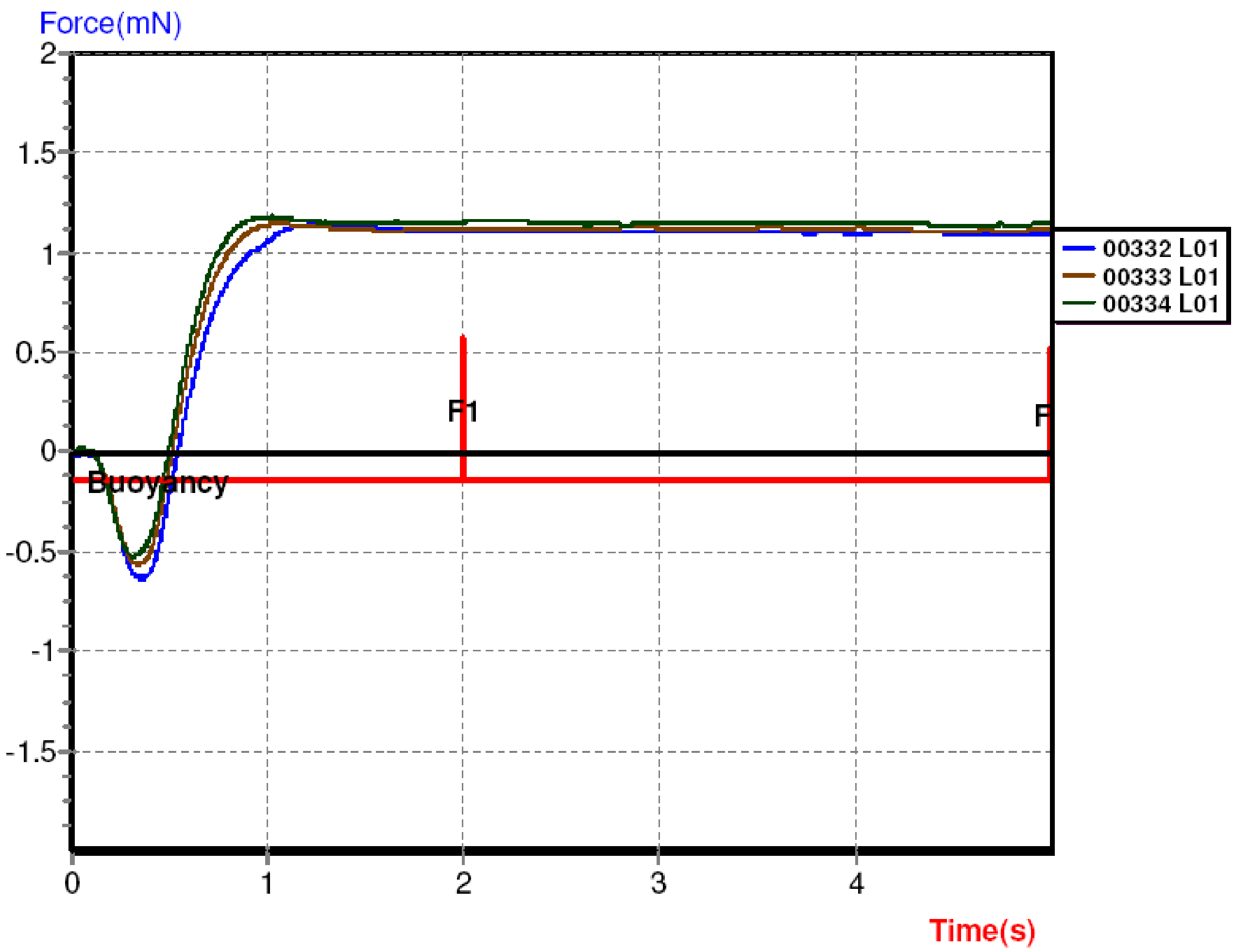
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00332 L01	0.516	0.543	0.747	1.247	1.233	1.143	1.203	Pass
SN100C Alloy	00333 L01	0.486	0.513	0.690	1.258	1.254	1.147	1.041	Pass
SN100C Alloy	00334 L01	0.471	0.495	0.666	1.295	1.285	1.185	1.017	Pass
	Standard Dev	0.023	0.024	0.042	0.025	0.026	0.023	0.101	
	Mean	0.491	0.517	0.701	1.267	1.258	1.158	1.087	
	Max	0.516	0.543	0.747	1.295	1.285	1.185	1.203	
	Min	0.471	0.495	0.666	1.247	1.233	1.143	1.017	

Number of Tests : 003 Passing rate : 100.0 %



RUN 72

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

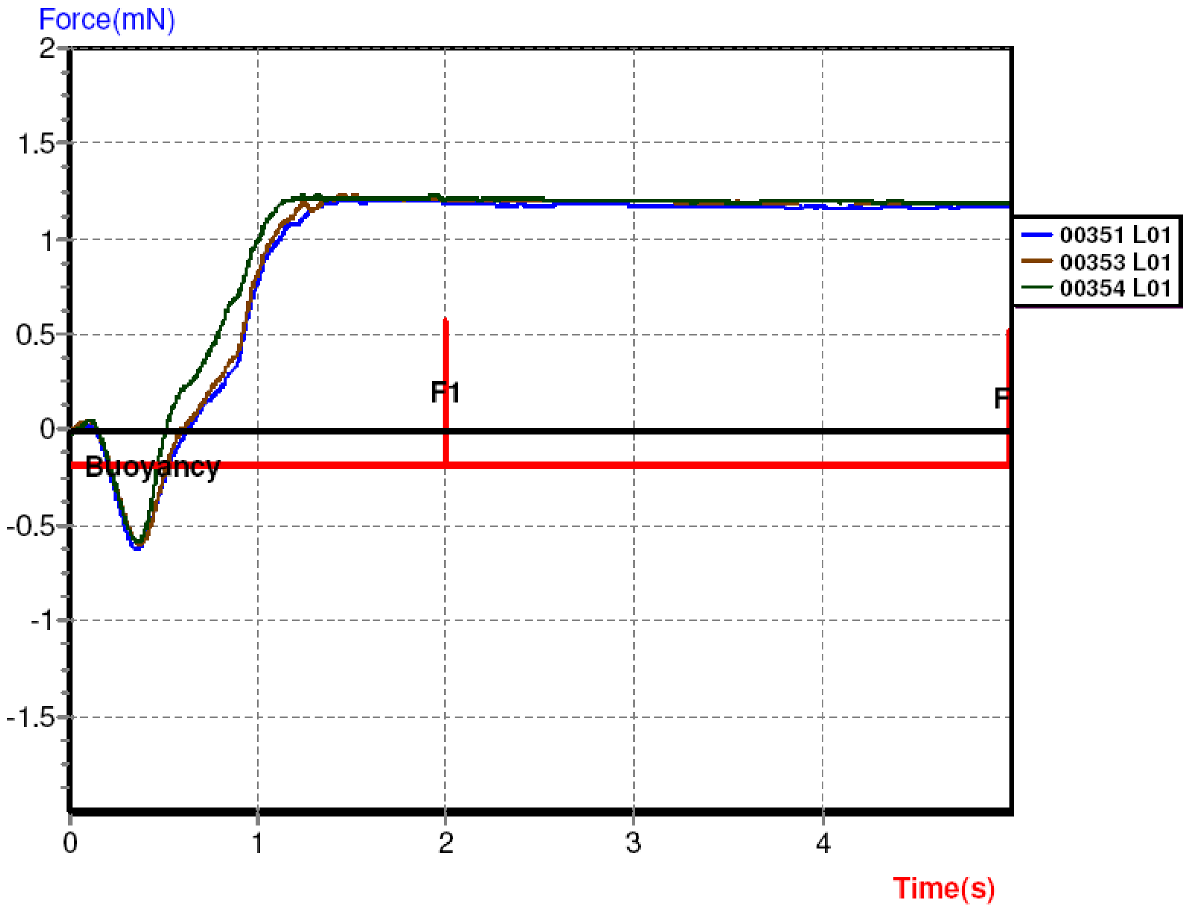
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00351 L01	0.528	0.627	1.005	1.376	1.355	1.209	1.443	Fail
SN100C Alloy	00353 L01	0.516	0.597	0.996	1.390	1.376	1.229	1.437	Pass
SN100C Alloy	00354 L01	0.468	0.513	0.933	1.393	1.376	1.233	1.929	Pass
	Standard Dev	0.032	0.059	0.039	0.009	0.012	0.013	0.282	
	Mean	0.504	0.579	0.978	1.386	1.369	1.224	1.603	
	Max	0.528	0.627	1.005	1.393	1.376	1.233	1.929	
	Min	0.468	0.513	0.933	1.376	1.355	1.209	1.437	

Number of Tests : 003 Passing rate : 66.7 %



RUN 73

Test Details

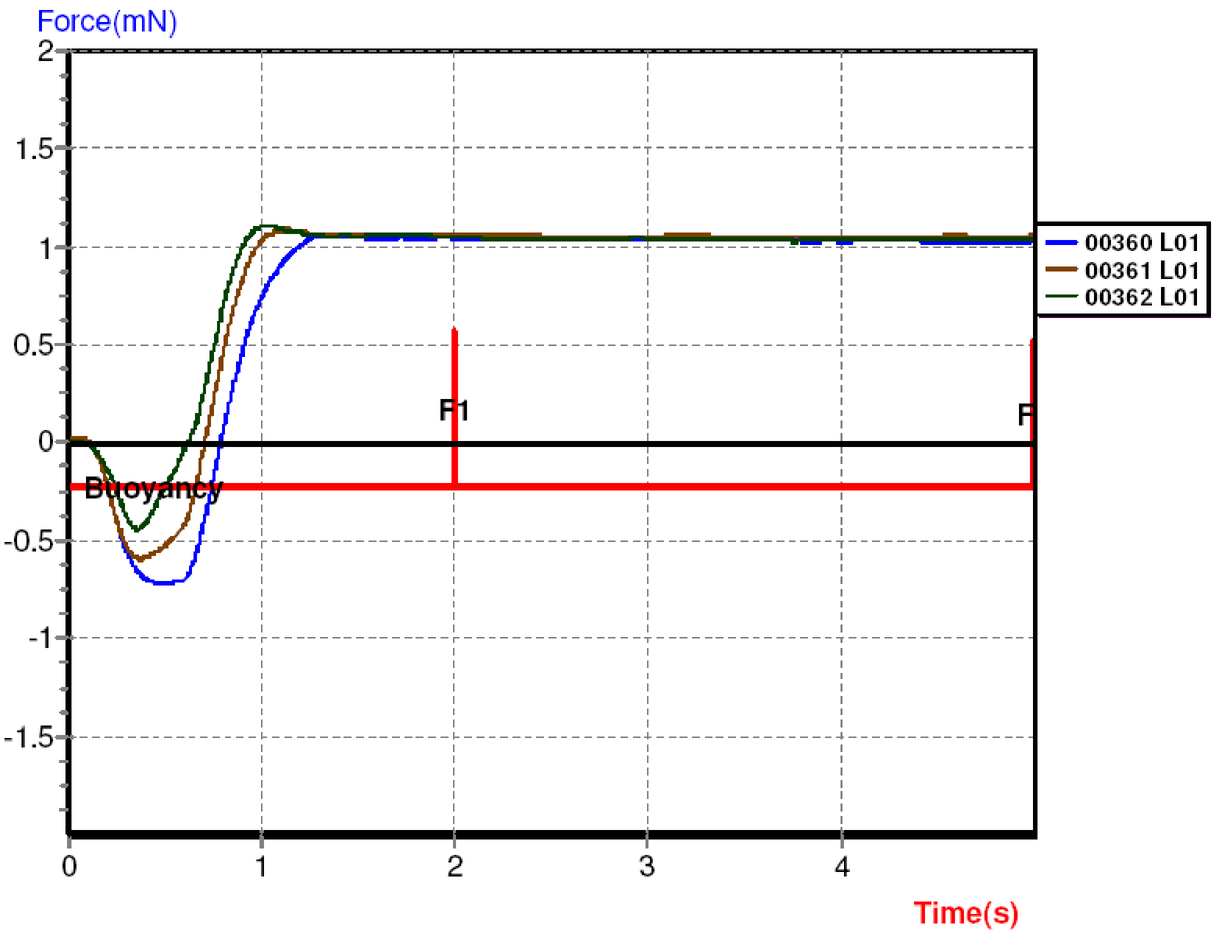
Component	: SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00360 L01	0.741	0.789	0.978	1.274	1.264	1.054	1.293	Fail
SN100C Alloy	00361 L01	0.657	0.705	0.864	1.298	1.291	1.088	1.113	Fail
SN100C Alloy	00362 L01	0.495	0.615	0.807	1.285	1.267	1.102	0.993	Pass
	Standard Dev	0.125	0.087	0.087	0.012	0.015	0.025	0.151	
	Mean	0.631	0.703	0.883	1.286	1.274	1.081	1.133	
	Max	0.741	0.789	0.978	1.298	1.291	1.102	1.293	
	Min	0.495	0.615	0.807	1.274	1.264	1.054	0.993	

Number of Tests : 003 Passing rate : 33.3 %



RUN 74

Test Details

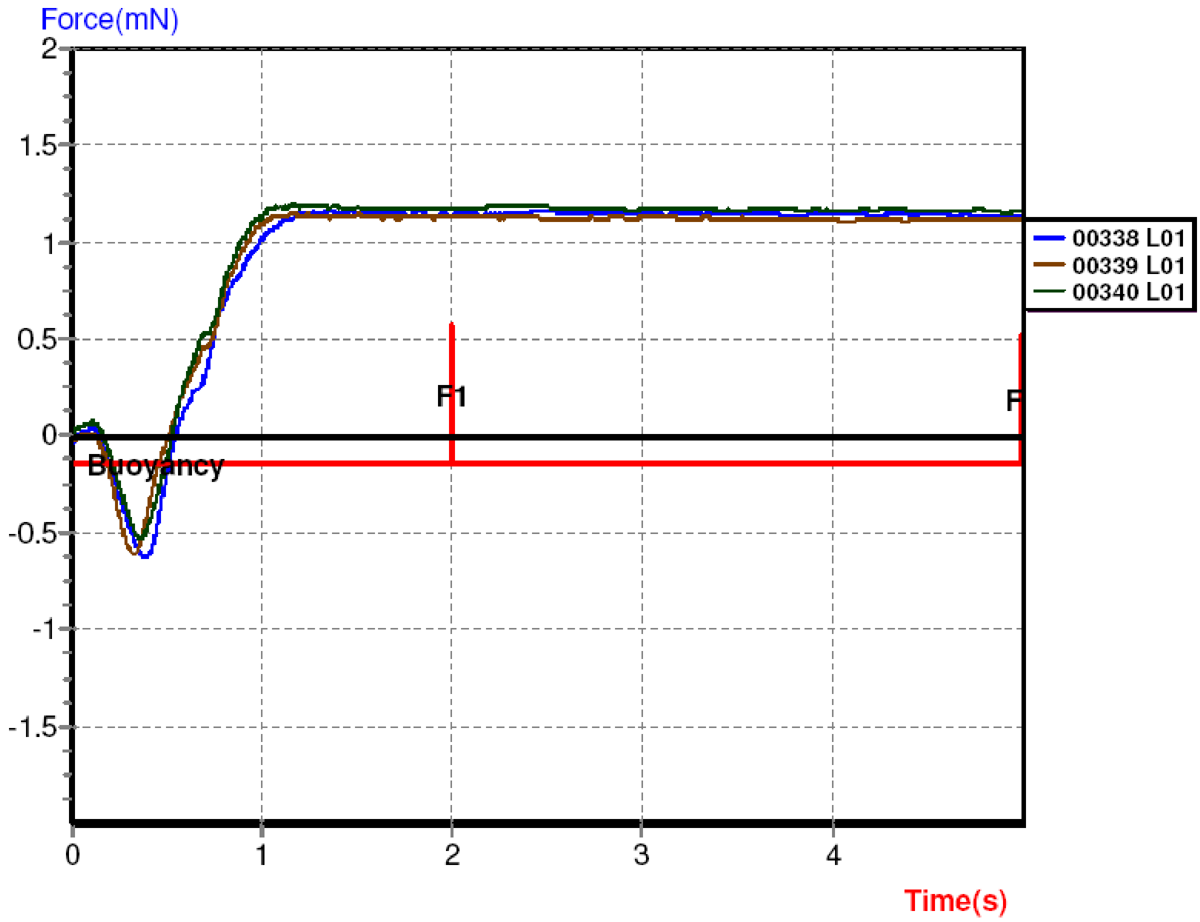
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00338 L01	0.510	0.543	0.834	1.278	1.271	1.164	1.821	Pass
SN100C Alloy	00339 L01	0.459	0.507	0.807	1.271	1.264	1.154	1.167	Pass
SN100C Alloy	00340 L01	0.495	0.528	0.801	1.320	1.302	1.198	1.161	Pass
	Standard Dev	0.026	0.018	0.018	0.026	0.020	0.023	0.379	
	Mean	0.488	0.526	0.814	1.290	1.279	1.172	1.383	
	Max	0.510	0.543	0.834	1.320	1.302	1.198	1.821	
	Min	0.459	0.507	0.801	1.271	1.264	1.154	1.161	

Number of Tests : 003 Passing rate : 100.0 %



RUN 75

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

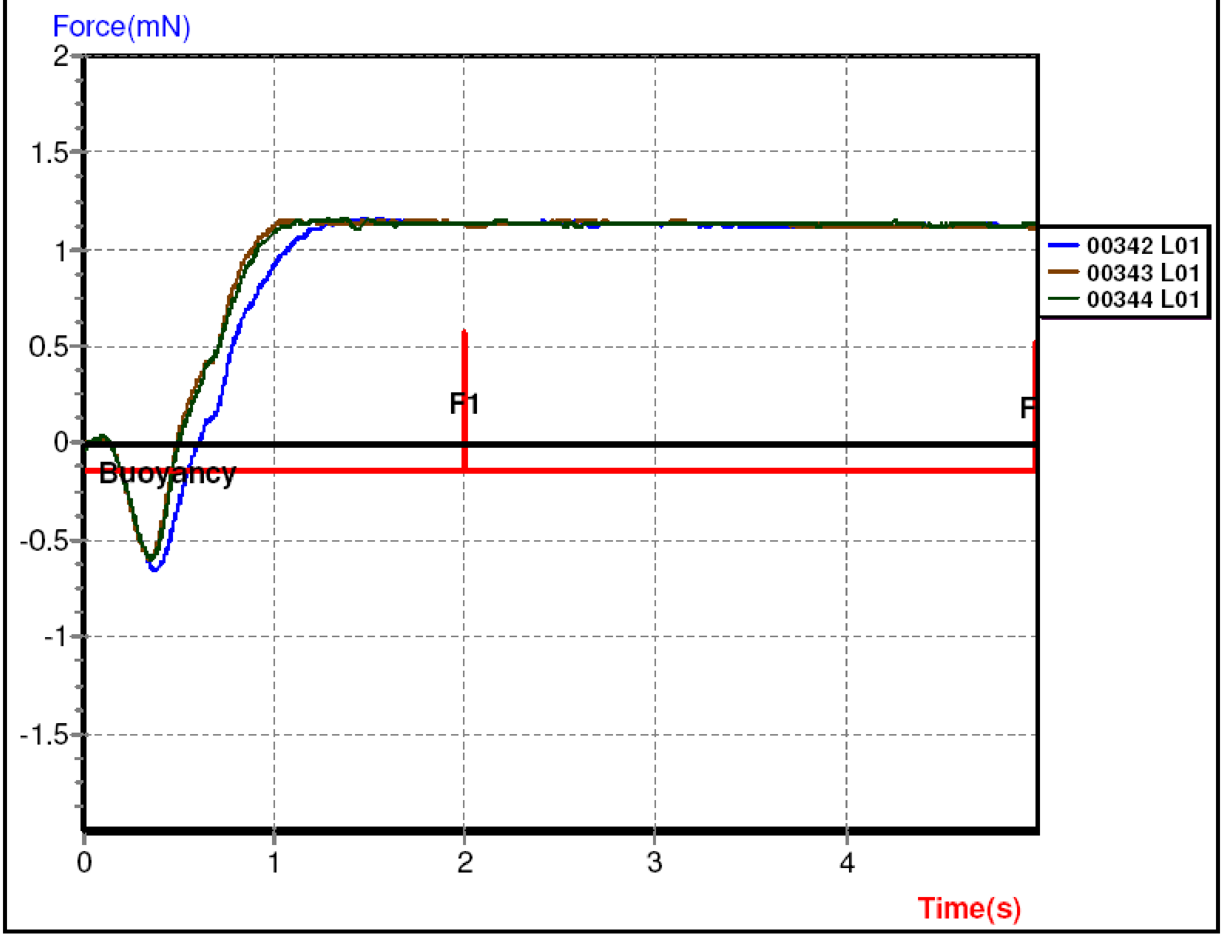
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00342 L01	0.549	0.603	0.903	1.275	1.268	1.160	1.545	Pass
SN100C Alloy	00343 L01	0.462	0.489	0.771	1.268	1.251	1.154	1.116	Pass
SN100C Alloy	00344 L01	0.468	0.498	0.801	1.275	1.271	1.157	1.278	Pass
	Standard Dev	0.049	0.063	0.069	0.004	0.011	0.003	0.217	
	Mean	0.493	0.530	0.825	1.273	1.263	1.157	1.313	
	Max	0.549	0.603	0.903	1.275	1.271	1.160	1.545	
	Min	0.462	0.489	0.771	1.268	1.251	1.154	1.116	

Number of Tests : 003 Passing rate : 100.0 %



RUN 76

Test Details

Component : SN100C Alloy

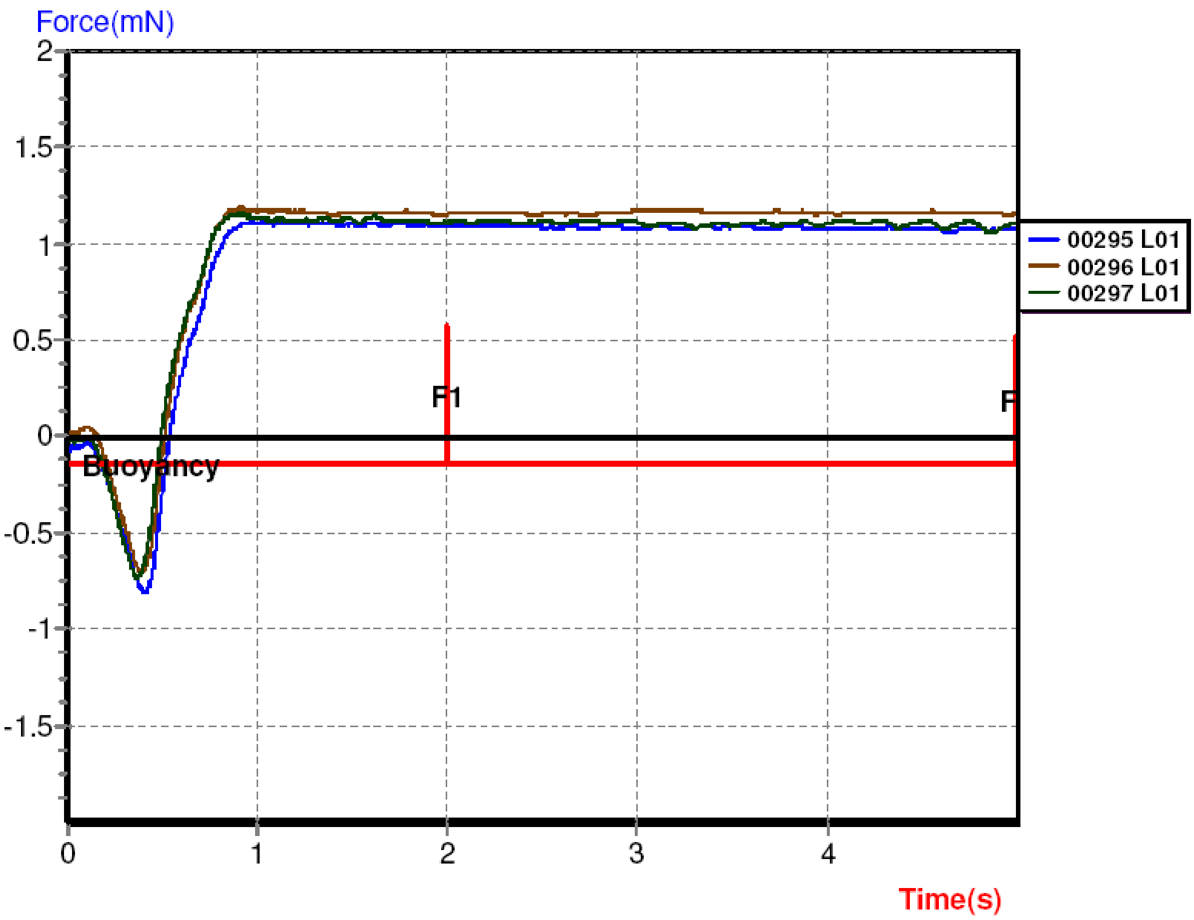
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00295 L01	0.519	0.540	0.729	1.237	1.223	1.123	1.032	Pass
SN100C Alloy	00296 L01	0.495	0.513	0.696	1.292	1.299	1.188	0.900	Pass
SN100C Alloy	00297 L01	0.477	0.495	0.684	1.251	1.240	1.157	0.897	Pass
	Standard Dev	0.021	0.023	0.023	0.029	0.040	0.033	0.077	
	Mean	0.497	0.516	0.703	1.260	1.254	1.156	0.943	
	Max	0.519	0.540	0.729	1.292	1.299	1.188	1.032	
	Min	0.477	0.495	0.684	1.237	1.223	1.123	0.897	

Number of Tests : 003   Passing rate : 100.0 %



RUN 77

Test Details

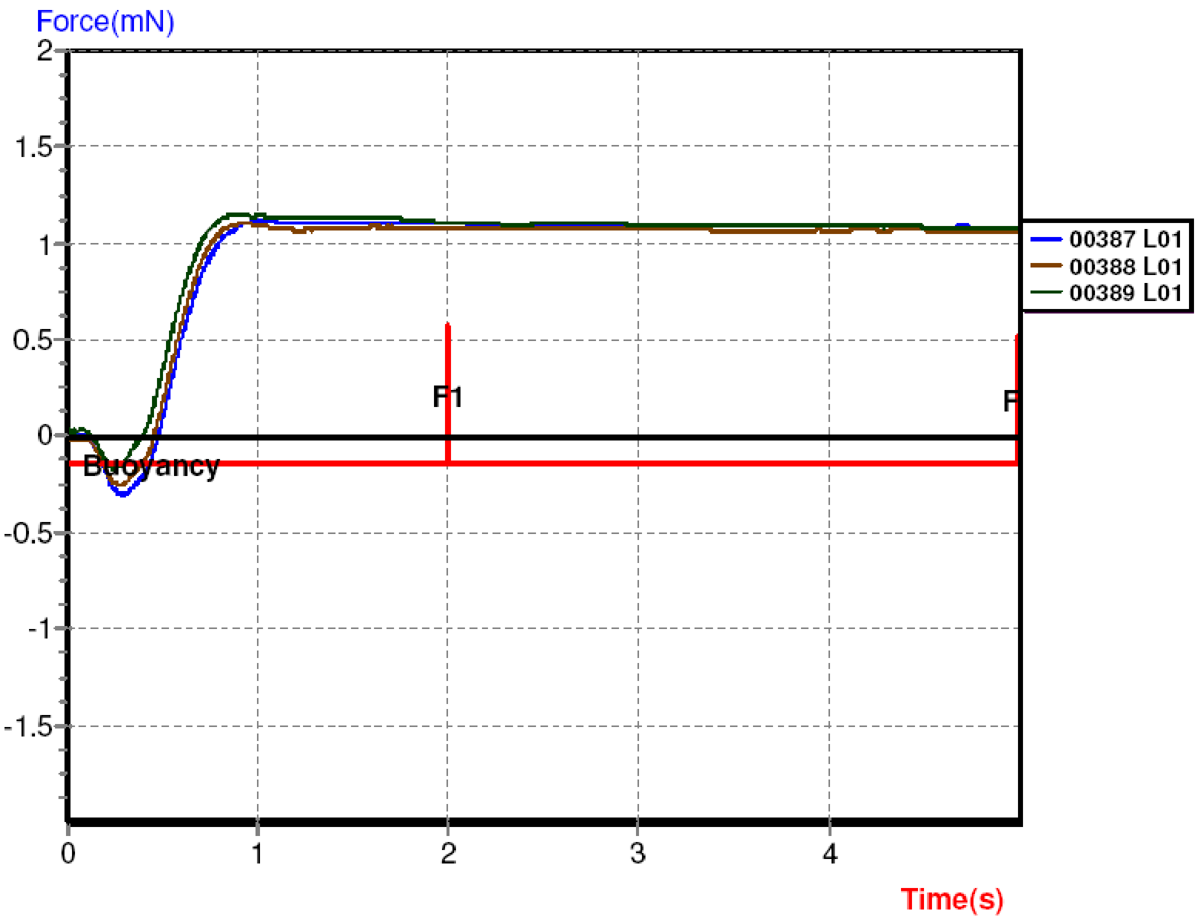
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00387 L01	0.432	0.474	0.669	1.244	1.220	1.119	0.987	Pass
SN100C Alloy	00388 L01	0.399	0.453	0.639	1.220	1.209	1.102	0.894	Pass
SN100C Alloy	00389 L01	0.291	0.393	0.606	1.251	1.213	1.147	0.876	Pass
	Standard Dev	0.074	0.042	0.032	0.016	0.005	0.023	0.060	
	Mean	0.374	0.440	0.638	1.238	1.214	1.123	0.919	
	Max	0.432	0.474	0.669	1.251	1.220	1.147	0.987	
	Min	0.291	0.393	0.606	1.220	1.209	1.102	0.876	

Number of Tests : 003 Passing rate : 100.0 %



RUN 78

Test Details

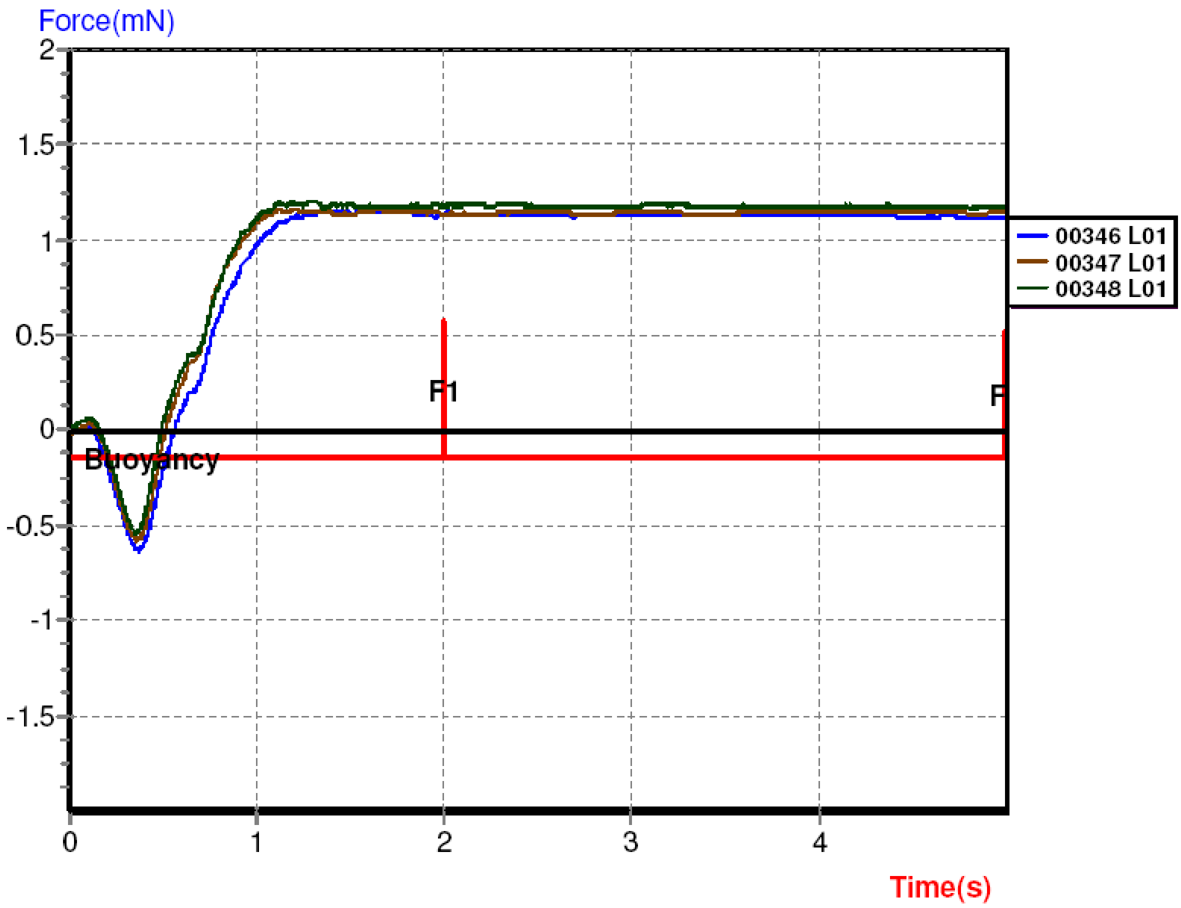
Component : SN100C Alloy
Test parameter filename : Bath Parameters.vts
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00346 L01	0.519	0.561	0.873	1.278	1.261	1.154	1.461	Pass
SN100C Alloy	00347 L01	0.483	0.516	0.801	1.278	1.282	1.160	1.119	Pass
SN100C Alloy	00348 L01	0.462	0.492	0.816	1.320	1.320	1.209	1.305	Pass
	Standard Dev	0.029	0.035	0.038	0.024	0.030	0.030	0.171	
	Mean	0.488	0.523	0.830	1.292	1.287	1.174	1.295	
	Max	0.519	0.561	0.873	1.320	1.320	1.209	1.461	
	Min	0.462	0.492	0.801	1.278	1.261	1.154	1.119	

Number of Tests : 003 Passing rate : 100.0 %



RUN 79

Test Details

Component : SN100C Alloy

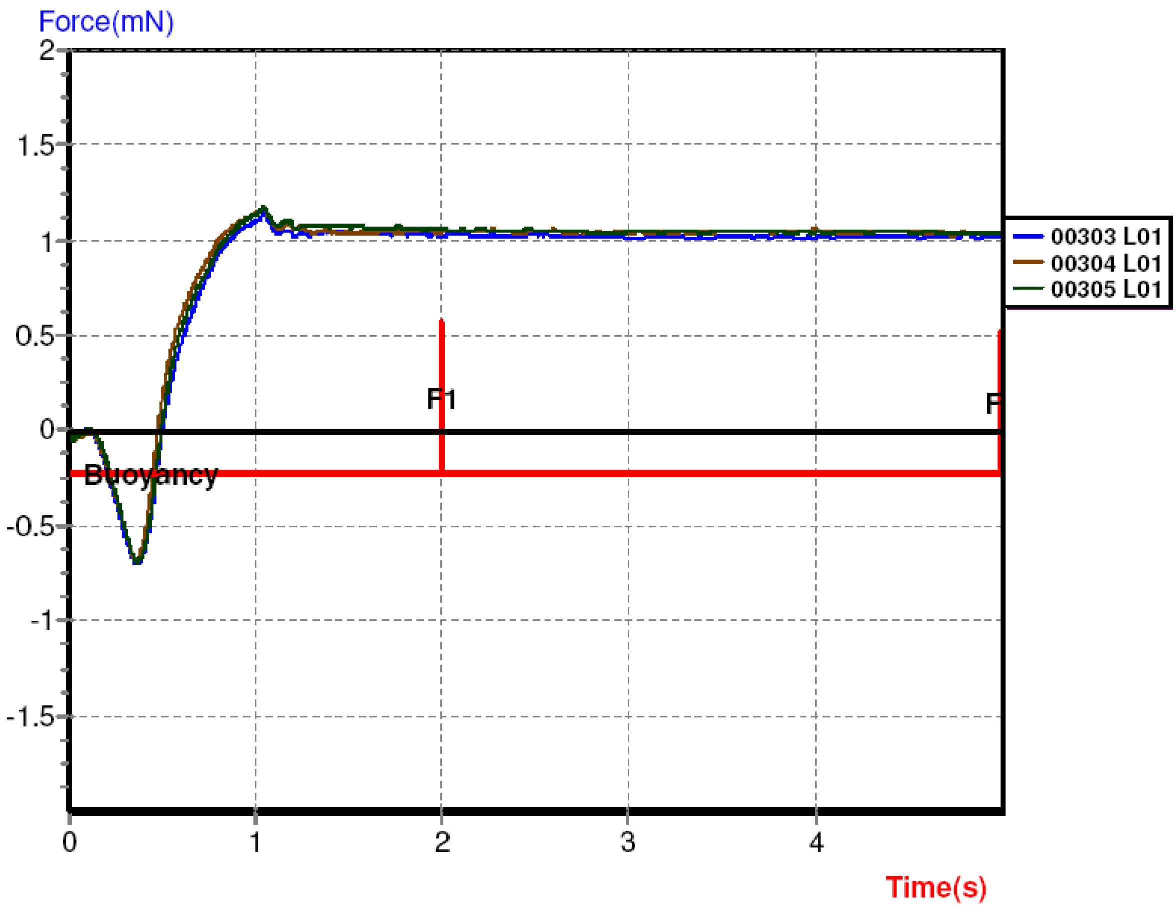
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 255.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00303 L01	0.471	0.504	0.714	1.260	1.260	1.143	1.041	Pass
SN100C Alloy	00304 L01	0.450	0.480	0.669	1.278	1.274	1.171	1.041	Pass
SN100C Alloy	00305 L01	0.465	0.498	0.708	1.295	1.267	1.174	1.038	Pass
	Standard Dev	0.011	0.012	0.024	0.017	0.007	0.017	0.002	
	Mean	0.462	0.494	0.697	1.278	1.267	1.163	1.040	
	Max	0.471	0.504	0.714	1.295	1.274	1.174	1.041	
	Min	0.450	0.480	0.669	1.260	1.260	1.143	1.038	

Number of Tests : 003   Passing rate : 100.0 %



RUN 80

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

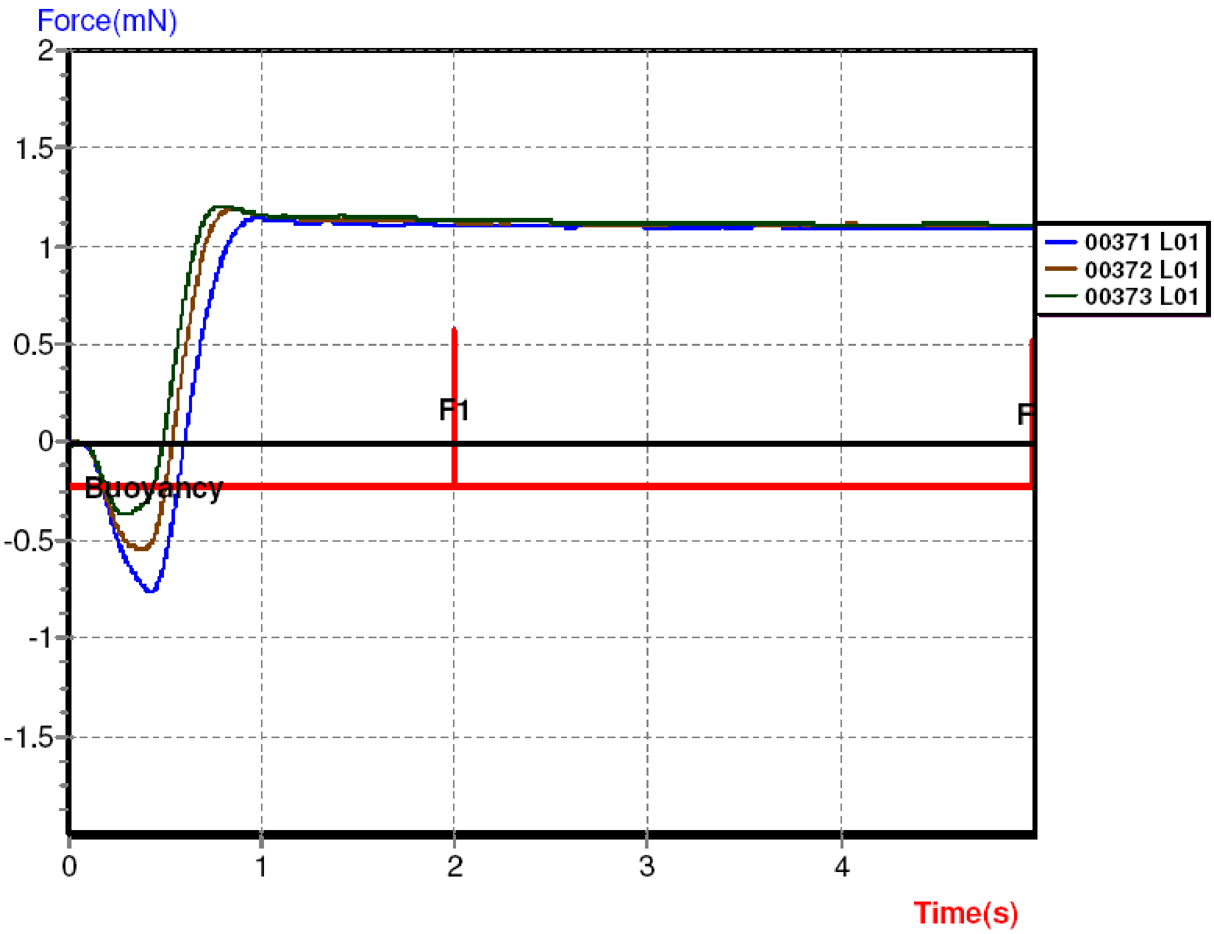
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00371 L01	0.567	0.600	0.741	1.343	1.322	1.147	0.978	Pass
SN100C Alloy	00372 L01	0.504	0.537	0.657	1.360	1.340	1.191	0.840	Pass
SN100C Alloy	00373 L01	0.438	0.489	0.612	1.367	1.336	1.209	0.774	Pass
	Standard Dev	0.065	0.056	0.065	0.012	0.009	0.032	0.104	
	Mean	0.503	0.542	0.670	1.357	1.333	1.182	0.864	
	Max	0.567	0.600	0.741	1.367	1.340	1.209	0.978	
	Min	0.438	0.489	0.612	1.343	1.322	1.147	0.774	

Number of Tests : 003 Passing rate : 100.0 %



RUN 81

Test Details

Component : SN100C Alloy

Test parameter filename : Bath Parameters.vts

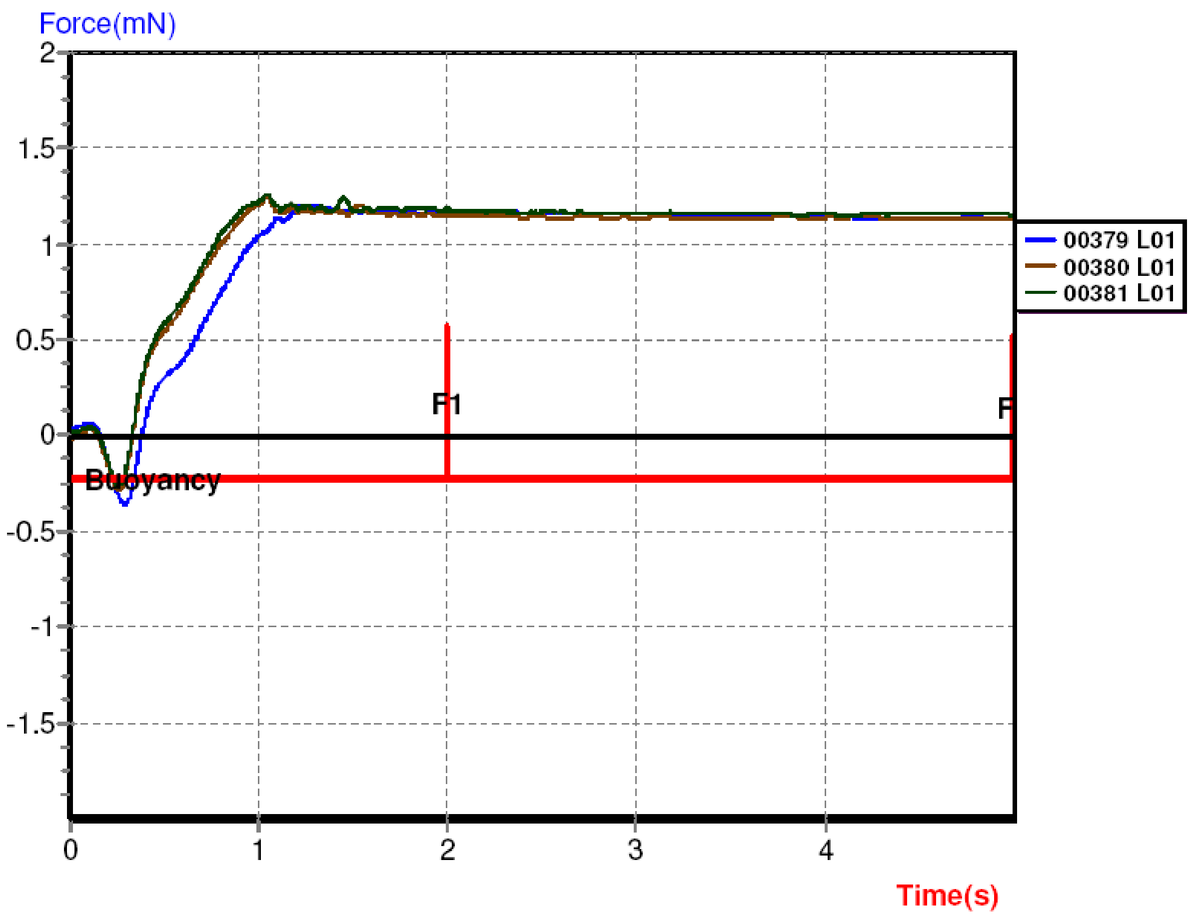
Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00379 L01	0.339	0.381	0.834	1.405	1.364	1.209	1.215	Pass
SN100C Alloy	00380 L01	0.291	0.333	0.684	1.384	1.364	1.246	1.038	Pass
SN100C Alloy	00381 L01	0.282	0.330	0.675	1.415	1.384	1.264	1.041	Pass
	Standard Dev	0.031	0.029	0.089	0.016	0.012	0.028	0.101	
	Mean	0.304	0.348	0.731	1.402	1.371	1.240	1.098	
	Max	0.339	0.381	0.834	1.415	1.384	1.264	1.215	
	Min	0.282	0.330	0.675	1.384	1.364	1.209	1.038	

Number of Tests : 003 Passing rate : 100.0 %



Appendix 9 Verification Wetting Balance Graphs

Appendix 9.1 Through Hole Relays, Ta and Tb, Least Stringent

Test Details

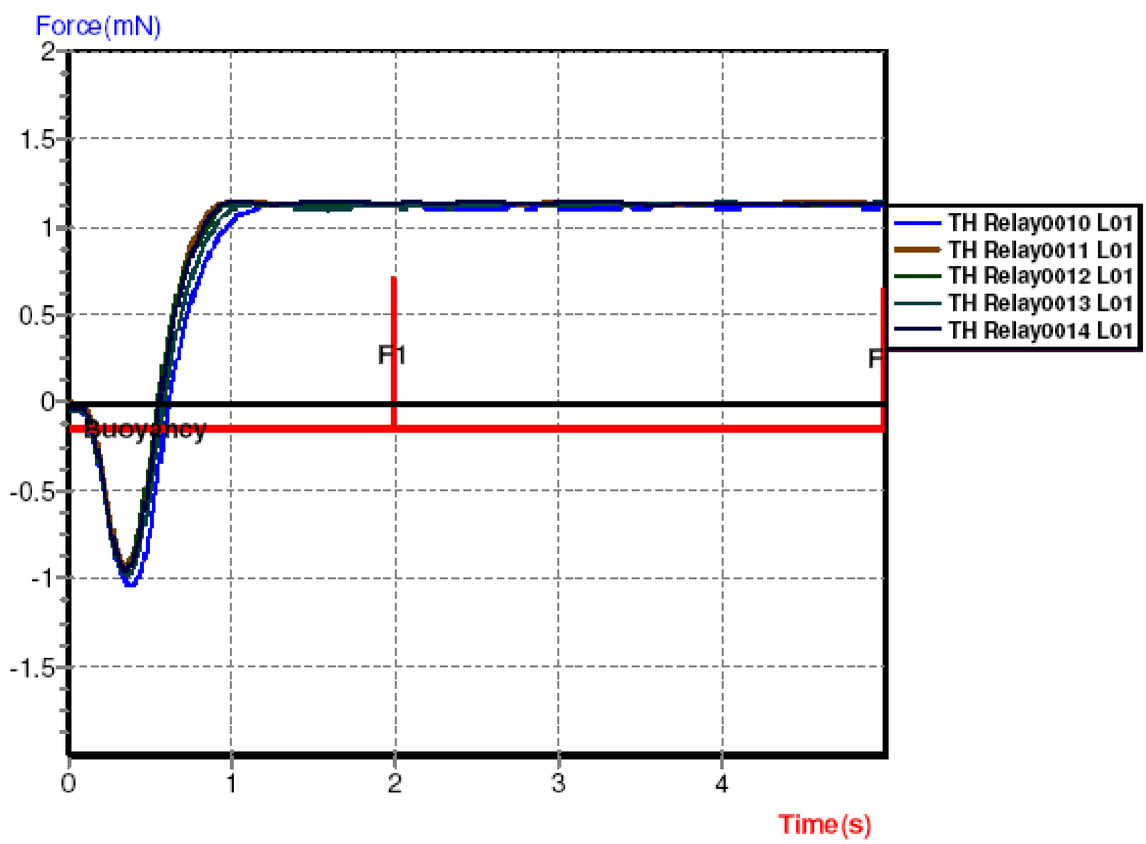
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Relay0010 L01	0.594	0.618	0.819	1.268	1.258	1.133	1.257	Pass
DOE - SN100C	ATH Relay0011 L01	0.531	0.555	0.705	1.278	1.278	1.150	1.011	Pass
DOE - SN100C	ATH Relay0012 L01	0.528	0.549	0.708	1.275	1.268	1.143	1.035	Pass
DOE - SN100C	ATH Relay0013 L01	0.558	0.582	0.771	1.254	1.285	1.147	3.990	Pass
DOE - SN100C	ATH Relay0014 L01	0.537	0.561	0.729	1.278	1.268	1.154	1.005	Pass
	Standard Dev	0.027	0.028	0.048	0.010	0.011	0.008	1.307	
	Mean	0.550	0.573	0.746	1.271	1.271	1.145	1.660	
	Max	0.594	0.618	0.819	1.278	1.285	1.154	3.990	
	Min	0.528	0.549	0.705	1.254	1.258	1.133	1.005	

Number of Tests : 005 Passing rate : 100.0 %



Appendix 9.2 Through Hole Relays, Ta and Tb, Most Stringent

Test Details

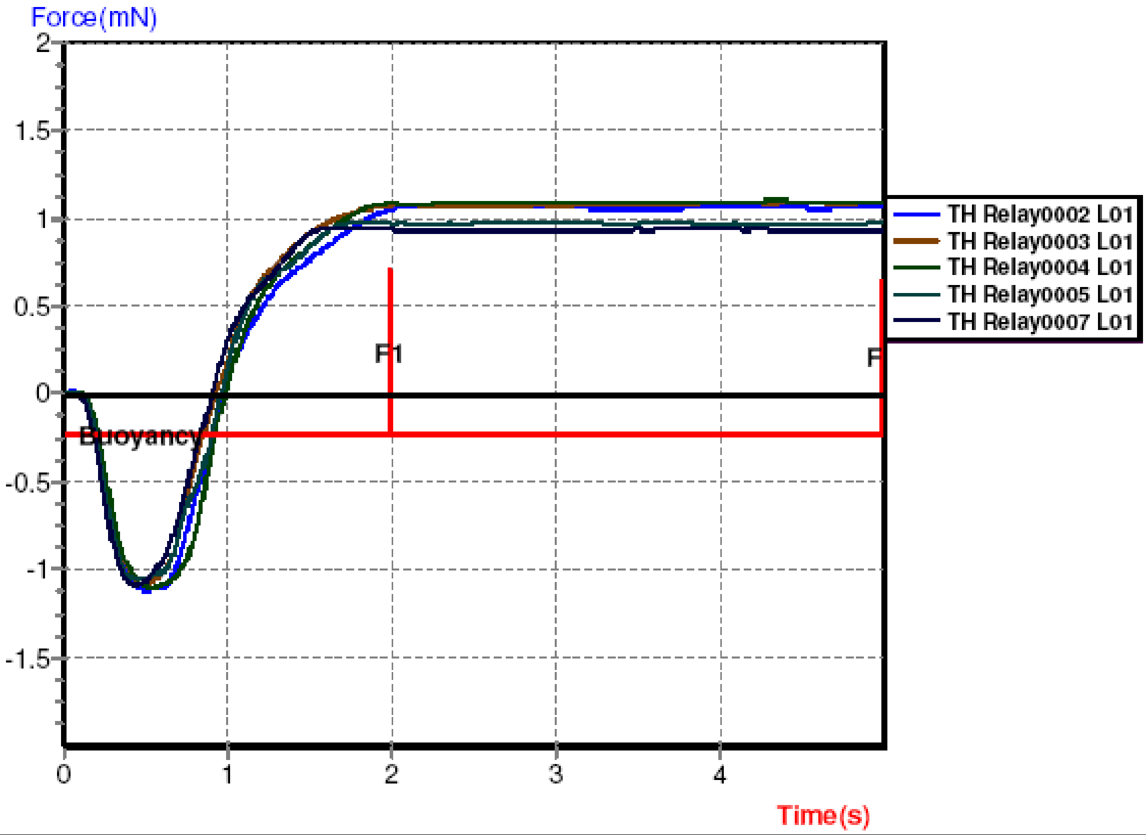
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ATH Relay0002 L01		0.912	0.963	1.428	1.288	1.295	1.071	2.094	Fail
DOE - SN100C ATH Relay0003 L01		0.852	0.930	1.284	1.302	1.322	1.095	3.966	Fail
DOE - SN100C ATH Relay0004 L01		0.924	0.987	1.362	1.319	1.326	1.102	4.275	Fail
DOE - SN100C ATH Relay0005 L01		0.903	0.960	1.245	1.205	1.209	0.988	2.748	Fail
DOE - SN100C ATH Relay0007 L01		0.831	0.906	1.221	1.167	1.154	0.947	1.605	Fail
	Standard Dev	0.041	0.032	0.086	0.066	0.076	0.069	1.159	
	Mean	0.884	0.950	1.308	1.256	1.261	1.041	2.938	
	Max	0.924	0.987	1.428	1.319	1.326	1.102	4.275	
	Min	0.831	0.906	1.221	1.167	1.154	0.947	1.605	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.3 Through Hole Relays, F1 and F2, Least Stringent

Test Details

Component : DOE - SN100C Alloy

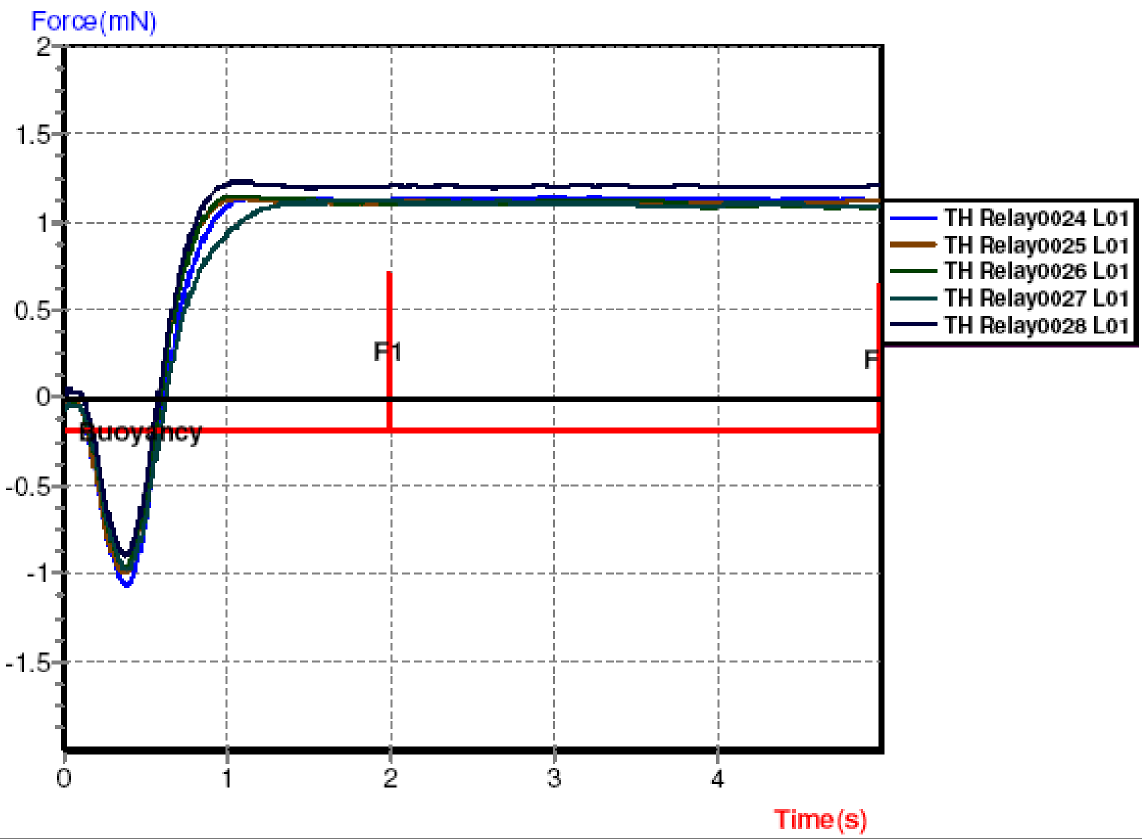
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Relay0024 L01	0.588	0.615	0.789	1.311	1.311	1.143	1.185	Pass
DOE - SN100C	ATH Relay0025 L01	0.555	0.582	0.738	1.297	1.300	1.136	1.098	Pass
DOE - SN100C	ATH Relay0026 L01	0.561	0.591	0.750	1.293	1.273	1.154	1.071	Pass
DOE - SN100C	ATH Relay0027 L01	0.591	0.624	0.843	1.300	1.283	1.119	1.650	Pass
DOE - SN100C	ATH Relay0028 L01	0.549	0.579	0.738	1.397	1.397	1.229	1.041	Pass
	Standard Dev	0.019	0.020	0.045	0.044	0.049	0.043	0.252	
	Mean	0.569	0.598	0.772	1.320	1.313	1.156	1.209	
	Max	0.591	0.624	0.843	1.397	1.397	1.229	1.650	
	Min	0.549	0.579	0.738	1.293	1.273	1.119	1.041	

Number of Tests : 005   Passing rate : 100.0 %



Appendix 9.4 Through Hole Relays, F1 and F2, Most Stringent

Test Details

Component : DOE - SN100C Alloy

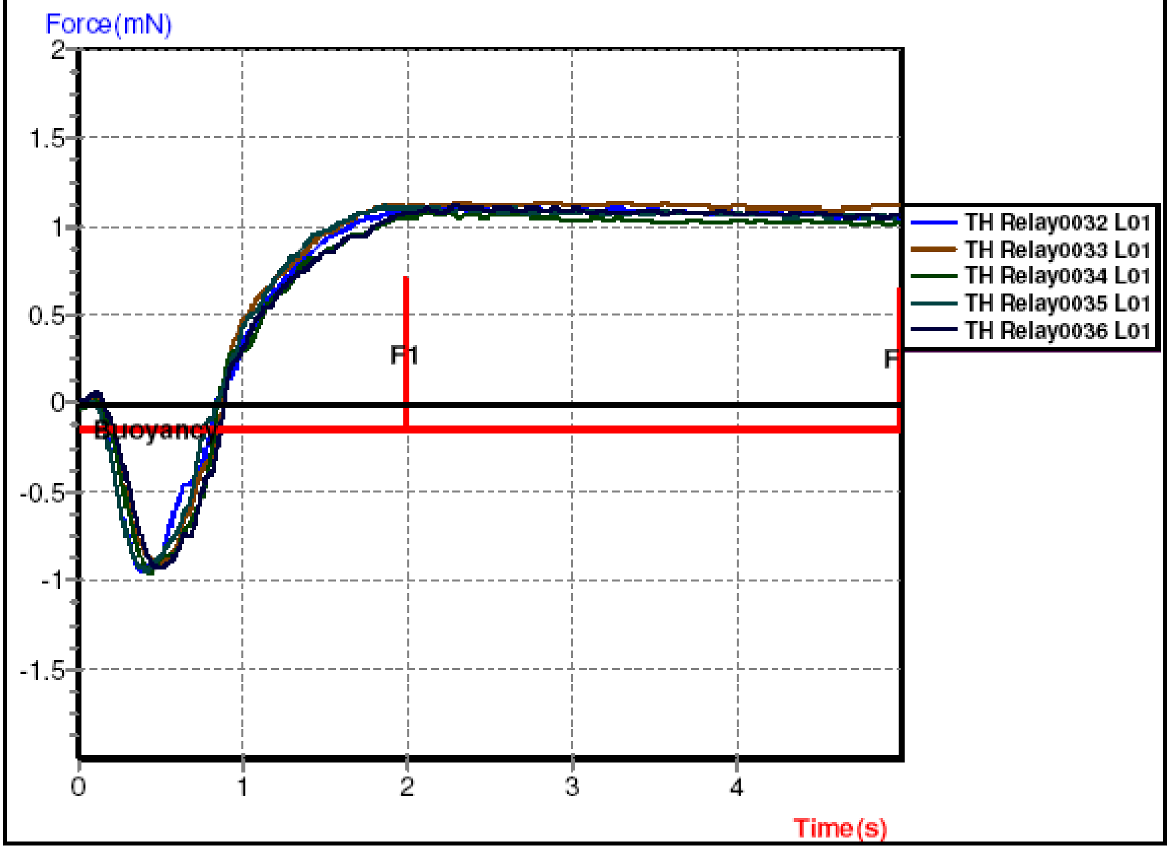
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Relay0032 L01	0.804	0.837	1.290	1.230	1.182	1.109	2.319	Fail
DOE - SN100C	ATH Relay0033 L01	0.855	0.882	1.263	1.251	1.254	1.133	2.814	Fail
DOE - SN100C	ATH Relay0034 L01	0.828	0.852	1.317	1.185	1.158	1.081	2.112	Fail
DOE - SN100C	ATH Relay0035 L01	0.765	0.840	1.221	1.247	1.202	1.116	1.860	Fail
DOE - SN100C	ATH Relay0036 L01	0.864	0.888	1.347	1.213	1.199	1.116	2.274	Fail
	Standard Dev	0.040	0.024	0.049	0.027	0.036	0.019	0.350	
	Mean	0.823	0.860	1.288	1.225	1.199	1.111	2.276	
	Max	0.864	0.888	1.347	1.251	1.254	1.133	2.814	
	Min	0.765	0.837	1.221	1.185	1.158	1.081	1.860	

Number of Tests : 005   Passing rate : 0.0 %



Appendix 9.5 Through Hole Relays, Fmax and TFmax, Least Stringent

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

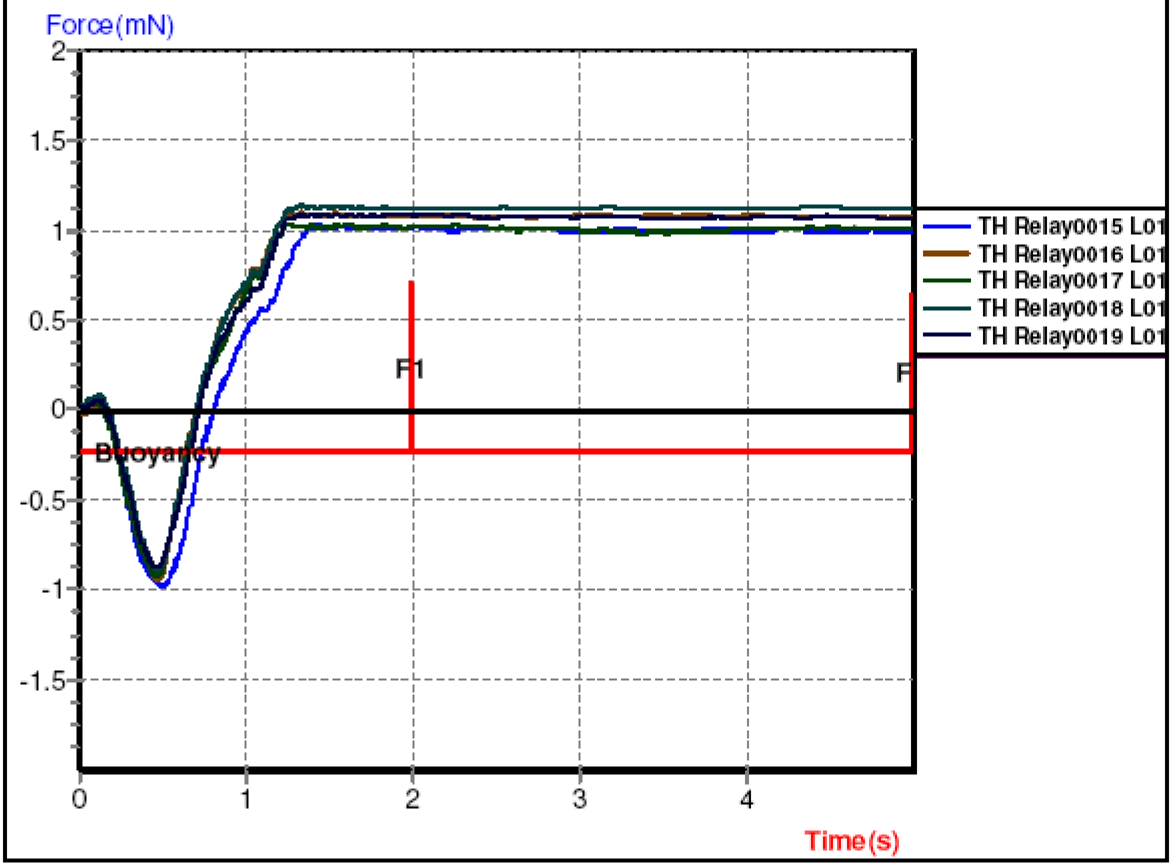
Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Relay0015 L01	0.735	0.804	1.191	1.247	1.226	1.033	1.431	Fail
DOE - SN100C	ATH Relay0016 L01	0.639	0.693	1.020	1.315	1.312	1.105	1.539	Fail
DOE - SN100C	ATH Relay0017 L01	0.645	0.696	1.020	1.254	1.240	1.040	1.251	Fail
DOE - SN100C	ATH Relay0018 L01	0.645	0.699	1.035	1.350	1.350	1.143	1.326	Fail
DOE - SN100C	ATH Relay0019 L01	0.666	0.717	1.101	1.319	1.302	1.098	1.899	Fail
	Standard Dev	0.040	0.047	0.074	0.045	0.052	0.047	0.254	
	Mean	0.666	0.722	1.073	1.297	1.286	1.084	1.469	
	Max	0.735	0.804	1.191	1.350	1.350	1.143	1.899	
	Min	0.639	0.693	1.020	1.247	1.226	1.033	1.251	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.6 Through Hole Relays, Fmax and TFmax, Most Stringent

Test Details

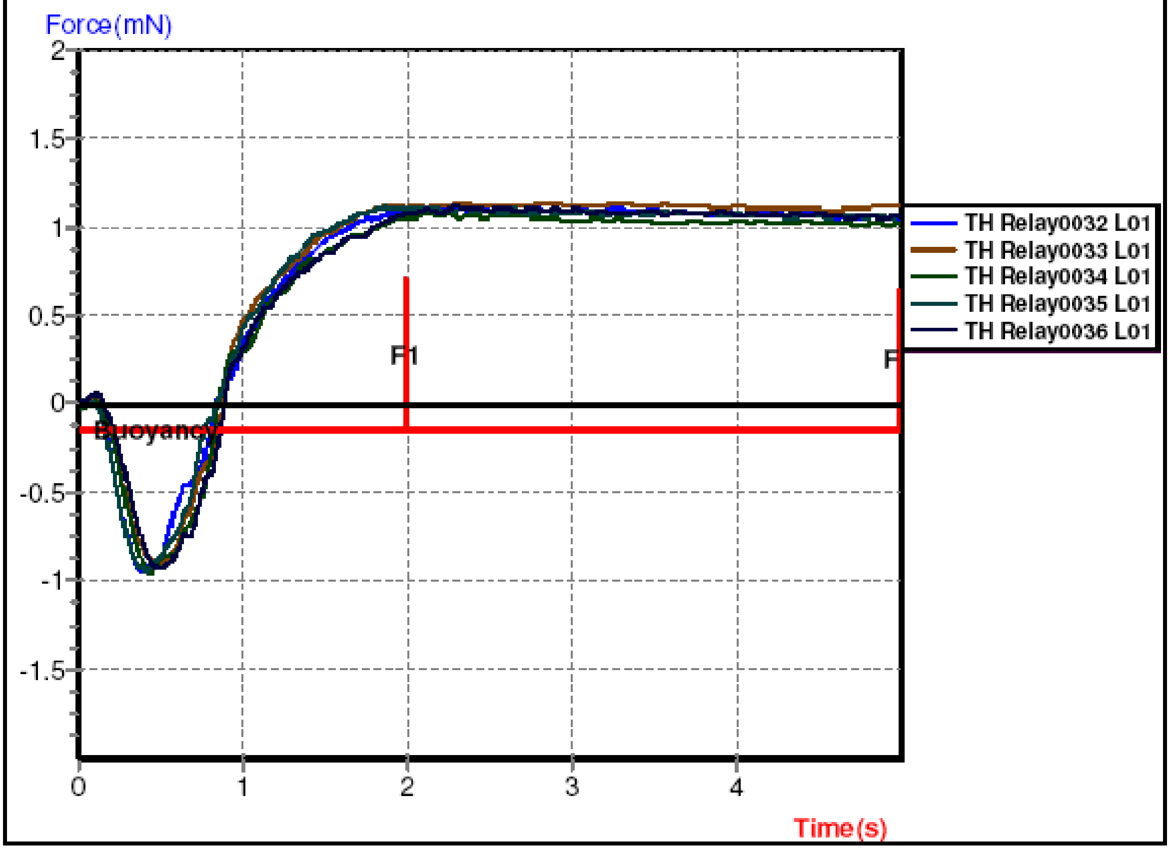
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ATH Relay0032 L01		0.804	0.837	1.290	1.230	1.182	1.109	2.319	Fail
DOE - SN100C ATH Relay0033 L01		0.855	0.882	1.263	1.251	1.254	1.133	2.814	Fail
DOE - SN100C ATH Relay0034 L01		0.828	0.852	1.317	1.185	1.158	1.081	2.112	Fail
DOE - SN100C ATH Relay0035 L01		0.765	0.840	1.221	1.247	1.202	1.116	1.860	Fail
DOE - SN100C ATH Relay0036 L01		0.864	0.888	1.347	1.213	1.199	1.116	2.274	Fail
	Standard Dev	0.040	0.024	0.049	0.027	0.036	0.019	0.350	
	Mean	0.823	0.860	1.288	1.225	1.199	1.111	2.276	
	Max	0.864	0.888	1.347	1.251	1.254	1.133	2.814	
	Min	0.765	0.837	1.221	1.185	1.158	1.081	1.860	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.7 Through Hole Socket Connectors, Ta and Tb, Least Stringent

Test Details

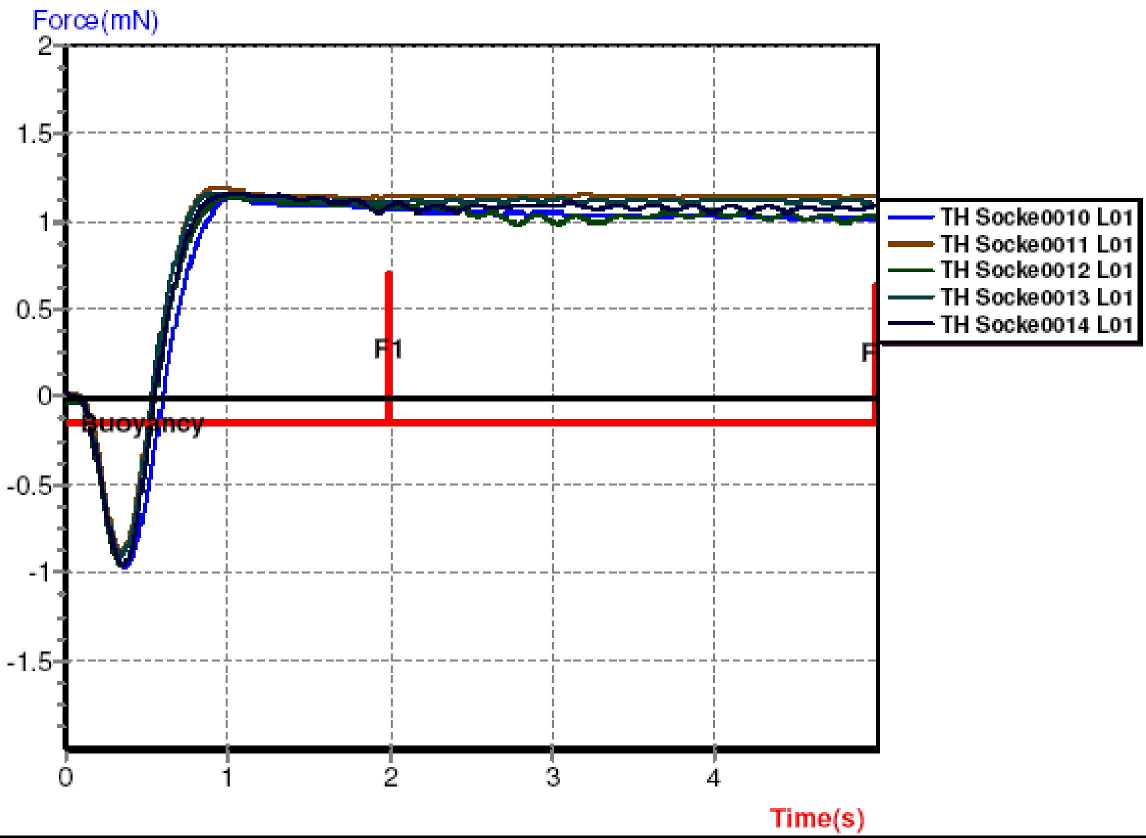
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ATH Socke0010 L01		0.576	0.597	0.762	1.206	1.151	1.136	1.014	Pass
DOE - SN100C ATH Socke0011 L01		0.510	0.531	0.675	1.285	1.285	1.195	0.924	Pass
DOE - SN100C ATH Socke0012 L01		0.531	0.552	0.708	1.227	1.165	1.136	0.987	Pass
DOE - SN100C ATH Socke0013 L01		0.510	0.528	0.672	1.247	1.237	1.167	0.918	Pass
DOE - SN100C ATH Socke0014 L01		0.528	0.549	0.702	1.230	1.227	1.167	1.038	Pass
	Standard Dev	0.027	0.028	0.036	0.030	0.055	0.025	0.054	
	Mean	0.531	0.551	0.704	1.239	1.213	1.160	0.976	
	Max	0.576	0.597	0.762	1.285	1.285	1.195	1.038	
	Min	0.510	0.528	0.672	1.206	1.151	1.136	0.918	

Number of Tests : 005 Passing rate : 100.0 %



Appendix 9.8 Through Hole Socket Connectors, Ta and Tb, Most Stringent

Test Details

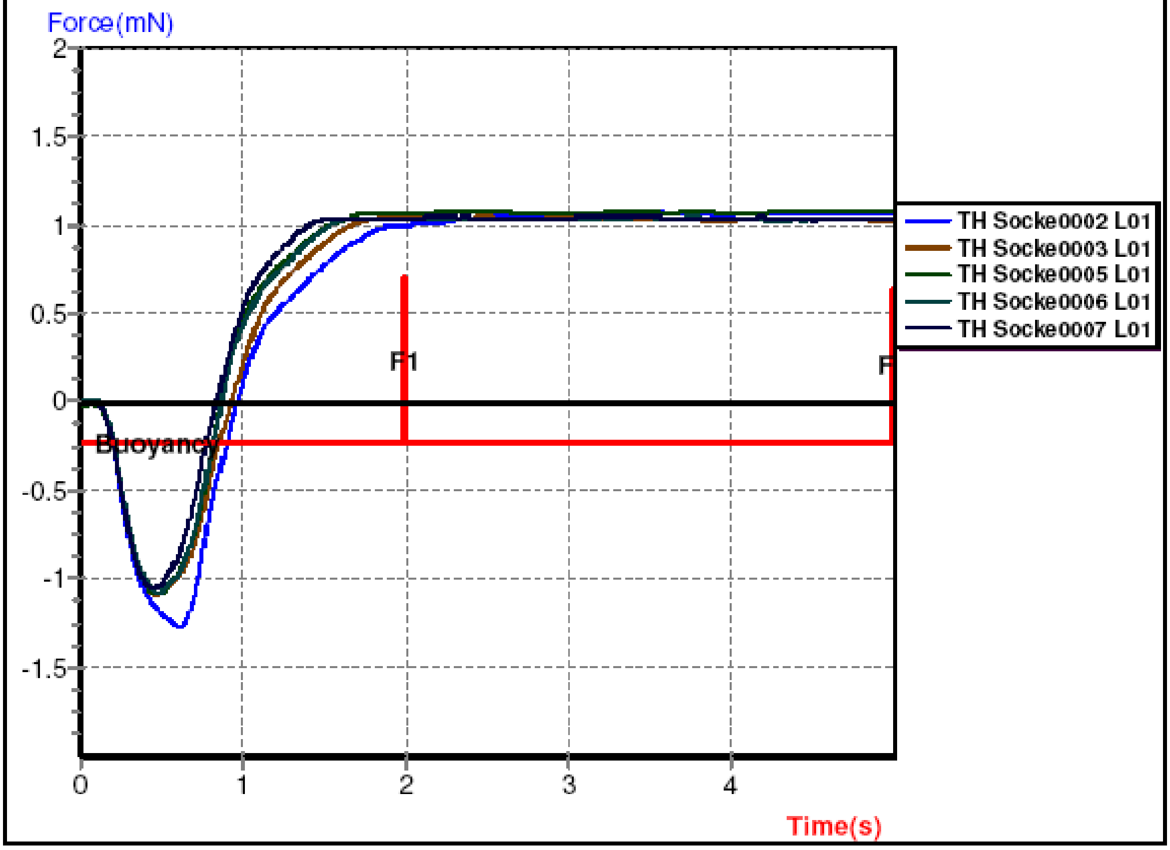
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Socke0002 L01	0.903	0.963	1.428	1.229	1.291	1.074	3.471	Fail
DOE - SN100C	ATH Socke0003 L01	0.849	0.930	1.263	1.278	1.260	1.050	2.904	Fail
DOE - SN100C	ATH Socke0005 L01	0.816	0.864	1.167	1.302	1.305	1.078	3.265	Fail
DOE - SN100C	ATH Socke0006 L01	0.816	0.867	1.176	1.267	1.274	1.050	3.462	Fail
DOE - SN100C	ATH Socke0007 L01	0.774	0.834	1.086	1.267	1.267	1.054	3.444	Fail
	Standard Dev	0.048	0.054	0.130	0.026	0.018	0.014	0.241	
	Mean	0.832	0.893	1.224	1.269	1.280	1.061	3.313	
	Max	0.903	0.966	1.428	1.302	1.305	1.078	3.471	
	Min	0.774	0.834	1.086	1.229	1.260	1.050	2.904	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.9 Through Hole Socket Connectors, F1 and F2, Least Stringent

Test Details

Component : DOE - SN100C Alloy

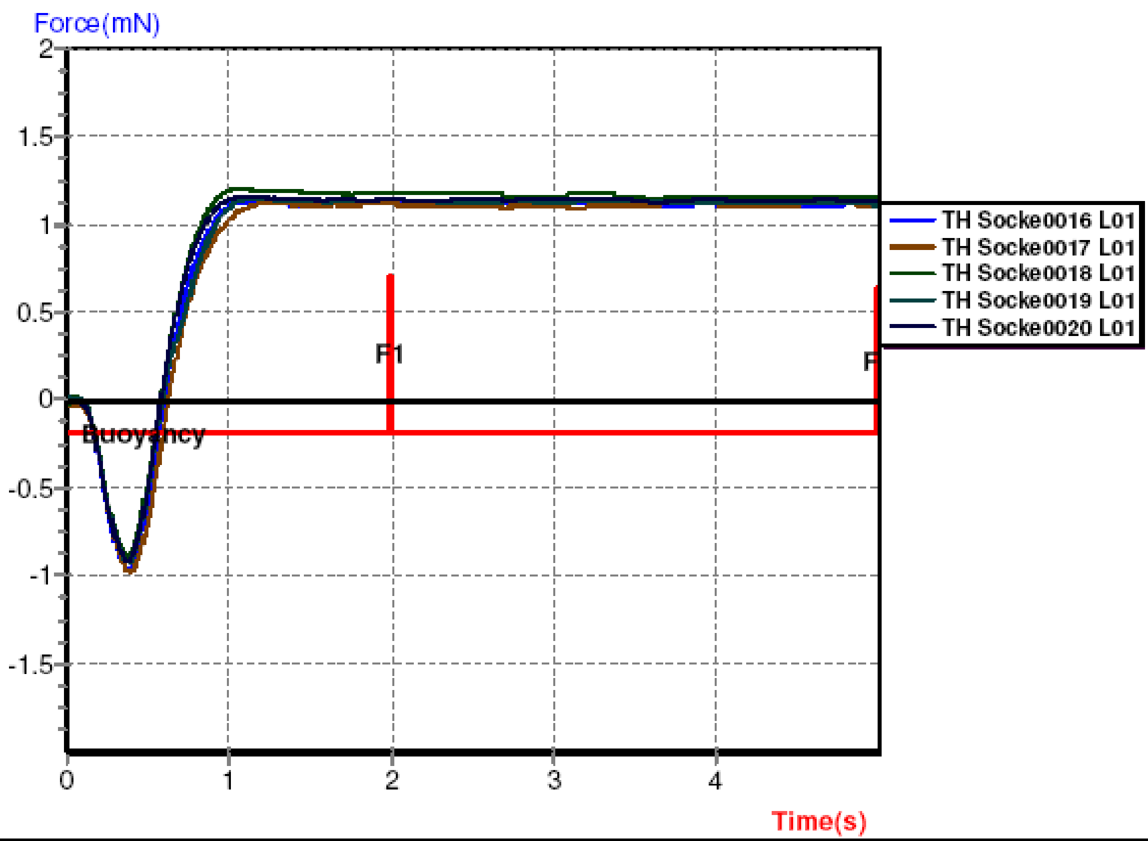
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ATH Socke0016 L01	0.567	0.597	0.777	1.307	1.304	1.129	1.059	Pass
DOE - SN100C ATH Socke0017 L01	0.594	0.624	0.819	1.304	1.297	1.123	1.215	Pass
DOE - SN100C ATH Socke0018 L01	0.549	0.579	0.750	1.359	1.349	1.205	1.053	Pass
DOE - SN100C ATH Socke0019 L01	0.555	0.585	0.807	1.331	1.293	1.154	1.131	Pass
DOE - SN100C ATH Socke0020 L01	0.549	0.579	0.750	1.328	1.318	1.167	1.128	Pass
Standard Dev	0.019	0.019	0.032	0.022	0.022	0.033	0.066	
Mean	0.563	0.593	0.781	1.326	1.312	1.156	1.117	
Max	0.594	0.624	0.819	1.359	1.349	1.205	1.215	
Min	0.549	0.579	0.750	1.304	1.293	1.123	1.053	

Number of Tests : 005   Passing rate : 100.0 %



Appendix 9.10 Through Hole Socket Connectors, F1 and F2, Most Stringent

Test Details

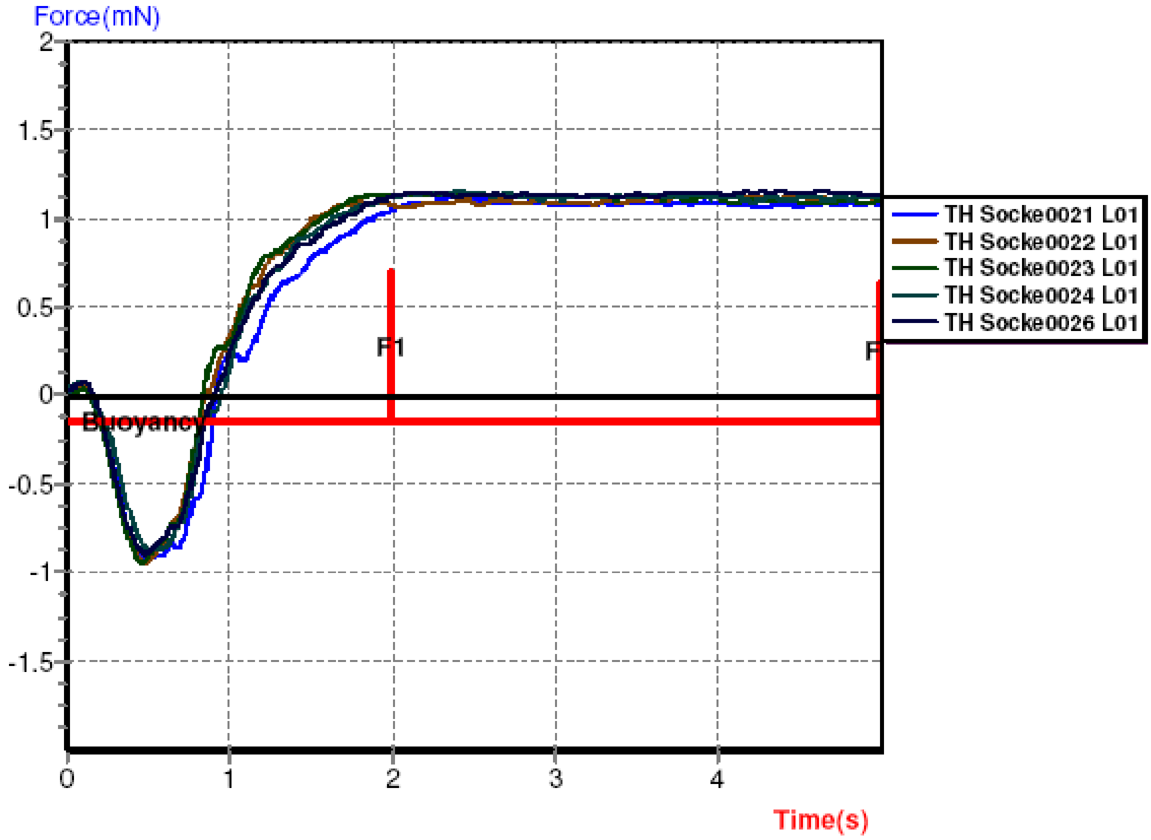
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C ATH Socke0021 L01		0.894	0.912	1.476	1.189	1.220	1.123	2.406	Fail
DOE - SN100C ATH Socke0022 L01		0.822	0.855	1.236	1.220	1.244	1.136	4.005	Fail
DOE - SN100C ATH Socke0023 L01		0.813	0.834	1.191	1.271	1.244	1.143	2.370	Fail
DOE - SN100C ATH Socke0024 L01		0.852	0.951	1.350	1.254	1.268	1.164	2.406	Fail
DOE - SN100C ATH Socke0026 L01		0.849	0.900	1.359	1.264	1.271	1.160	4.614	Fail
	Standard Dev	0.032	0.047	0.112	0.035	0.021	0.017	1.071	
	Mean	0.846	0.890	1.322	1.240	1.249	1.145	3.160	
	Max	0.894	0.951	1.476	1.271	1.271	1.164	4.614	
	Min	0.813	0.834	1.191	1.189	1.220	1.123	2.370	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.11 Through Hole Socket Connectors, Fmax and TFmax, Least Stringent

Test Details

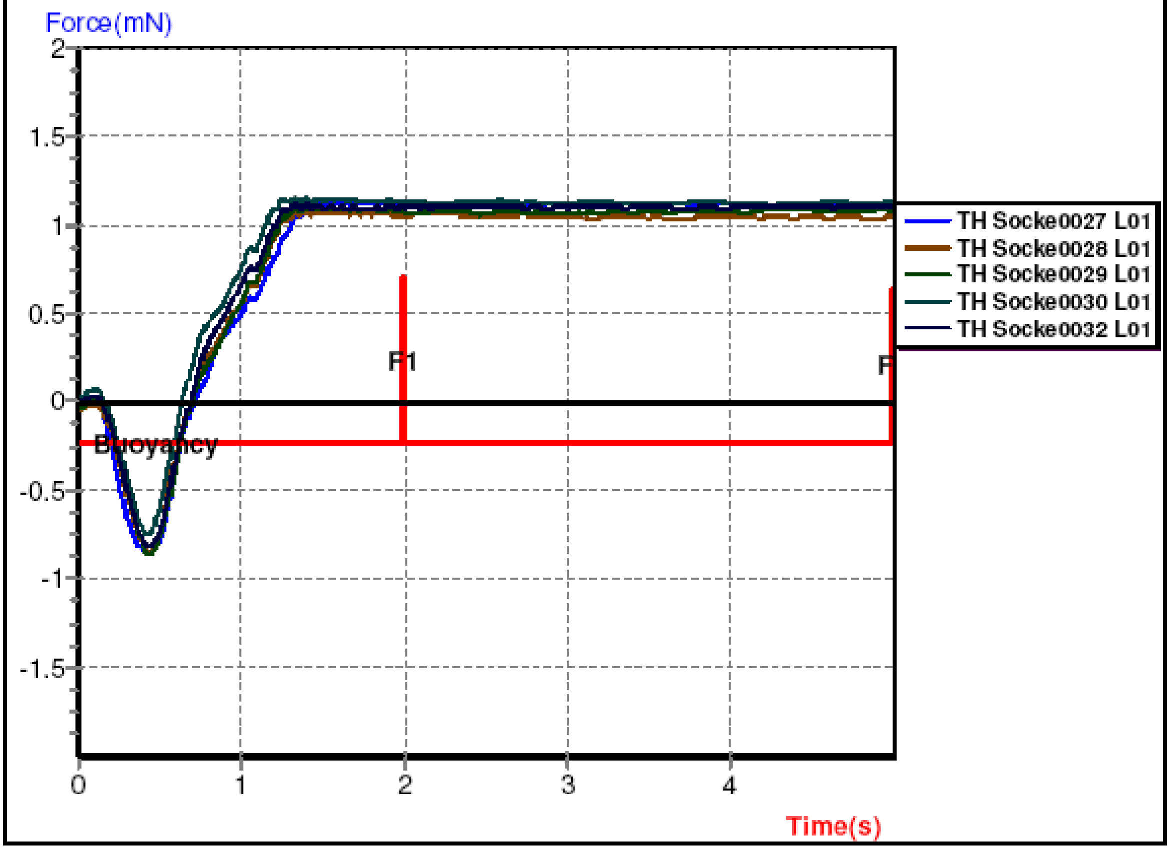
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Socke0027 L01	0.630	0.708	1.164	1.346	1.336	1.126	1.605	Fail
DOE - SN100C	ATH Socke0028 L01	0.615	0.687	1.116	1.285	1.285	1.081	1.395	Fail
DOE - SN100C	ATH Socke0029 L01	0.627	0.696	1.116	1.302	1.315	1.109	1.398	Fail
DOE - SN100C	ATH Socke0030 L01	0.582	0.636	1.002	1.360	1.364	1.157	1.323	Fail
DOE - SN100C	ATH Socke0032 L01	0.615	0.687	1.077	1.333	1.333	1.119	1.332	Fail
	Standard Dev	0.019	0.028	0.060	0.031	0.029	0.027	0.114	
	Mean	0.614	0.683	1.095	1.325	1.327	1.118	1.411	
	Max	0.630	0.708	1.164	1.360	1.364	1.157	1.605	
	Min	0.582	0.636	1.002	1.285	1.285	1.081	1.323	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.12 Through Hole Socket Connectors, Fmax and TFmax, Most Stringent

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

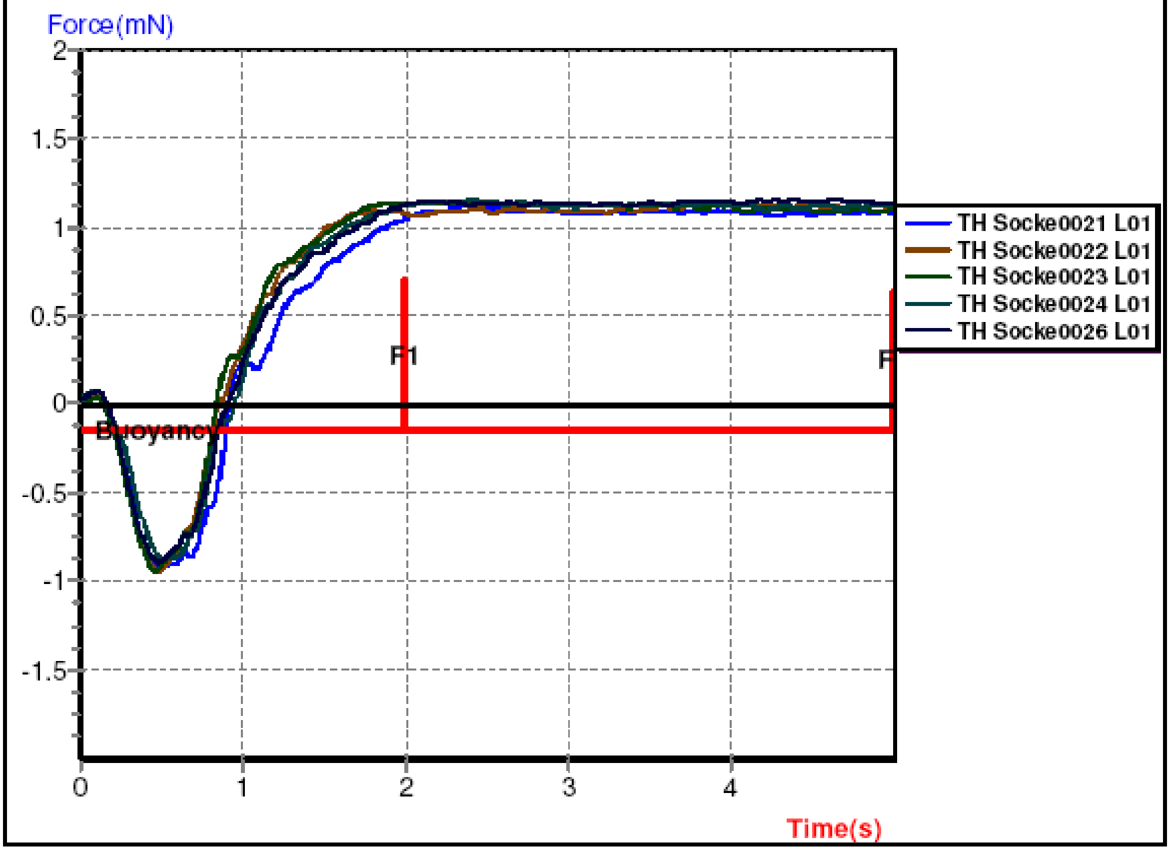
Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	ATH Socke0021 L01	0.894	0.912	1.476	1.189	1.220	1.123	2.406	Fail
DOE - SN100C	ATH Socke0022 L01	0.822	0.855	1.236	1.220	1.244	1.136	4.005	Fail
DOE - SN100C	ATH Socke0023 L01	0.813	0.834	1.191	1.271	1.244	1.143	2.370	Fail
DOE - SN100C	ATH Socke0024 L01	0.852	0.951	1.350	1.254	1.268	1.164	2.406	Fail
DOE - SN100C	ATH Socke0026 L01	0.849	0.900	1.359	1.264	1.271	1.160	4.614	Fail
	Standard Dev	0.032	0.047	0.112	0.035	0.021	0.017	1.071	
	Mean	0.846	0.890	1.322	1.240	1.249	1.145	3.160	
	Max	0.894	0.951	1.476	1.271	1.271	1.164	4.614	
	Min	0.813	0.834	1.191	1.189	1.220	1.123	2.370	

Number of Tests : 005 Passing rate : 0.0 %



Appendix 9.13 Through Hole LED, Ta and Tb, Most Stringent

Test Details

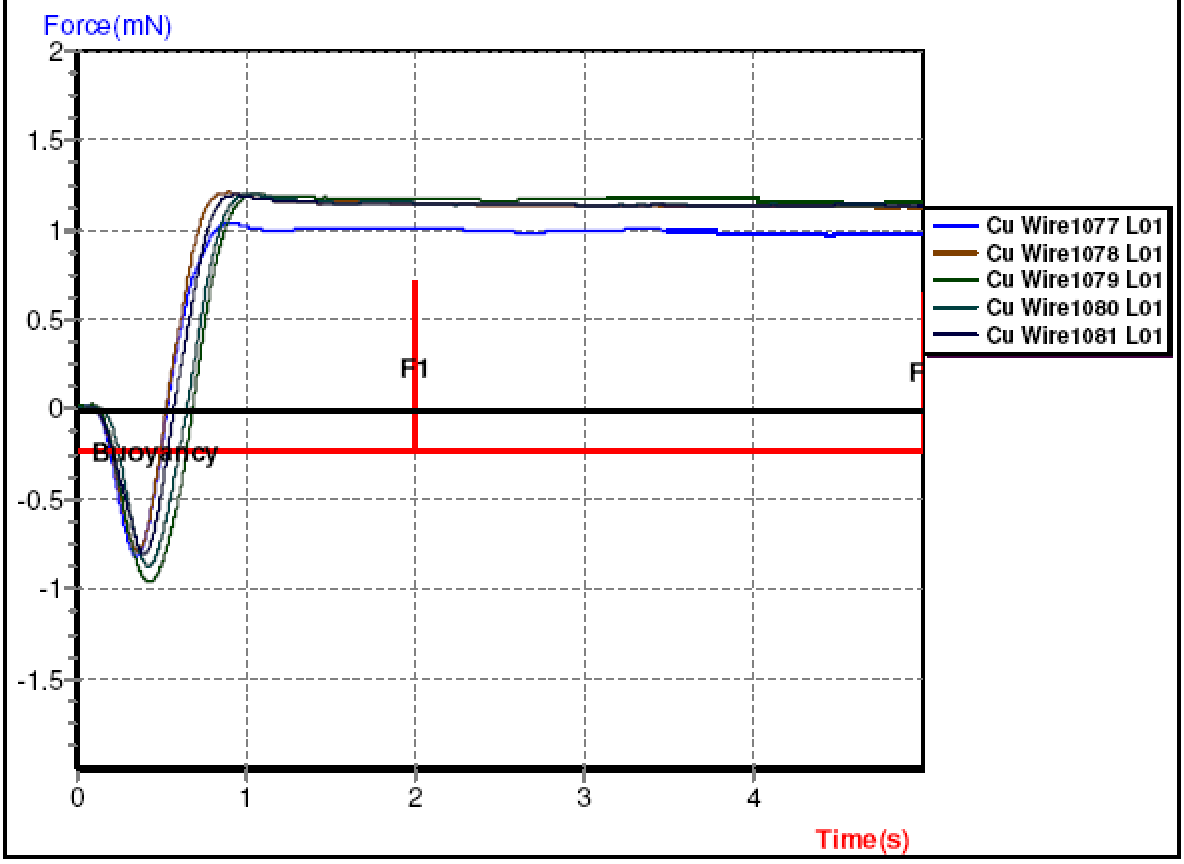
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 10.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	1077 L01	0.495	0.531	0.666	1.240	1.216	1.036	0.873	Pass
DOE - SN100C	1078 L01	0.492	0.525	0.666	1.374	1.357	1.212	0.885	Pass
DOE - SN100C	1079 L01	0.648	0.681	0.813	1.405	1.388	1.202	1.035	Fail
DOE - SN100C	1080 L01	0.603	0.648	0.786	1.384	1.364	1.202	0.990	Fail
DOE - SN100C	1081 L01	0.534	0.573	0.717	1.374	1.371	1.198	0.915	Pass
	Standard Dev	0.069	0.070	0.068	0.066	0.070	0.075	0.070	
	Mean	0.554	0.592	0.730	1.355	1.339	1.170	0.940	
	Max	0.648	0.681	0.813	1.405	1.388	1.212	1.035	
	Min	0.492	0.525	0.666	1.240	1.216	1.036	0.873	

Number of Tests : 005 Passing rate : 60.0 %



Appendix 9.14 Through Hole LED, Ta and Tb, Least Stringent

Test Details

Component : DOE - SN100C Alloy

Test parameter filename : Bath Parameters.vts

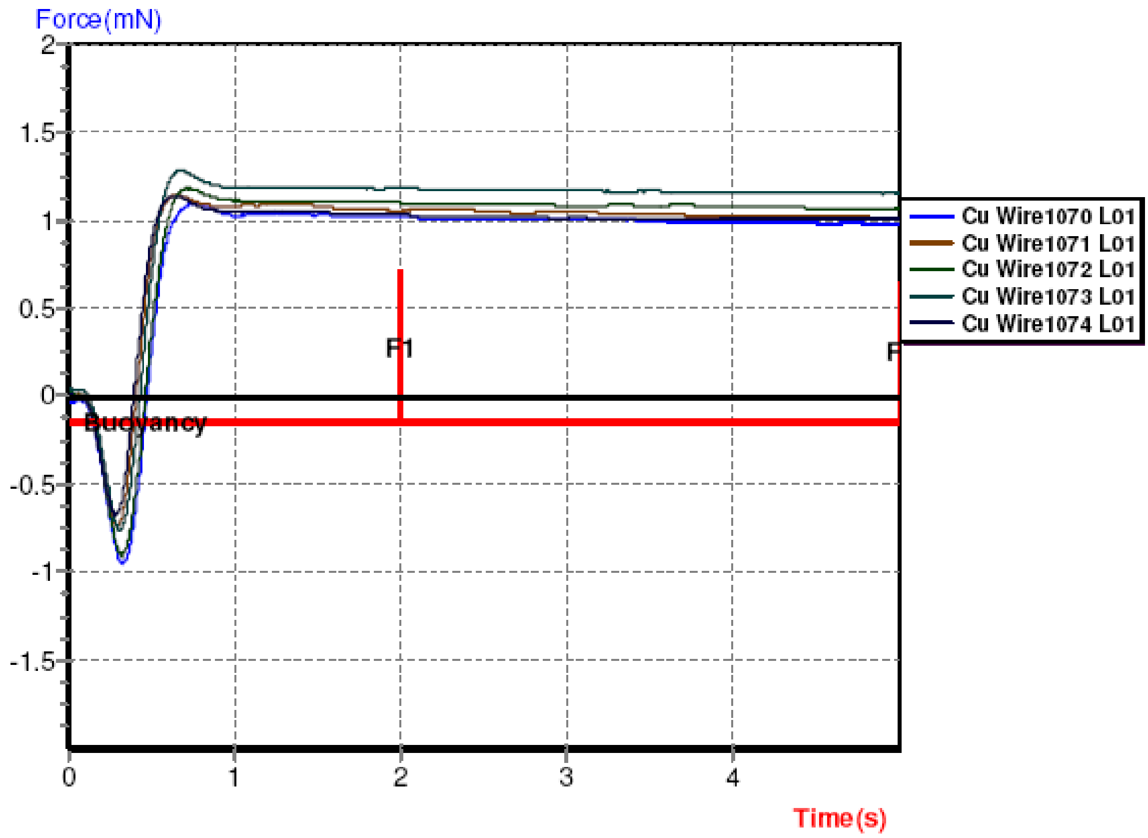
Test parameter line : 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	1070 L01	0.459	0.471	0.555	1.161	1.127	1.098	0.750	Pass
DOE - SN100C	1071 L01	0.393	0.405	0.489	1.196	1.151	1.150	0.642	Pass
DOE - SN100C	1072 L01	0.447	0.462	0.552	1.237	1.209	1.185	0.708	Pass
DOE - SN100C	1073 L01	0.414	0.429	0.519	1.323	1.295	1.288	0.681	Pass
DOE - SN100C	1074 L01	0.378	0.393	0.477	1.175	1.154	1.140	0.615	Pass
	Standard Dev	0.035	0.034	0.036	0.065	0.068	0.072	0.053	
	Mean	0.418	0.432	0.518	1.218	1.187	1.172	0.679	
	Max	0.459	0.471	0.555	1.323	1.295	1.288	0.750	
	Min	0.378	0.393	0.477	1.161	1.127	1.098	0.615	

Number of Tests : 005 Passing rate : 100.0 %



Appendix 9.15 Through Hole LED, Fmax and TFmax, Least Stringent

Test Details

Component : SN100C Alloy

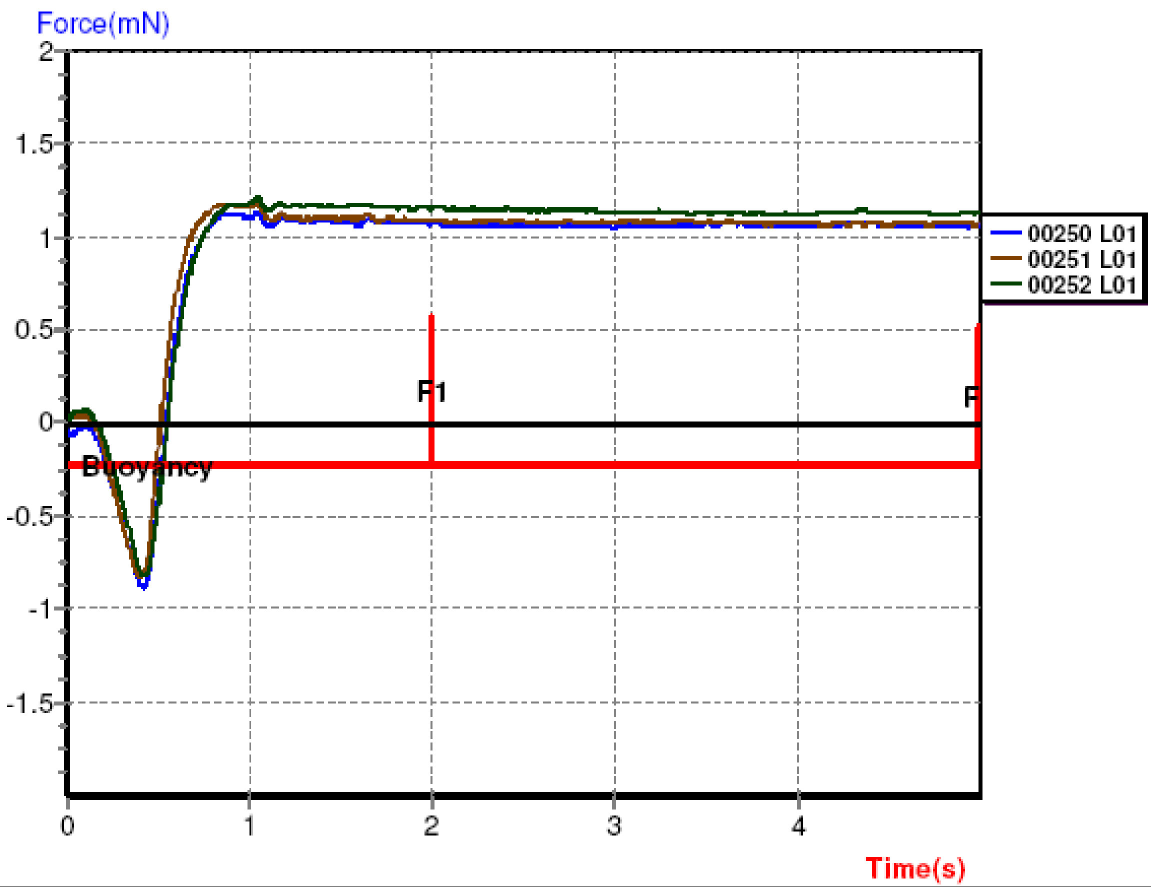
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.23 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 5.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00250 L01	0.519	0.543	0.648	1.309	1.295	1.136	1.041	Pass
SN100C Alloy	00251 L01	0.492	0.513	0.612	1.326	1.305	1.181	0.870	Pass
SN100C Alloy	00252 L01	0.525	0.549	0.672	1.388	1.364	1.212	1.038	Pass
	Standard Dev	0.018	0.019	0.030	0.042	0.037	0.038	0.098	
	Mean	0.512	0.535	0.644	1.341	1.321	1.176	0.963	
	Max	0.525	0.549	0.672	1.388	1.364	1.212	1.041	
	Min	0.492	0.513	0.612	1.309	1.295	1.136	0.870	

Number of Tests : 003   Passing rate : 100.0 %



Appendix 9.16 Through Hole LED, Fmax, TFmax, F1 and F2, Most Stringent

Test Details

Component : SN100C Alloy

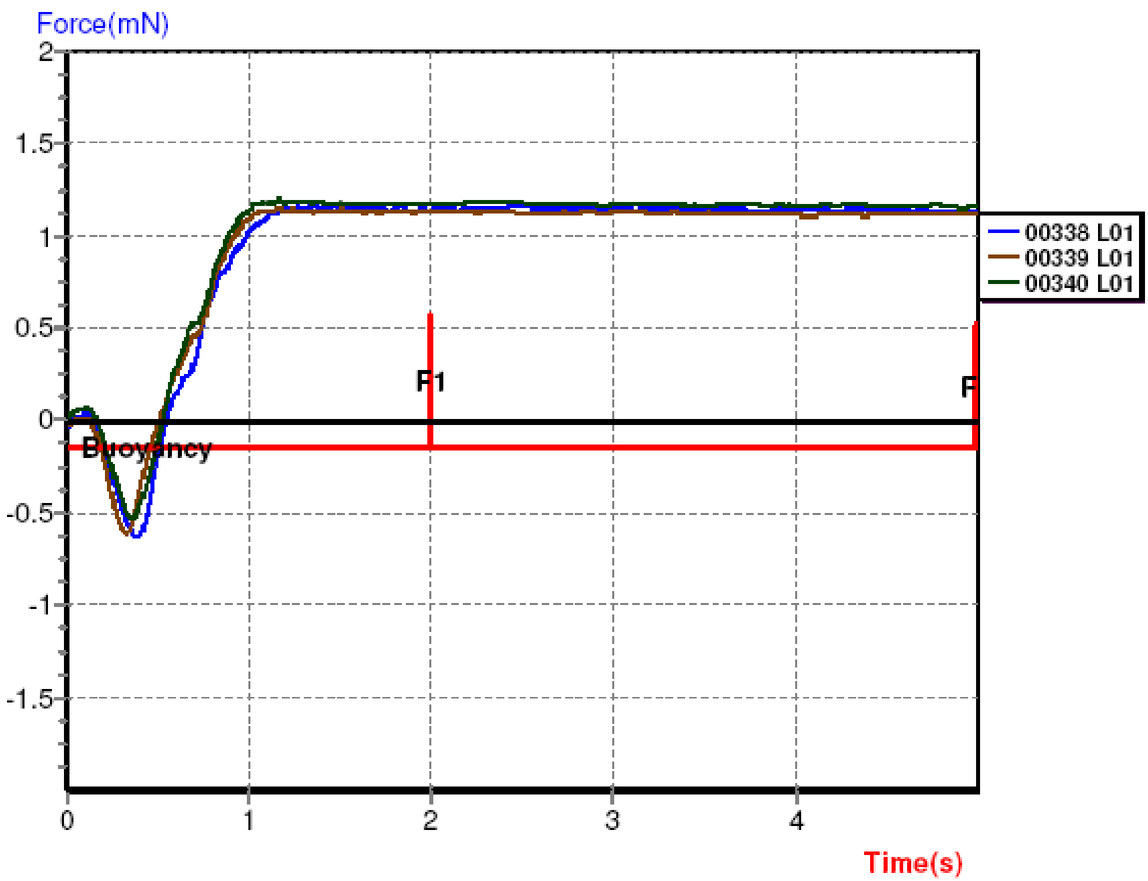
Test parameter filename : Bath Parameters.vts   Test parameter line : 1

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.51 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.14 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 5.0 mm/s	Immersion Depth	= 3.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 250.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
SN100C Alloy	00338 L01	0.510	0.543	0.834	1.278	1.271	1.164	1.821	Pass
SN100C Alloy	00339 L01	0.459	0.507	0.807	1.271	1.264	1.154	1.167	Pass
SN100C Alloy	00340 L01	0.495	0.528	0.801	1.320	1.302	1.198	1.161	Pass
	Standard Dev	0.026	0.018	0.018	0.026	0.020	0.023	0.379	
	Mean	0.488	0.526	0.814	1.290	1.279	1.172	1.383	
	Max	0.510	0.543	0.834	1.320	1.302	1.198	1.821	
	Min	0.459	0.507	0.801	1.271	1.264	1.154	1.161	

Number of Tests : 003   Passing rate : 100.0 %



Appendix 9.17 Through Hole LED, F1 and F2, Least Stringent

Test Details

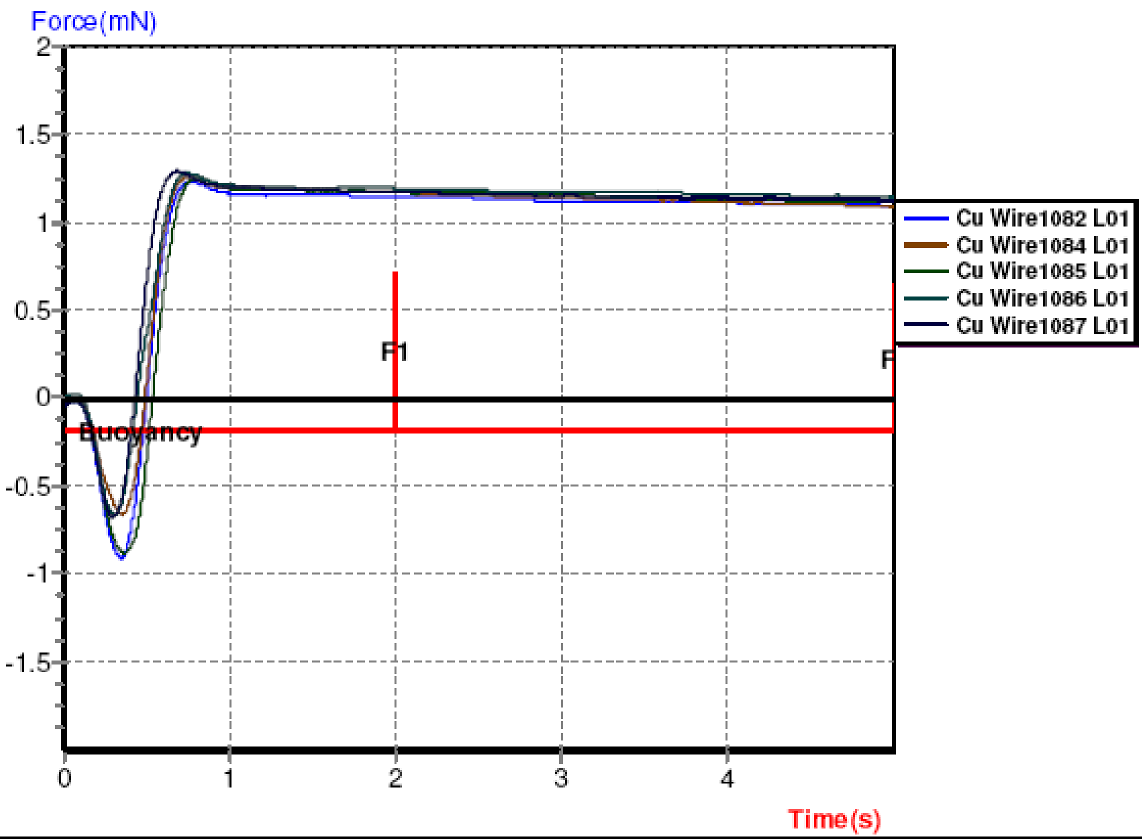
Component	: DOE - SN100C Alloy		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 1

Test Limits and Conditions

F1	= 0.71 mN @ 2.00 s	F2	= 0.64 mN @ 5.00 s
Ta	= 0.60 s	Buoyancy	= -0.18 mN
Tb	= 1.00 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 15.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 260.0 °C	Flux	= Production Flux

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	Fmax (mN)	TFmax (s)	Pass/Fail
DOE - SN100C	082 L01	0.477	0.495	0.591	1.338	1.283	1.233	0.750	Pass
DOE - SN100C	084 L01	0.465	0.486	0.582	1.355	1.273	1.264	0.738	Pass
DOE - SN100C	085 L01	0.516	0.534	0.630	1.355	1.311	1.257	0.789	Pass
DOE - SN100C	086 L01	0.417	0.438	0.576	1.380	1.335	1.281	0.726	Pass
DOE - SN100C	087 L01	0.405	0.426	0.519	1.355	1.307	1.295	0.678	Pass
	Standard Dev	0.045	0.044	0.040	0.015	0.024	0.024	0.040	
	Mean	0.456	0.476	0.580	1.357	1.302	1.266	0.736	
	Max	0.516	0.534	0.630	1.380	1.335	1.295	0.789	
	Min	0.405	0.426	0.519	1.338	1.273	1.233	0.678	

Number of Tests : 005 Passing rate : 100.0 %



Appendix 10 Published Conference Papers

Appendix 10.1 IMC24 –

INVESTIGATE THE DIP AND LOOK TEST PROCEDURE FOR COMPONENTS IN A PB AND PB-FREE SOLDERING PROCESS

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ABSTRACT

Most tests are not very helpful in controlling the production process. They are very slow and usually give results at a very late date, when the production line has run for a considerable time and has produced potentially defective products. Test are been used to establish process parameters, to fix the general quality of the product, and to protect against unpleasant surprises. Special test are available to ensure the quality of materials received.

The majority of solder defects are attributable to lacking solderability of components. Testing for solderability is necessary. As a matter of procedure in an automotive manufacturing company, special solderability requirements should be included in any purchase agreement for component suppliers.

Process improvement is very mush based on trial and error. Within the Dip and Look solderability test in many of the international standards there are many variables/factors present – solder bath temperature, component immersion depth, Solder immersion time etc. Therefore it is necessary to extract the optimum parameter settings and use them to get the optimum automated Dip and Look test settings for components in a Pb and Pb-free process using a MUST II wetting balance machine. This will be done by means of a Design of Experiments (D.O.E) and the integrity of the Dip and Look test method investigated.

KEYWORDS: Solderability, Dip and Look Test, Optimum parameter settings

1. INTRODUCTION

With the introduction of the Waste Electrical and Electronic Equipment (WEEE) (1) and the Restriction of use of Certain Hazardous Substances (RoHS) (2), a lot of focus has been aimed at a components solderability characteristic. The solderability of a component's metallic termination is a critical parameter in any soldering process because it represents the likelihood of that termination forming a good alloy with the solder and a high quality solder fillet (4). As components continue to become smaller and more fine pitch, coupled with the widespread use of less active fluxes, the soldering process window narrows and the impact of poor solderability increases. Although components are generally assembled from parts of known (good) solderability, there is no way of guaranteeing this without testing, especially given that the prime cause of solderability is how well a part has been stored and its age (4).

A quick and easy way to determine the solderability of a component is by means of a Dip and Look method (5). In order to give a repeatable and consistent test, a Design of Experiments (D.O.E) will be carried out to determine the most optimum parameter settings on a MUST II Wetting Balance machine. This machine will be used as a means of automating the Dip and Look test. As the name suggests the Dip and Look test involves manually dipping a component by hand into a solder bath and visually inspecting the termination for 95% solder coverage, but this can lead to a lot of inconsistency as the immersion depth and immersion/emersion speed will undoubtedly vary, due to human error.

This paper investigates the variables within the parameter settings in the International Solderability test standards with a view to achieving the optimum settings to be used in the MUST II Wetting Balance machine.

A Dip and Look test procedure for both the wave and reflow soldering processes, lead and lead-free, will be investigated in this paper. Component finish and type will vary to try and determine all optimum settings are workable on all solderability problematic components.

2. REVIEW OF INTERNATIONAL STANDARDS

The main International standards used for analysis in this paper are:

1. J-STD-002C –Solderability Test for Component Leads, Terminations, Lugs, Terminals and Wires
2. IPC/EIA J-STD-002B – Joint Industry Standard, Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires9
3. JEDEC Standard – JESD22-B102D, Solderability
4. Department of Defence – MIL-STD-202G, Test Method Standard of Electronic and Electrical Component Parts
5. International Standard - CEI IEC 68-2-20, Basis Environmental Testing Procedures, Part 2: Test T, Soldering

3. DESIGN OF EXPERIMENTS – D.O.E

There are various Dip and Look test options available to Kostal, however there is no clear consensus as to the appropriate combination of tests which defines an acceptable Dip and Look standard at component level. In order to achieve a workable standard, a review of each available international standard is required to develop a Design of Experiments with a view to obtaining the optimum settings. The goal of this experiment is to determine the critical variables and any interactions present during the automated Dip and Look solderability testing of components. The resulting settings from the DOE should provide a Dip and Look test that would detect any form of contamination on the termination of the components which could affect solderability. Currently, from experience, Dip and Look tests, using the specified settings in the international standards, are very forgiving towards components. The software use to conduct this D.O.E is ‘Design Experiment 6.0.6’.

The experiment involved components, Quad Flat Pack’s (QFP) and capacitors, and was conducted using the MUST II solderability test machine. The reason for choosing QFP’s and capacitors was due to their physical size which would incorporate most component types in industry.

3.1 Responses

The most critical output response is the percentage of Wettability on the component termination. These were visually inspected using a microscope at up to 40x magnification, with a target of 95% solder coverage on the termination of the component. In the event of achieving solder coverage below the 95% threshold, this would be deemed a failure.

3.2 Factors and Run Combinations

Appendix 1 shows the factors and parameters used in the experiment for both lead and lead-free wave/reflow soldering of components using the Dip and Look method. These factors were determined by reviewing the international standards as stated in section 2. From speaking with some component manufacturers, the main factors of the Dip and Look test are solder temperature, immersion depth and immersion speed. The number of factors for components were 3, resulting in 27 runs for each process, lead (Pb) and lead-free.

At the beginning of every run, the machine settings were made with reference to the arrays in Appendix 3. Once steady state conditions were achieved and settings verified, the run was initiated. Each run consisted of one component lead. After the test was completed, each termination was visually inspected using a microscope for the 95% threshold level and results were recorded as per "**Response: Wettability (%)"** column in Appendix 1.

Table 1 shows the factors used for Wave and Reflow processes using components in a lead (Pb) and lead-free process for the Dip and Look D.O.E. As can be seen temperature was the only setting difference for a lead (Pb) and lead-free process.

Factor Name for Components	**Min Value**	**Medium Value**	**Max Value**
Wave Solder Temperature (Pb)	235^0	240^0	245^0
Wave Solder Temperature (Pb-free)	240^0	250^0	260^0
Reflow Solder Temperature (Pb)	210^0	215^0	220^0
Reflow Solder Temperature (Pb-free)	240^0	245^0	250^0
Immersion Time (Pb and Pb-free))	4sec	5sec	6sec
Immersion Depth (Pb and Pb-free)	0.1mm	0.8mm	1.4mm

Table 1 – Wave/Reflow settings for Components in a Pb and Pb-free Process

3.3 Analysis of D.O.E.

The solder coverage was entered as a percentage in to the DOE software for analysis. As each run gave the required 95% solder coverage it was concluded without using the DOE software for analysis, that no factor had any significant effect on the wettability. The only explanation for these results at this stage of the project was to conclude that the Dip and Look test was a forgiving test and would require further investigation to prove whether or not it was a reliable means of testing solderability.

It was decided to take the medium settings of table 1 above and run a series of Dip and Look tests on a samples range of components to determine if any failures would result.

4. RESULTING DIP AND LOOK PARAMETER SETTINGS

Table 2 is a summary of the parameter settings for the three variables as a result of the D.O.E for the Dip and Look solderability test for components in a lead (Pb) and lead-free wave soldering process.

Wave Process	**Pb**	**Pb-free**
Solder Temperature	240 +-1^{0}C	250 +-1^{0}C
Immersion Time	5 seconds	5 seconds
Immersion Depth	0.8mm	0.8mm

Table 2 Dip and Look settings for Components in a Pb/Pb-free Wave Process

5. FURTHER INVESTIGATION - OPTIMISING DIP AND LOOK SETTINGS

In order to test the validity of the settings in tables 3, a wide range of components from resistors to large electrolytic caps were tested. The sequence of the testing was a repeat of the testing initially used to determine the medium DOE settings. Again each component reached the 95% target for solder coverage.

At this stage of the investigation it was concluded that the resulting DOE settings did not provide a valid test as all components were passing. Even components of known solderability issues passed the 95% solder coverage. To achieve settings that resulted in a failure (less than 95%) it was decided to reduce the temperature of the solder in increments of 5^{0}C and keep all other settings constant. The reason for varying temperature was due to the fact that temperature is one of the main factors in forming a solder joint along with flux and base metal [18]. The results show that for:

a) Pb process – Wave/Reflow for components

- The temperature reached 185^{0}C before results of less than 95% solder coverage were achieved. As 183^{0}C is the liquidus point of Sn/Pb solder the result was expected at this point. An example of the failure can be seen in figure 1 below, solder does not wet to the leads resulting in a failure.

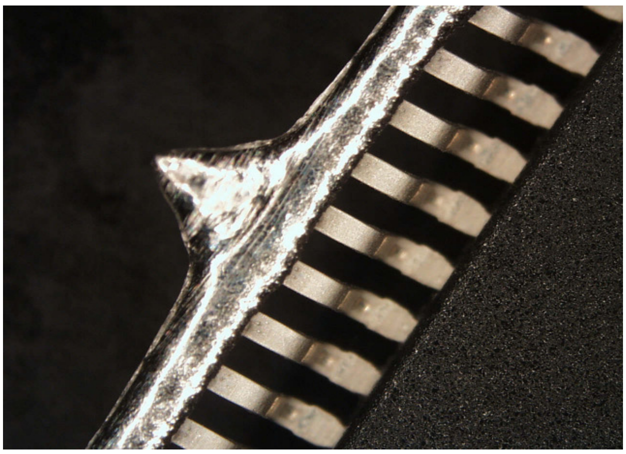

Figure 1 – QFP leads with Pb solder not wetting @ 183^{0}C [6]

b) Pb-free process - Wave/Reflow for components
- The temperature reached 225^0C before results of less than 95% solder coverage were achieved. As 221^0C is the liquidus point of SAC alloy solder the result was again expected at this point, see figure 2.

Figure 2 – QFP leads with Pb-free solder not wetting @ 221^0C [6]

Given the results above, it could be concluded that Dip and Look testing in a Pb and Pb-free environment does not effectively scrutinise the solderable properties of components to an extent that contamination on the surface of the termination or pad could be detected.

Some International standards use a preconditioning test on the components before the Dip and Look test. The preconditioning test acts as a means of aging the component. A preconditioning of the component would need to be investigated to determine if any failures would result by using the same DOE settings are per Appendix 1.

5.1 Pre-Conditioning Testing: Dry Bake and Steam

Due to the fact that some components are not used immediately after purchase in some companies, the storage would also need to be included in Dip and Look testing which would factor in aging. The ideal preconditioning test would age the surface to be checked and impose restrictive conditions of weak flux, standard temperature, and adequate time.

5.1.1 Components

After reviewing the IPC standards mentioned in section 2 the two preconditioning tests are used for components;
1. Dry bake
2. Steam test.

The exposure time for the Dry bake preconditioning test was 16 hours +- 30 minutes in a constant temperature of 150^0C and for the Steam preconditioning test the oven been used only had the capability of 8 hours at 125^0C with 95% relative

humidity. The components were exposed to a controlled environment in specialised ovens and the settings were applied for the Steam and Dry test.
After removing the components from the ovens, the Dip and Look test was again set up on the MUST II wetting balance machine using the same settings previously used in Appendix 1. Again each component was tested and visually inspected for the 95% solder coverage.

The results showed that all components passed the 95% solder coverage. It was concluded that using the Dry Bake preconditioning test before Dip and Look solderability testing did not affect the results for 95% solder coverage. See figure 3.

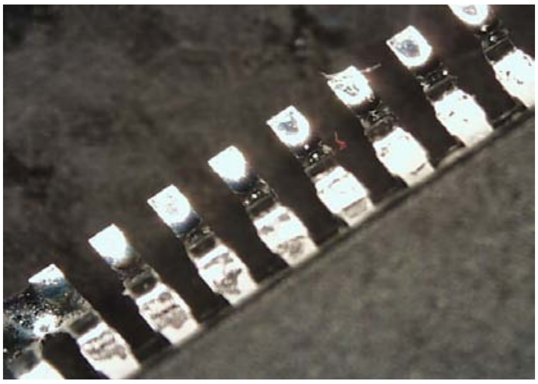

Figure 3– QFP leads with solder [6]

Similar to the Dry Bake preconditioning test, the component that had been subjected to a controlled environment Steam test were ran using the same DOE settings. Again the results showed that all components passed the 95% solder coverage level. It was concluded that the Steam precondition test did not have any effect on the components performance while using the Dip and Look solderability test.

Both the Dry Bake and Steam preconditioning of components before Dip and Look testing do not affect the 95% solder coverage.

6. CONCLUSION

Dip and Look testing provides a quick and easy means of checking the solderability of a component. The settings for Dip and Look testing vary from standard to standard and for some companies, component suppliers can use different settings to suit their manufacturing process. The aim of this paper is to determine and investigate using Design Experiment 6.0.6, a suitable set of parameters for Dip and Look solderability testing using the MUST II solderability tester and to investigate the integrity of Dip and Look solderability testing as a viable test in industry. The reason for using the MUST II solderability tester was to rule out operator error.

The results of the Design of Experiments show that all components tested using the arrays in Appendix 3, achieve the 95% solder coverage without any preconditioning. Again when the preconditioning of the components was used, the 95% solder coverage was achieved.

It can be concluded that the Dip and Look test method is a very forgiving test. The termination of the component would require an extremely contaminated surface before it would fail the 95% solderability coverage. The Dip and Look test should not be the only means of checking the solderability of components; the Wetting Balance method has more theory behind the results as it tests for wetting time and wetting force – two important factors not investigated when using the Dip and Look method.

7. REFERENCES

1. European Parliament and the Council of the European Union, 2002. Directive 2000/0158 (COD) of the European Parliament and Council of 8 November 2002 on Waste Electrical and Electronic Equipment (WEEE)

2. European Parliament and the Council of the European Union, 2003. Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction Of the use of certain Hazardous Substances in electrical and electronic equipment

3. Rahn, Armin, 1993. The Basics of Soldering, John Wiley & Sons, Inc., 605 Third Avenue, NY

4. Singler, Timothy J., Meschter, Stephen J., Spalik, James. Solder Wetting and Spreading. In: Handbook of Lead-Free Solder Technology for Microelectronic Assemblies, 2004: Edited by; Karl J. Puttlitz and Kathleen A. Stalter. IBM Corporation, New York, U.S.A., 2004, 331-429.

5. Rahn, Armin, 1993. The Basics of Soldering, John Wiley & Sons, Inc., 605 Third Avenue, NY

6. Kostal Ireland GmbH

Appendix 1

Run	Solder Temp. (°C) - Pb	Solder Temp. (°C) Pb-free	Immersion Depth (mm)	Solder Immersion Time (sec.)	Response: Wettability (%)
1	240	240	1.4	6	95
2	245	260	0.8	6	95
3	235	250	0.1	6	95
4	235	260	0.8	5	95
5	235	250	0.8	4	95
6	235	250	1.4	6	95
7	235	250	0.1	5	95
8	240	240	0.1	5	95
9	240	260	1.4	4	95
10	240	260	1.4	5	95
11	245	250	0.1	5	95
12	235	240	1.4	5	95
13	245	240	1.4	4	95
14	240	240	0.1	6	95
15	245	260	0.1	6	95
16	240	240	0.8	4	95
17	245	240	0.8	4	95
18	245	260	1.4	5	95
19	235	250	0.1	4	95
20	245	260	0.1	4	95
21	234	260	0.8	6	95
22	235	240	1.4	4	95
23	240	250	0.8	6	95
24	240	250	0.1	4	95
25	245	240	1.4	6	95
26	240	260	0.8	5	95
27	245	240	0.8	5	95

Appendix 1: Factors and settings for Dip and Look test for Components – D.O.E

Appendix 10.2 FAIM 2009

Determine the Optimum Settings for Maximum Force (Fmax) on Quad-Flat-Pack's (QFP's) using a Wetting Balance Machine.

Robert Woods*, Christy Gillick

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ABSTRACT

Solderability is an extremely important factor for electronics assembly. The majority of solder defects are attributable to poor (insufficient) component solderability. Testing for solderability is necessary. Within many electronics manufacturing companies a lot of focus is aimed at reducing the amount of soldering defects by carrying out sample solderability testing on batches of components using the Wetting Balance test method.

Feedback from a variety of component suppliers indicate the main factors that influence the soldering characteristics for the Wetting Balance test are: Solder Temperature, Immersion Depth, Immersion Speed, and Dwell Time. Similar to the Dip and Look solderability test, there are various International Standards with varying settings for the aforementioned factors when trying to evaluate a components soldering ability using a Wetting Balance machine. A review of the International Standards such as J-STD-002C, IEC60068-2-54 and IEC68-2-69 was required to obtain the range of settings used for each of the factors. A matrix of all the settings within the standards was developed and from this a Design of Experiments (DOE) was set-up and conducted. It was decided to investigate the Wetting Balance test in more detail paying particular attention to Quad-Flat-Packs (QFP's). This paper focuses on the Fmax, maximum force reached during the Wetting Balance test. Fmax is one of a number of responses associated with the Wetting Balance test. Others include Tb (time to buoyancy), TFmax (time to reach Fmax), F1 (force after 2 seconds) and F2 (force after 5 seconds). The effect each of the four variables has on Fmax is determined by Main Effects and Interaction Plots.

DOE 1 was set-up using Minitab and a total of 48 runs were carried out for the four factors. Each factor had two levels, high and low. A Pareto Chart of the Standardised effects showed all four factors had an affect on the Fmax. Immersion Speed had the largest effect - as the speed increases from 1mm/sec to 5mm/sec the Fmax increases. DOE 2 provided a more in-depth analysis of the four factors. Each factor had three levels, low, medium and high resulting in 81 runs. Again analysis was carried out using Minitab. The investigations and analysis from DOE 2 determined the optimum settings for a high Fmax using a Wetting Balance machine. These settings are Solder Temperature - 230^{0}C, Immersion Speed – 0.5mm/sec, Immersion Depth – 0.5mm and Dwell Time – 4 seconds.

1. INTRODUCTION

The solderability of a component's metallic termination is a critical parameter in any soldering process because it represents the likelihood of that termination forming a good alloy with the solder and a high quality solder fillet. As components continue to become smaller and more fine pitch, coupled with the widespread use of less active fluxes, the soldering process window narrows and the impact of poor solderability increases. Although components are generally assembled from parts of known (good) solderability, there is no way of guaranteeing this without testing a sample batch using the Wetting Balance Machine to access the components soldering characteristics [1]. The Wetting Balance Machine is a purpose designed instrument for testing components such as QFP's, SMT and also pads of Printed-Circuit-Boards. In essence, a Wetting Balance Machine exploits the fact that if a metallic body is dipped into a bath of molten solder, the force and speed with which the solder meniscus climbs upwards on the body's immersed surface indicates how well the solder wets it and thus its solderability. In simple terms, the greater the solderability, the higher a meniscus will climb, which can be measured as a change in the vertical force acting on the suspended specimen, in this case a component lead. [2]

The Dip and Look test is another quick method of testing the solderability of a component but previous research and investigation has deemed this test to be invalid. [3] Only a pass/fail result is given by the Dip and Look test whereas the Wetting Balance investigates the components soldering characteristics.

For the purpose of this investigation the maximum force (Fmax) reached during the Wetting Balance test will be focused on. The Fmax is measured in milli-newtons (mN) by the Wetting Balance machine. Fmax is the maximum force reached during the Wetting Balance test, i.e. the maximum force required for the solder to wet to the lead of the component. [2] A high Fmax result on the Wetting Balance Machine is a high attraction of force required for solder to attach to the component lead. The objective of this paper is to develop the optimum settings to achieve the highest Fmax allowable with the range of settings within the International Standards.

2. Review of International Standards

The main International Standards reviewed for this paper are:

- J-STD-002C –Solderability Test for Component Leads, Terminations, Lugs, Terminals and Wires.
- IEC60068-2-54 – Test Ta: Solderability testing of electronic components by the Wetting Balance method.
- IEC68-2-69 – Test Te: Solderability testing of electronic components for surface mount technology by the Wetting Balance method.

Table 1 is a matrix of the settings got from the aforementioned standards. A high and low value was used for each factor.

Table 1 Settings for each factor in DOE1

Factor	Min Value	Max Value
Solder temperature (^{0}C)	230	250
Immersion speed (mm/sec)	1	5
Immersion depth (mm)	0.25	0.5
Dwell time (sec)	4	10

The immersion speeds stated in IEC68-2-69 (1mm/sec to 5mm/sec) was taken due to the fact that the speed specified in J-STD-002C and IEC60068-2-54 (1mm/sec to 20mm/sec) was too fast for the MUST II machine at the high end (20mm/sec). This resulted in the machine going into an ‘error fault’ failing to record any data.

3. Design of Experiment (DOE)

There are various Wetting Balance test parameter settings available for solderability testing using the Wetting Balance method; however there is no clear consensus as to the appropriate combination of parameters which define an acceptable Fmax standard at component level. In order to achieve a workable standard, a review of each available International Standard is required to develop a Design of Experiments with a view to obtaining the optimum settings. The goal of this experiment is to determine the critical variables and any interactions present during the Wetting Balance testing of components. The resulting settings from the DOE should provide an optimum set of parameter settings to achieve the highest possible Fmax in order to detect any form of contamination on the termination of the components which could affect solderability.

The software use to conduct this D.O.E is ‘Minitab V13.

The components investigated were Quad Flat Pack’s (QFP) using the MUST II Wetting Balance Machine. No preconditioning of the components was carried out prior to the testing and all components used in the test were from the same supplier batch and date code.

3.1 RESPONSES

The maximum force (Fmax) will be analysed by Design of Experiments. Fmax is a very important response to determine a component's ability to solder. During the Wetting Balance test, the machine automatically records the maximum force reached and this is graphically represented by the machine. Three replicates were conducted for each array.

3.2 FACTORS AND RUN COMBINATIONS

Minitab developed the array of factors and settings used in the experiment. These factors were determined by reviewing the international standards as stated in section 2. As stated earlier, the main factors of the Wetting Balance test are;

i. Solder Temperature – temperature at which the solder of the Wetting Balance machine is set at. SnPb alloy used

ii. Immersion Depth – the depth the component is immersed into the SnPb solder

iii. Immersion Speed – the speed at which the component enters the solder

iv. Dwell Time – amount of the time the component is immersed in the solder

These four factors had two levels, high and low (see table 1), resulting in 48 runs.

At the beginning of every run, the machine settings were made with reference to the arrays determined by Minitab. Once steady state conditions were achieved and settings verified, the run was initiated. Each run consisted of three replicates. One lead of a QFP was used for each replicate resulting in three replicates for each array. After the test was completed, each result for Fmax was automatically recorded by the Wetting Balance machine. For each array the results were inserted into Minitab in column "Fmax".

3.3 ANALYSIS OF DESIGN OF EXPERIMENTS

Figure 1 displays a Pareto of standardised effects for Fmax. It can be seen that all four factors show some form of effect on the Fmax. The magnitudes of the effects are represented by the position on the Pareto, i.e. the interaction of BD (Immersion Speed and Dwell Time) has the largest influence on the Fmax but B (Immersion Speed) on its own has little or no effect. All interactions to the right of the red line will be investigated further using Main Effect (Figure 2) and an Interaction Plots (Figure 3).

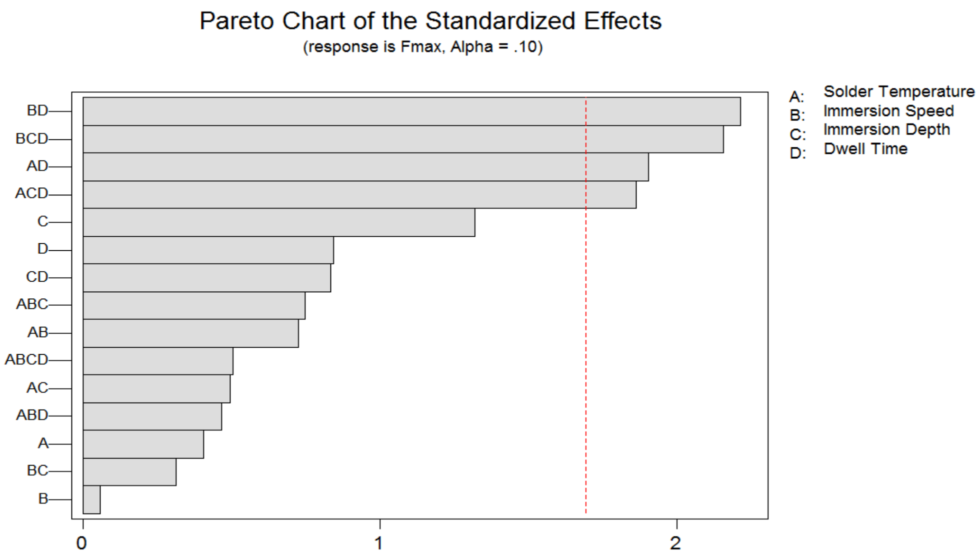

Figure 1 Pareto Chart of the Standardised Effects for F_{max}

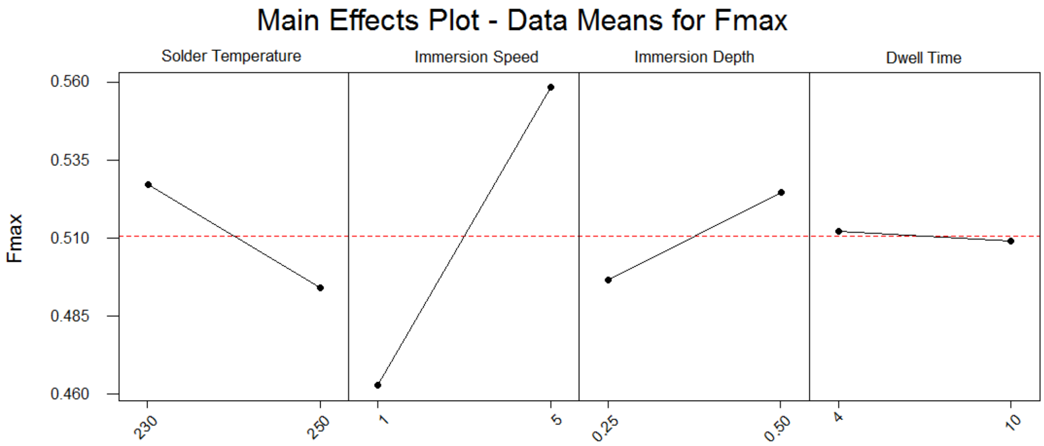

Figure 2 Main Effects for Fmax DOE 1

The main effects that the four factors have on the Fmax are shown in Figure 2.

- Immersion Speed has the biggest effect. As the speed increases from 1mm/sec to 5mm/sec the Fmax increases. The range is approximately 0.1mN.
- Solder Temperature decreases the Fmax as it is increased from 230^{0}c to 250^{0}C with a range of 0.035mN approximately.
- As the Immersion Depth is increased from 0.25mm to 0.5mm the Fmax increases with a range of 0.03mN approximately.
- Varying the Dwell time from 4 to 10 seconds has little effect on the Fmax.

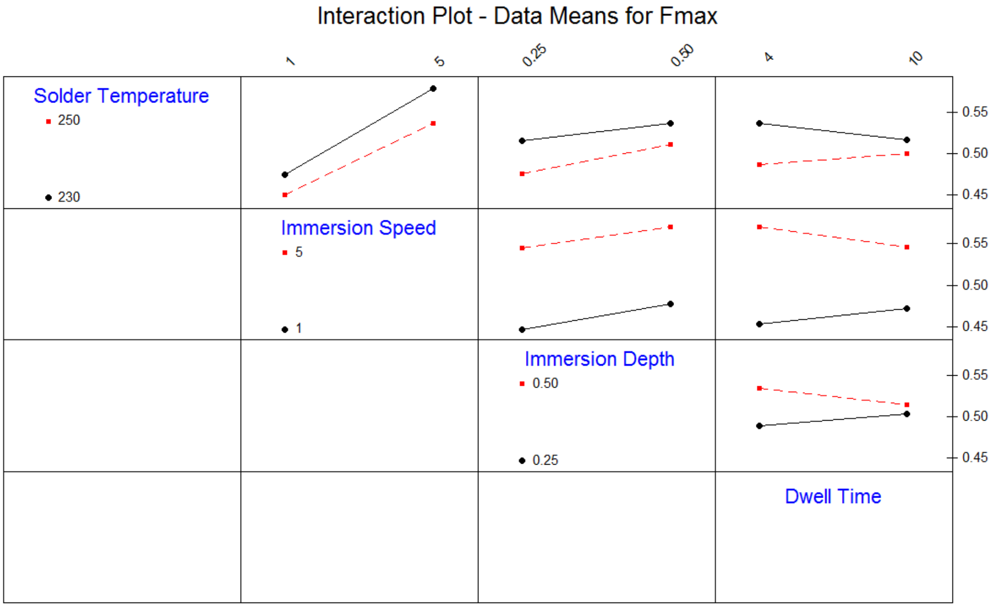

Figure 3 Interaction Plots for DOE1

The interactions of Solder Temperature and Dwell Time, Immersion Speed and Dwell Time, and Immersion Depth and Dwell Time have been established as those that have a significant effect on the Fmax. Figure 2 displays the two way interaction of all four variables. The interactions with parallel line indicate that their interaction does not affect the Fmax.

3.4 Conclusions from Design of Experiments 1

By focusing on the interactions that are significant the following is evident:

- Solder Temperature and Dwell Time – A constant solder temperature of 230^0C and increasing the dwell time from 4 to 10 seconds will result in a decrease in Fmax. A constant solder temperature of 250^0C and varying the dwell time from 4 to 10 seconds increases the Fmax result.
- Immersion Speed and Dwell Time – By maintaining an immersion speed of 5mm/sec and varying the dwell time from 4 to 10 seconds cause the Fmax to decrease but by maintaining an immersion speed of 1mm/sec and varying the dwell time from 4 to 10 seconds cause the Fmax to increase.
- Immersion Depth and Dwell Time – By maintaining an immersion depth of 0.5mm and varying the dwell time from 4 to 10 seconds cause the Fmax to decrease but by maintaining an immersion depth of 0.25mm and varying the dwell from 4 to 10 seconds cause the Fmax to increase.

The next step in the experimentation involved planning a second DOE to provide a deeper understanding of the Maximum Force (Fmax) reached during the Wetting Balance test.

3.5 Design of Experiments 2

DOE 2 was planned using Minitab and the objective was to generate a set of parameters on a Wetting Balance machine that would give a low Fmax of the Wetting Balance test. The four variables from DOE 1 were selected and experimented at 3 levels, 'Low', 'Medium' and 'High'. All other variables were constant, i.e. solder, component type and all other Wetting Balance machine parameters. 81 runs were made with one replicate. The reason for only using one replicate for DOE 2 was due to the fact that no variation was seen for DOE 1 and Gauge R&R study carried out on the machine prior to the experiment was within the limit of 10% [2]. Table 2 shows the low, medium and high settings that were use.

Table 2 Values for each factor-DOE2

Factor	**Low**	**Medium**	**High**
Solder Temperature	230	240	250
Immersion Speed	1	3	5
Immersion Depth	0.25	0.5	0.75
Dwell Time	4	10	15

Figure 4 and 5 show the Main effects and Interaction plots as a result of DOE 2 for Fmax. The main effects the four variables have on the Fmax are shown in Figure 4.

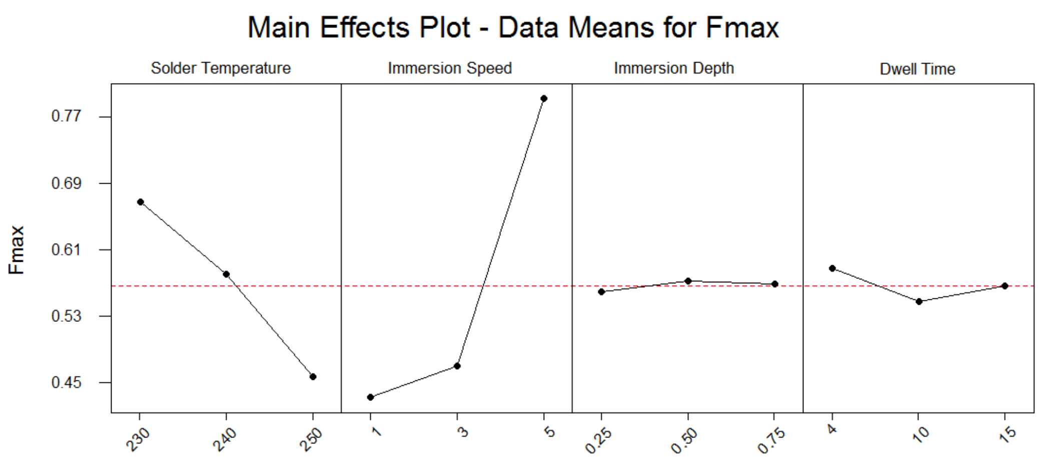

Figure 4 Main Effects for Fmax DOE 2

Similar to DOE 1, Immersion Speed has the biggest affect on the four variables. Immersion Depth shows little or no affect.

- Solder Temperature – As the temperature is increased the Fmax decreases, with a range of 0.21mN approximately.
- Immersion Speed – As the speed is increased the Fmax decreases, with a range of 0.34mN approximately.
- Immersion Depth – Very little effect on Fmax.
- Dwell time – the affect of dwell time is very small similar to that of the immersion depth. As dwell time increases from 4 to 10 seconds the Fmax decrease but increasing from 10 to 15 the Fmax increases.

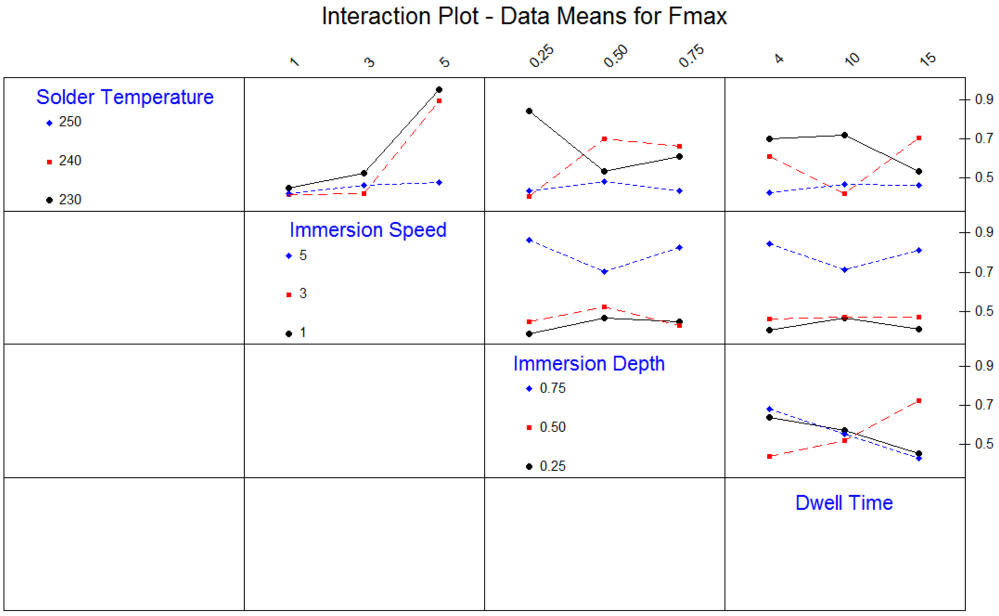

Figure 5 Interaction Plots for DOE2

3.6 CONCLUSIONS FROM DESIGN OF EXPERIMENTS 2

Again focusing on the interactions that were significant from DOE 1, the following conclusions can be made;

- Solder Temperature and Dwell Time – By maintaining a constant temperature of 230^0C and varying the dwell time from 4 to 10 seconds there is very little affect on Fmax but the Fmax results are highest at this temperature. A dwell time of 10 to 15 seconds cause the Fmax to decrease. A constant temperature of 240^0C and a dwell time variation of 4 to 10 seconds cause Fmax to increase but a dwell time from 10 to 15 seconds result in an increase of Fmax. A temperature of 250^0C has little of no affect on Fmax with a dwell time variation of 4 to 15 seconds and gives the lowest Fmax results.
- Immersion Speed and Dwell Time – A constant immersion speed of 0.1mm/sec and a varying dwell time from 4 to 10 seconds show a slight increase in Fmax but a dwell time from 10 to 15 seconds decrease the Fmax. An immersion speed of 0.3mm/sec with dwell time variation from 4-15 seconds has minimal affect on Fmax. A high Fmax result is evident with an immersion speed of 0.5mm/sec. A reduction in Fmax is seen from 4-10 seconds and the opposite effect is seen from 10-15 seconds. Overall an immersion speed of 0.5mm/sec gives the highest Fmax results.
- Immersion Depth and Dwell Time – It can be concluded that the interaction between immersion depth and dwell time is not as significant from the results in the Main Effect graph in Figure 4 and also the Pareto of the Standardised Effects in Figure 1. For the purpose of this investigation it can be stated that an immersion depth of 0.5mm and a dwell time of 4 seconds will give the highest Fmax result. This can be seen from the Main Effects graph in Figure 4.

3.7 SUMMARY OF FACTOR SETTINGS FOR HIGH FMAX

Table 3 is a summary of the settings for each of the factors to achieve the optimum high Fmax value using a Wetting Balance machine.

Table 3 Settings for high Fmax

Factors	**Settings**
Solder Temperature	230^0C
Immersion Speed	0.5mm/sec
Immersion Depth	0.5mm
Dwell Time	4 seconds

Fmax provides important information in determining the soldering characteristics of a QFP lead in a tin/lead (Sn/Pb) process. A high maximum force (Fmax) result got by using the Wetting Balance Machine represents a high attraction of force required for solder to attach to the component lead. The higher the Fmax the more difficult the solder has to attach to the lead of the component under test.

3.8 REFERENCES

1. *Wassink, Klein R.J., May 1989. Soldering in Electronics, 2nd Ed., Electrochemical Publications Limited.*
2. *MUST II Wetting Balance Machine User Manual.*
3. *Woods, Robert. Investigate the Dip and Look Test procedure for Components in a Pb and Pb-free Soldering Process. 24th International Manufacturing Conference 2007, IMC24.*
4. *Park, J. Y., Jung, J. P., September 1999. The analysis of the withdrawal force curve of the Wetting Balance curve. Components and Packaging Technologies, IEEE Transactions on Volume 22, Issue 3, Pages: 372 – 377.*

Appendix 10.3 WCE 2010

The Effect of Testing a Copper Wire and a Copper Wire Coated with SnPb Solder using a Wetting Balance Machine

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ABSTRACT

A copper surface chemically passivated using some form of flux has been suggested as providing samples of different but reproducible degrees of solderability. The importance of closely controlling the preparation, and cleaning of the copper to obtain reproducible solderability is of high importance to ensure accurate and repeatable results when using the Wetting Balance Machine.

After completing a capability study of the Wetting Balance machine prior to conducting any experiments, 20mm lengths of copper wire were used to assess the effect of soldering directly onto a copper wire surface compared with soldering onto a copper wire surface coated with tin/lead (SnPb) solder paying particular attention to the responses Fmax, maximum force reached during the test, TFmax, time to reach maximum force, $T^{2/3}$ Fmax, time to reach two thirds of maximum force, Tb, time to reach buoyancy, and finally Ta, Time to reach the zero line of the x-axis. For the benefit of this investigation, 20mm lengths of the same reel of 0.9mm diameter insulated copper wire were used in order to minimise as much as possible any variances.

For each 20mm length of copper wire used, an initial dip of the specimen into the solder bath, calculating the aforementioned responses, was followed by a second dip using the same initial copper wire but this time it had a coating of tin/lead solder from the first dip and again the relevant responses calculated using the Wetting Balance machine. A comparison of each response was done to compare the first dip with on a Cu surface and the second dip with the SnPb coating in order to assess the effect of thermal conduction.

1.0 INTRODUCTION

Before conducting any experiments on the Wetting Balance machine an indebt capability study was concluded in order to assess the machine's performance paying particular attention to its ability to provide accurate and repeatable results, while gaining a complete understanding of the machines capability. It was also vitally important to understand and minimise, as much as possible, any external influences other than the machine operation, which may affect the accuracy of the results. A systematic examination of the machine would ensure that the quality features and characteristics required could be experimented under statistically controlled conditions. As well as the calibration check of the Wetting Balance machine, it was also taken into account the effect external influences such as vibrations from other equipment within the vicinity of the Wetting Balance machine had on the accuracy of the results. [1]

Because of the importance in quality assurance of solderability testing of components and printed circuit boards, a large number of test procedures have been developed. Each type of test provides one or more criteria upon which the solderability of a component (and hence the batch of which it is representative) can be accepted or rejected. In order to quantify the tests and enable direct comparisons to be made, standard reference surfaces must be tunable to fall within the range encountered in practice, such that components with solderability worse than the standard are rejected while those better than the standard are accepted, for all test procedures. A copper surface chemically passivated using some form of flux has been suggested as providing samples of different but reproducible degrees of solderability. The importance of controlling the preparation and fluxing of each sample in order to obtain reproducibility must be adhered to. [2]

Copper has a red, orange or brown colour because a thin layer of tarnish (including oxides) gradually forms on its surface when gases (especially oxygen) in the air react with it. It is a good conductor of heat and electricity. To investigate further the conduction of heat and also the effect of testing a copper wire surface for solderability using a MUST II Wetting Balance machine, test copper wire samples of 20mm lengths were used. 20mm lengths were the minimum length to which the clip on the machine could grip securely.

2.0 OBJECTIVES

The main objectives of this investigation were;

- Determine the maximum and minimum results for Fmax, TFmax, Tb, and Ta for;
  1. Copper wire surface
  2. Copper wire surface coated with SnPb
- Determine the standard deviation for each of the aforementioned responses.
- Graphically represent the results for the responses using Minitab.

3.0 PROCEDURE

The capability study was conducted on the current Wetting Balance machines performance using a 0.9mm copper wire. In total seventy repeated measurements were conducted using the settings in Table 1. Thirty-five readings for Copper wire surface and thirty-five readings for copper wire surface coated with SnPb and flux.

The following procedure was carried out to determine the machine's capability;

- 20mm lengths of 0.9mm diameter copper wire were used. The reason for using the copper wire instead of component leads was to minimise any variation in the leads ability to solder as a result of poor component storage and shelf life. The 20mm lengths were taken from the same reel of insulated wire directly before use. For each of the seventy measurements one length of 20mm copper wire was used twice.
- The settings in Table 1 were entered into the Wetting Balance machine. These settings were recommended by the Wetting Balance machine manufacturer.
- The solder used in the bath was tin/lead (SnPb), a standard alloy used throughout the industry for soldering electronic components.
- The flux used for the test was a standard qualified production flux used within many electronics manufacturing companies.
- Using gloves, the 20mm lengths of copper wire were mounted onto the Wetting Balance holder using clip no. 18. This is the recommended clip type for wires.
- The program was enabled and each step was automatically prompted by the machine, i.e. flux applied, dross removed from solder bath surface, copper wire change etc.
- An initial dip of the Copper wire into the solder bath was completed and the results for Fmax, TFmax, Tb, and Ta were recorded. After this dip the copper wire was coated with SnPb.
- Using the same length of Copper (now coated with SnPb) a further dip was initiated into the solder bath. Again the results for Fmax, TFmax, Tb, and Ta were recorded.
- The same procedure was completed for all thirty-five lengths of copper wire. Each result was automatically recorded by the machine and presented in a graph format. The software on the Wetting Balance machine was only capable of recording fifteen measurements on one graph so the above procedure was repeated until the seventy measurements were complete. Appendix 1 shows a typical wetting balance graph for 14 readings – 7 readings first dip and 7 readings second dip.

Variable	Settings
Immersion Speed	20mm/sec
Immersion Depth	4mm
Dwell Time	5 seconds
Solder Temperature	235^0C

Table 1 Main Settings used on the Wetting Balance Machine [3]

The seventy recorded results using the settings in Table 1 were analysed using the Minitab software for the responses;

- Fmax (maximum force reached during the test)
- Tb (time to reach buoyancy)
- TFmax (time to reach maximum force, TFmax)
- Ta (time to cross the zero line (x-axis) on the Wetting Balance Graph.

4.0 ANALYSES OF RESULTS

- Maximum Force, Fmax

In order to determine the theoretical Fmax result using a 0.9mm diameter copper wire the following formula was used;

Fmax = [0.4P – 0.08V]………. [4]

Where, 0.4 is the surface tension (γ) of solder; P is the circumference of the wire; 0.08 is the density (ρ) of the solder (Pb); V is the immersed volume and Immersion depth of 4mm used from Table 1.

$P = 2\pi r \Rightarrow P = 2 \times \pi \times 0.45 \Rightarrow P = 2.8274\text{mm}$

$0.4P = 0.4 \times 2.8274 \Rightarrow 0.4P = 1.1309$

$V = (\pi d2/ 4) \times 4$

$V = (\pi (0.9)^2 / 4) \times 4 = 2.544\text{mm}^3$

$0.08V = 0.08 \times 2.544 = 0.20357$

$F = [1.1309 - 0.20357] \Rightarrow F = 0.9274\text{mN}$

Figure 1 Line Plot of Fmax First Dip vs. Fmax Second Dip

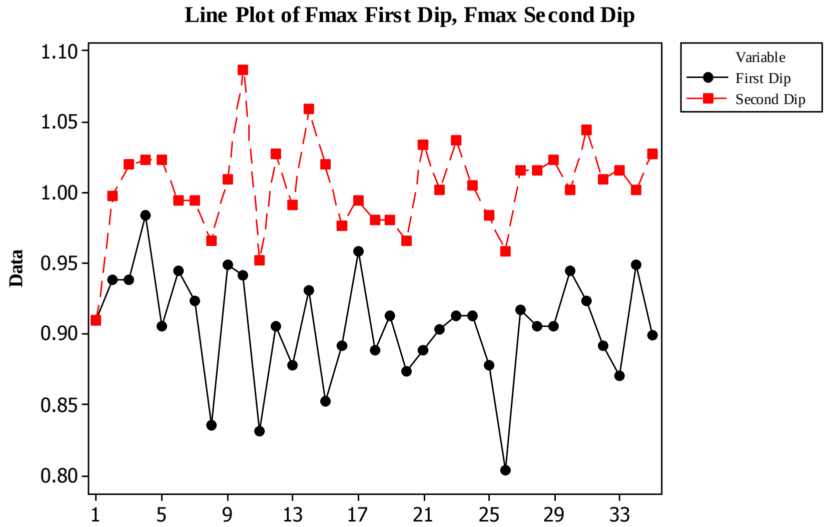
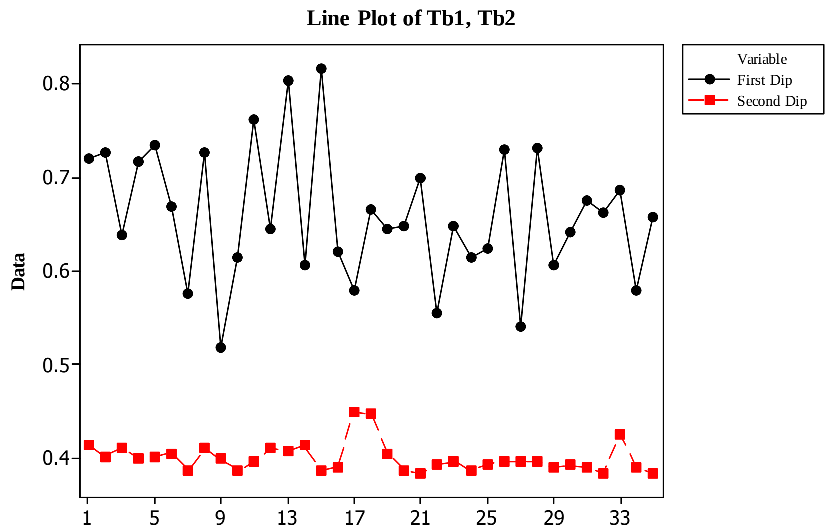


Figure 1 above represents a line graph generated by Minitab for Fmax values automatically calculated using the Wetting Balance machine for the first and second dip measurements of thirty-five copper wires. It is clearly evident that the first Dip of the copper wire surface into the bath of solder presents maximum forces much less than the second dip. The standard deviations differ for both dips between the thirty five readings, first Dip (0.04) and second Dip (0.03). A maximum reading of 0.98mN and a minimum of 0.80mN for first dip (average 0.91mN) and maximum 1.09mN and minimum 0.91mN for the second dip (average 1mN) were achieved. The difference between first and second dip of the copper solder wire highlight the thermal conductivity of copper and this adds to the fact the testing using a wetting balance machine for solderability of a copper wire surface will not give accurate readings because of this variation.

- Time to Buoyancy, Tb

The recognised standard time to buoyancy is less than 0.6 seconds [3]. Figure 2 below is a representation showing the Tb results from the same thirty five copper wires used throughout this investigation. Again the evidence is visually portrayed that the second dip provides much more stable results. All of the thirty five readings for the first dip surpass the standard requirement of less than 0.6 seconds but for the first dip results approximately 83% failed.

Figure 2 Line Plot of Tb First Dip vs. Fmax Second Dip

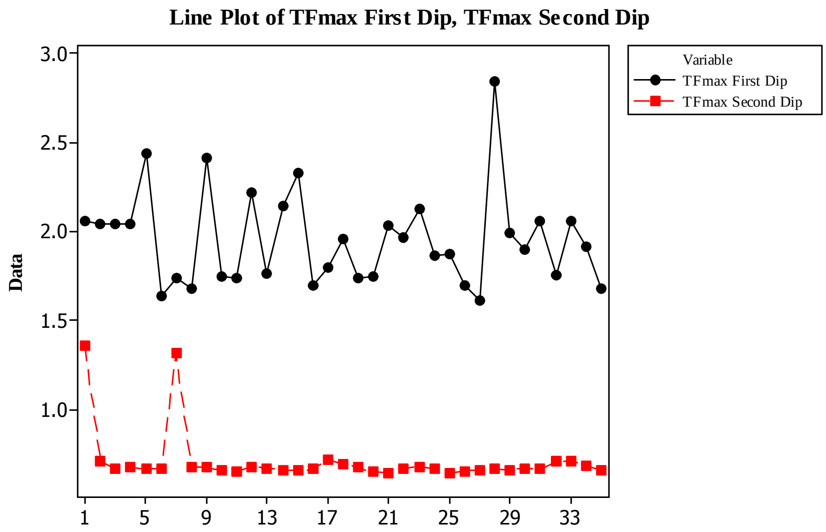


A maximum and minimum of 0.82 and 0.52 seconds respectively for first dip and a maximum and minimum of 0.45 and 0.38 seconds respectively for the second dip were achieved. The standard deviation was calculated by Minitab to be 0.07 seconds for first dip and 0.02 seconds for second dip.

- Time to reach maximum force, TFmax.

The time for the solder to reach its maximum force for the first and second dip is graphically shown in Figure 3 below. A maximum value 2.84 seconds, a minimum 1.61 and a standard deviation of 0.27 seconds was calculated for the first dip results. The second dip line illustrates almost a linear line except for two readings which may be as a result of an external noise or the solderability of the copper wires. For the benefit of calculating the standard deviation and maximum readings for the seconds dip, these two outliers were removed and the results were maximum 0.72 seconds, minimum 0.6 seconds and standard deviation 0.02 seconds (1.36 maximum and standard deviation of 0.16 seconds if outliers included).

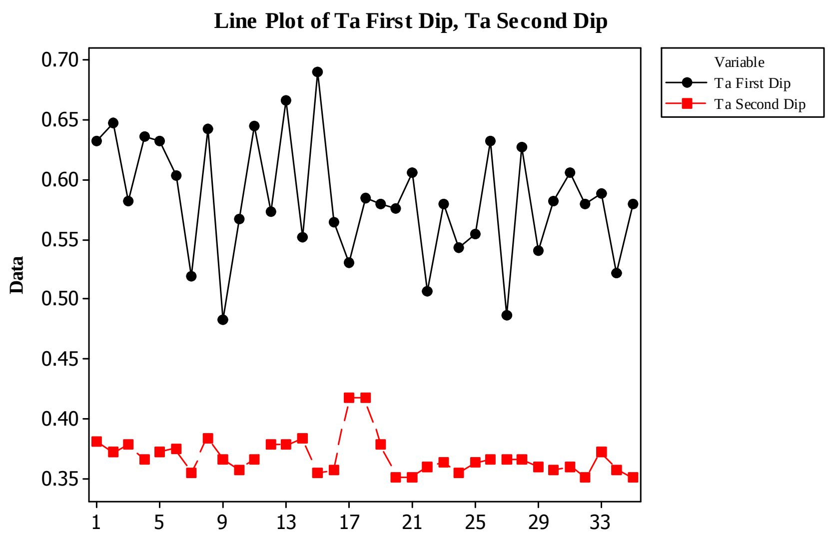
Figure 3 Line Plot of TFmax First Dip vs. TFmax Second Dip



- Time to cross zero line (x-axis), Ta

Similar to the Tb response, Ta also has a requirement to be achieved during the testing. Less than 1 second is the standard required. Figure 4 below present the results generated by Minitab.

Figure 4 Line Plot of Ta First Dip vs. Ta Second Dip



Again similar to the previous graphs seen so far there is a significant difference between the first and second dip results. For Ta, a minimum of 0.48 seconds, a maximum of 0.69 seconds and a standard deviation of 0.05 seconds were achieved for the first dip. For the second dip, a minimum of 0.35 seconds, a maximum of 0.42 seconds and a standard deviation of 0.02 seconds were achieved.

5.0 Summary

The main focus of the investigation in the paper was to compare the affect of testing a copper wire surface using a Wetting Balance machine to testing that same piece of copper wire coated with tin-lead solder. Table 2 is a summary of the results achieved for Fmax, Tb, TFmax and Ta using two dips.

		First Dip			**Second Dip**	
Response	**Std. Dev.**	**Maximum**	**Minimum**	**Std. Dev.**	**Maximum**	**Minimum**
Fmax	0.04	0.98	1.09	0.03	0.80	0.91
Tb	0.07	0.82	0.52	0.02	0.45	0.38
TFmax	0.27	2.84	1.61	0.72	0.60	0.02
Ta	0.05	0.69	0.48	0.02	0.42	0.35

Table 2 Summary table of results

Using Fmax, the maximum force reached during the wetting balance test, the maximum reading for the first dip was 0.18mN lower than the maximum reading for the second dip and this is visually evident from Figure 1.

The results showed for Tb that 83% failed the limit of less than 0.6 seconds. The standard deviation was calculated to be 0.07 seconds for first dip and 0.02 seconds for second dip. Figure 2 is a good visual representation in that the stableness of the first dip compared with the seconds dip is much less.

TFmax, time to reach maximum force, almost gave a linear line for the seconds dip results but for two readings. These two readings may have been as a result of poor solderability Cu wires. Again evidence of instability for the first dip is present and verified in Figure 3. There is a significant difference between the maximum value for the first and second dips, 2.84 seconds and 0.6 seconds respectively.

Using Ta, time to cross the x-axis on the wetting balance graph, Figure 4 shows the difference in results for the first and second dips. Overall the readings for the second dip are less than those for the second dip.

Appendix 1 shows a typical wetting balance graph for 14 readings – 7 readings first dip and 7 readings second dip.

The difference between first and second dip of the copper solder wire in terms of the responses, Fmax, Tb, TFmax and Ta, highlight the effect thermal conductivity of copper has and this adds to the fact the testing using a wetting balance machine for solderability of a copper wire surface will not give accurate readings because of this variation.

4. References

5. *Woods, Bobby, A Capability Study of a Wetting Balance Machine using 0.9mm Diameter Copper Wires, FAIM2010*
6. *Lea, C., A Scientific Guide to Surface Mount Technology, 1998*
7. *MUST II Wetting Balance Machine User Manual.*
8. *Joint Industry Standard – Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires, J-STD-002C, December 2007.*

Appendix 1 – Results of 7 Copper Wire Wetting Balance test – First and Second Dip

Test Details

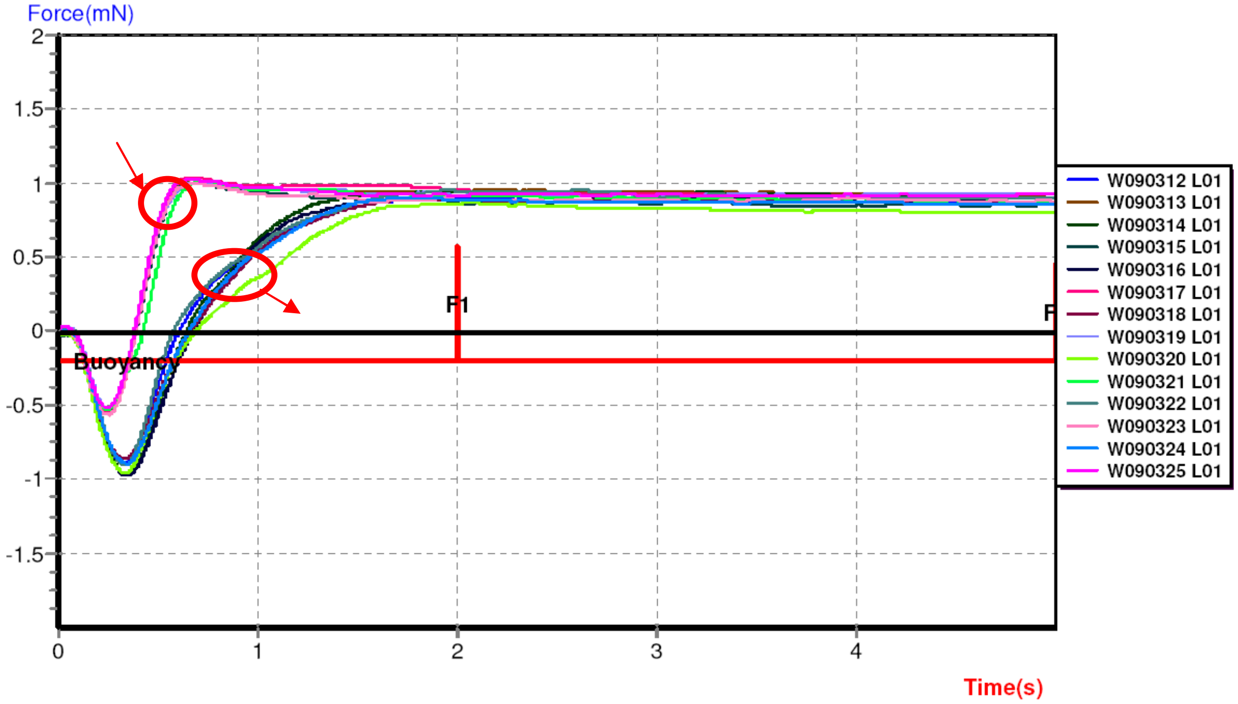
Component	: Cu Wire 0.9mm (20mm length)		
Test parameter filename	: Bath Parameters.vts	Test parameter line	: 7

Test Limits and Conditions

F1	= 0.57 mN @ 2.00 s	F2	= 0.45 mN @ 5.00 s
Ta	= 1.00 s	Buoyancy	= -0.20 mN
Tb	= 0.60 s	Time 2/3 Fmax	= 1.00 s
Immersion Speed	= 20.0 mm/s	Immersion Depth	= 4.00 mm
Test Time	= 5 s	Pre-heat Time	= 0 s
Test Temperature	= 235.0 °C	Flux	= Pure Rosin

Description	Results Filename	Ta (s)	Tb (s)	T2/3 (s)	F1 (mN)	F2 (mN)	A.U.C. (mN/s)	Fmax (mN)	TFmax (s)	Pass/Fail
Cu Wire 0.9mm	(W090312 L01)	0.540	0.606	1.059	1.109	1.063	4.303	0.906	1.989	Fail
Cu Wire 0.9mm	(W090313 L01)	0.360	0.390	0.495	1.148	1.127	5.178	1.023	0.663	Pass
Cu Wire 0.9mm	(W090314 L01)	0.582	0.642	1.005	1.148	1.102	4.464	0.945	1.896	Fail
Cu Wire 0.9mm	(W090315 L01)	0.357	0.393	0.501	1.066	1.052	4.890	1.002	0.672	Pass
Cu Wire 0.9mm	(W090316 L01)	0.606	0.675	1.020	1.116	1.074	4.303	0.924	2.061	Fail
Cu Wire 0.9mm	(W090317 L01)	0.360	0.390	0.498	1.151	1.105	5.171	1.044	0.669	Pass
Cu Wire 0.9mm	(W090318 L01)	0.579	0.663	1.056	1.091	1.059	4.254	0.892	1.755	Fail
Cu Wire 0.9mm	(W090319 L01)	0.351	0.384	0.492	1.123	1.137	5.142	1.009	0.711	Pass
Cu Wire 0.9mm	(W090320 L01)	0.588	0.687	1.215	1.063	1.010	3.949	0.871	2.058	Fail
Cu Wire 0.9mm	(W090321 L01)	0.372	0.426	0.534	1.116	1.074	5.005	1.016	0.711	Pass
Cu Wire 0.9mm	(W090322 L01)	0.522	0.579	1.059	1.148	1.105	4.488	0.949	1.914	Fail
Cu Wire 0.9mm	(W090323 L01)	0.357	0.390	0.495	1.091	1.081	4.962	1.002	0.690	Pass
Cu Wire 0.9mm	(W090324 L01)	0.579	0.657	1.086	1.088	1.063	4.248	0.899	1.683	Fail
Cu Wire 0.9mm	(W090325 L01)	0.351	0.384	0.486	1.123	1.134	5.152	1.027	0.660	Pass
	Standard Dev	0.112	0.133	0.300	0.030	0.036	0.432	0.059	0.644	
	Mean	0.465	0.519	0.786	1.113	1.085	4.679	0.965	1.295	
	Max	0.606	0.687	1.215	1.151	1.137	5.178	1.044	2.061	
	Min	0.351	0.384	0.486	1.063	1.010	3.949	0.871	0.660	

Number of Tests : 014 **Passing rate :** 50.0 %



Appendix 10.4 FAIM 2010

A Capability Study of a Wetting Balance Machine using 0.9mm Diameter Copper Wires

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ABSTRACT

Ensuring a Wetting Balance machine is accurate and repeatable prior to conducting any experiments, are important factors to consider prior when assessing a component's solderability. The accuracy and repeatability of the Wetting Balance machine is vitally important to understand and minimise, as much as possible, any external influences other than the machine operation, which may affect the precision of the results. A systematic examination of the Wetting Balance machine would ensure that the quality features and characteristics required could be experimented under statistically controlled conditions. The Six Sigma philosophies, Define-Measure-Analyse-Improve-Control or DMAIC, were used to provide a framework for assessing the Wetting Balance machines capability paying particular attention Fmax, maximum force reached during the test, and Tb, time to reach buoyancy for sixty measurements. For the benefit of this experimentation, 20mm lengths of the same reel of 0.9mm diameter insulated copper wire were used. The justification for using copper wire was to minimise solderability variation compared to using the leads of a Quad-Flat-Packs or other component types prone to solderability issues due to storage or poor termination finish.

It was evident during the initial testing that some form of 'noise' was causing unstableness in the graphical representations for the Wetting Balance results, thus giving inaccurate measurements and a large variation between the sixty measurements. The location of the Wetting Balance machine proved to be a fundamental cause of this unstableness. Vibrations from other equipment within the vicinity, such as an X-RAY machine and Surface Mount Technology line, were influencing the measurements and consequently giving inaccurate measurements. The elimination of these vibrations proved to be the solution in achieving capable results and the experiment was repeated when all other equipment within the vicinity of the Wetting Balance machine were powered off. The graphical representations as well as the standard deviation were improved significantly.

5.0 INTRODUCTION

Before conducting any experiments on the Wetting Balance machine an indebt capability study was required in order to assess the machine's performance paying particular attention to its ability to provide accurate and repeatable results, while gaining a complete understanding of the machines capability. It was also vitally important to understand and minimise, as much as possible, any external influences other than the machine operation, which may affect the accuracy of the results. A systematic examination of the machine would ensure that the quality features and characteristics required could be experimented under statistically controlled conditions.

The supplier of the Wetting Balance machine carried out the necessary annual calibration and the machine was certified for use. The calibration involved the following [1];

- Verified the deviation in force measured by the clip holder was within the IEC68-2-54 standard of <5%.
- Verified the deviation of solder temperature of the bath was within the IEC68-2-54 standard of +/-3^{0}C.
- Immersion Depth of the component lead in the solder – Meets the requirements of the IEC68-2-54 standard.

- Immersion Speed of the component lead in the solder – Meets the requirements of the IEC68-2-54 standard.
- Dwell Time of the component lead in the solder – Meets the requirements of the IEC68-2-54 standard.

The above calibration checks ensured that the machine operation for the variables used in the study; force, temperature, immersion depth, immersion speed and dwell time were all measuring within the desired requirements of the International Standard IEC68-2-54[2]. Since the force measurements are in milli-newtons (mN), the variation for all the aforementioned variables is required to be to an absolute minimum in order to achieve reliable, repeatable and accurate results.

2.0 SIX-SIGMA ANALYSIS

The Six Sigma Philosophy, Define-Measure-Analyse-Improve-Control or DMAIC, was used to provide a framework for assessing the Wetting Balance machines capability [3]. The approach to this framework used the following;

- Define Phase
- Measure Phase
- Analyse Phase
- Improve Phase
- Control Phase

2.1 DEFINE PHASE

The main goals of this investigation were;

- Assess the Wetting Balance machine ability to provide accurate and repeatable results.
- Eliminate and reduce as much as possible any external influences which may affect the results.

2.2 MEASURE PHASE

The capability study was conducted on the current Wetting Balance machines performance using a 0.9mm copper wire. In total sixty repeated measurements were conducted using the settings in Table 1.

The following procedure was carried out to determine the machine's capability;

- Lengths of 20mm copper wire of 0.9mm diameter were used. The reason for using the copper wire instead of component leads was to minimise any variation of the leads ability to solder as a result of poor component storage and shelf life. The 20mm lengths were taken from the same reel of wire. An investigation was carried out to determine the optimum length of wire between a 20mm and 40mm length. The results were far more stable with a 20mm length. This is because of the heat conduction within copper. For each of the sixty measurements one length of 20mm copper wire was used [4]. A double dip into the solder bath was done for each length of wire. The first dip coated the copper wires with SnPb solder. This coating eliminated the thermal affect and variation on the copper surface.
- The settings in Table 1 were entered into the Wetting Balance machine. These settings were recommended by the Wetting Balance machine manufacturer.
- The solder used in the bath was tin/lead (SnPb), a standard alloy used throughout the industry for soldering electronic components.
- The flux used for the test was a standard qualified production flux used within many electronics manufacturing companies.
- Using gloves, the 20mm lengths of copper wire were mounted onto the Wetting Balance holder using clip no. 18.
- The program was enabled and each step was automatically prompted by the machine, i.e. flux applied, dross removed from solder bath surface, copper wire change etc.

- Each result was automatically recorded by the machine and presented in a graph format. The software on the Wetting Balance machine was only capable of recording fifteen measurements on one graph so the above procedure was repeated until the sixty measurements were complete.

Table 1 Wetting Balance settings used for Capability Analysis

Variable	Settings
Immersion Speed	20mm/sec
Immersion Depth	4mm
Dwell Time	5 seconds
Solder Temperature	235^0C

The sixty recorded results using the settings in Table 1 were analysed using the Minitab software for the responses;

- Fmax (maximum force reached during the test)
- Tb (time to reach buoyancy)

The reason for focusing on these two responses was simply to analyse one force and one time setting and also the fact that for Fmax, a theoretical value could be calculated and for Tb a value of less than 0.6 seconds could be used [1]. 0.6 seconds is the standard used throughout industry in the standard J-STD-002C [5].

2.3 ANALYSE PHASE

- Maximum Force, Fmax

In order to assess the machine capability using the Fmax response, the theoretical value for Fmax using a 0.9mm diameter copper wire was calculated. The formula used for this calculation is;

Fmax = [0.4P – 0.08V]   [5]

Where, 0.4 is the surface tension (γ) of solder; P is the circumference of the wire; 0.08 is the density (ρ) of the solder (Pb); V is the immersed volume and Immersion depth of 4mm used from Table 1.

$P = 2\pi r \Rightarrow P = 2 \times \pi \times 0.45 \Rightarrow P = 2.8274\text{mm}$

$0.4P = 0.4 \times 2.8274 \Rightarrow 0.4P = 1.1309$

$V = (\pi d2/ 4) \times 4$

$V = (\pi (0.9)^2 / 4) \times 4 = 2.544\text{mm}^3$

$0.08V = 0.08 \times 2.544 = 0.20357$

$F = [1.1309 – 0.20357] \Rightarrow F = 0.9274\text{mN}$

A theoretical maximum force of 0.9274mN is the nominal value expected for a 0.9mm diameter copper wire immersed 4mm into the solder. With this value a Six-Sigma process could be determined by calculating the Upper and Lower Control Limits to +/-6σ. Minitab automatically calculated the Standard Deviation (σ) for the sixty measurements to be 0.267381 = 0.267mN.

UCL = 0.9274 + 6(0.267) = 2.5294mN = 2.53mN

LCL = 0.9274 – 6(0.267) = -0.6746mN = -0.67Mn

Using Minitab a Capability Analysis graph was generated for the sixty measurements, see Figure 1, and the limits for UCL = 2.53mN and LCL = -0.67mN were used.

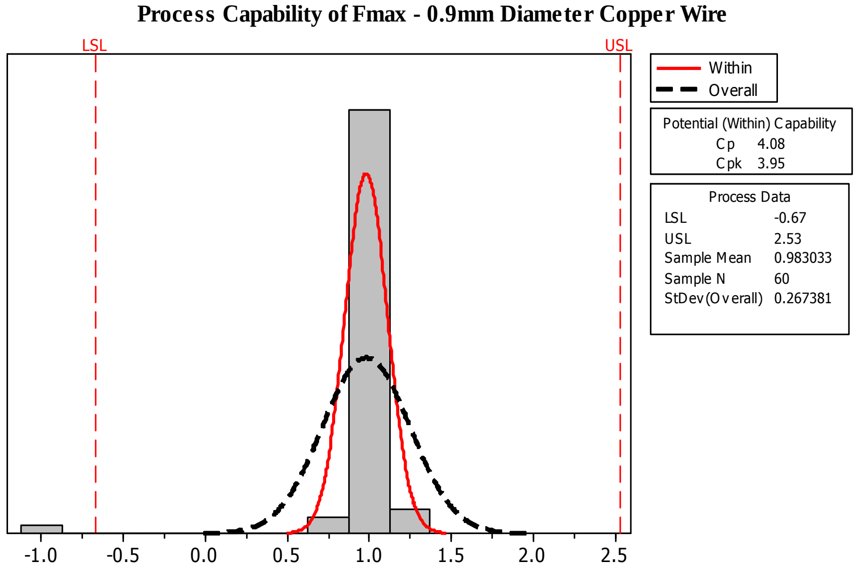

Figure 1 – Process Capability of Fmax

Minitab automatically calculated a Cpk of 4.08, a Cp of 3.95 for the sixty measurements of Fmax using the 0.9mm diameter copper wire. These two values exceeded the Six-Sigma requirements of 2 or more [3]. However, it was noted at this point that the graphical representations of the sixty measurements did not give a high level of confidence. Figure 2 is a snap-shot of fifteen results from the sixty measurements taken.

It can be seen that there are unstable graph lines in Figure 2 and the instability of these lines can have a major impact on the results. It was evident at this point that there were some unknown influences causing this instability whether it was;

- A significant variation on the solderability between each of the copper wires
- Some external factors affecting the machines performance

In order to ascertain further information about this instability, the machines capability in terms of Tb, Time to Buoyancy, was investigated using the same sixty measurements for the same sixty pieces of copper wires.

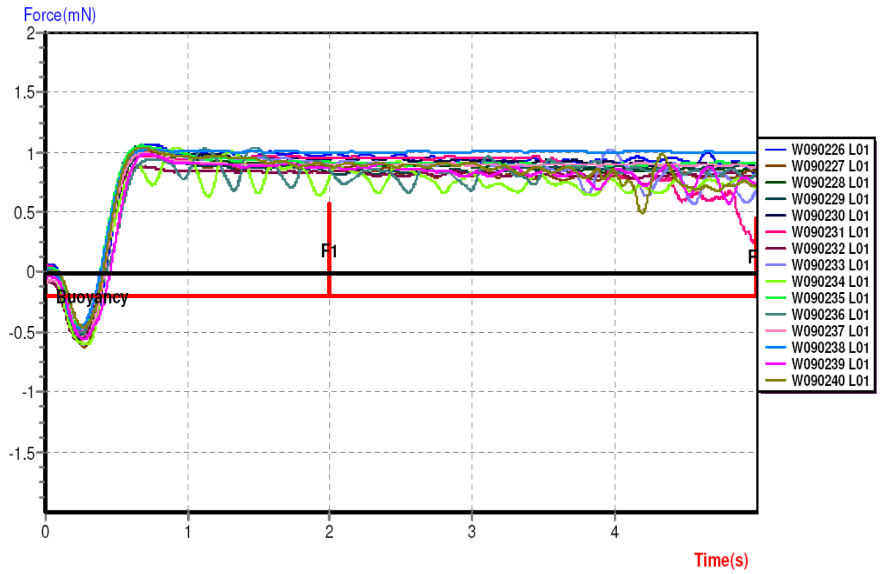

Figure 2 – Fifteen readings from the sixty measurements – Machines powered on

- Time to Buoyancy, Tb

For Tb, the globally recognised specification which is stated in J-STD-002C is ≤ 0.6 seconds and from this the UCL of 0.6 and LCL of 0 were defined [5]. Figure 3 is a Capability Analysis graph of the sixty readings for Tb generated from the same sixty pieces of copper wires used for the Fmax result in Figure 1.

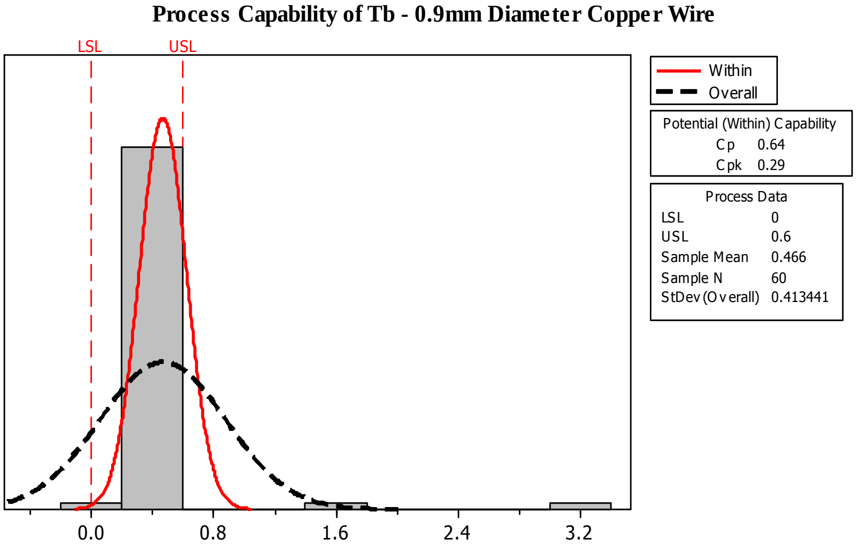

Figure 3 – Process Capability of Tb

Again Minitab automatically calculated the Cpk and Cp values of 0.29 and 0.64 respectively. These two values do not meet the Six Sigma requirement and the results supports the initial observations seen from the graphical lines in Figure 2. The instability of the graphical representations for the sixty readings was not stable and the root cause to this instability required further investigation.

2.4 Improve Phase

During the Analysis Phase it was determined that there was some factor or a combination of factors affecting the readings. Even though the Cp and Cpk results for Fmax meet the Six-Sigma requirements, the graphical lines in Figure 2 displayed an instability which was supported by the Cp and Cpk values got for Tb.

The Wetting Balance machine was located in a laboratory where machines such as an X-Ray, Force tester and a mini SMT (Surface Mount Technology) line are constantly in operation during the weekdays, Monday to Friday. In order to assess if the operation of these machines had any affect on the results, sixty measurements were repeated when all other machines within the laboratory were switched off. The same procedure as in section 2.2 was also used for these sixty readings but with different pieces of copper 20mm in length.

- Maximum Force, Fmax

Using the readings from these sixty pieces of copper, Minitab automatically calculated the standard deviation (σ) to be 0.0319390 - 0.032. From this the UCL and LCL were calculated;

LCL = Fmax theoretical - 6(σ)

Where the same Fmax theoretical calculated earlier in section 2.3 is used – 0.9274mN

=> LCL = 0.9274 - 6 (0.032) => LCL = 0.7354mN = 0.74mN

UCL = Fmax theoretical + 6(σ)

=> UCL = 0.9274 + 6(0.032) => UCL = 1.1194mN = 1.12mN

Using a UCL of 1.12mN and a LCL of 0.74mN Minitab generated a Capability Analysis graph for sixty readings. See Figure 4 below.

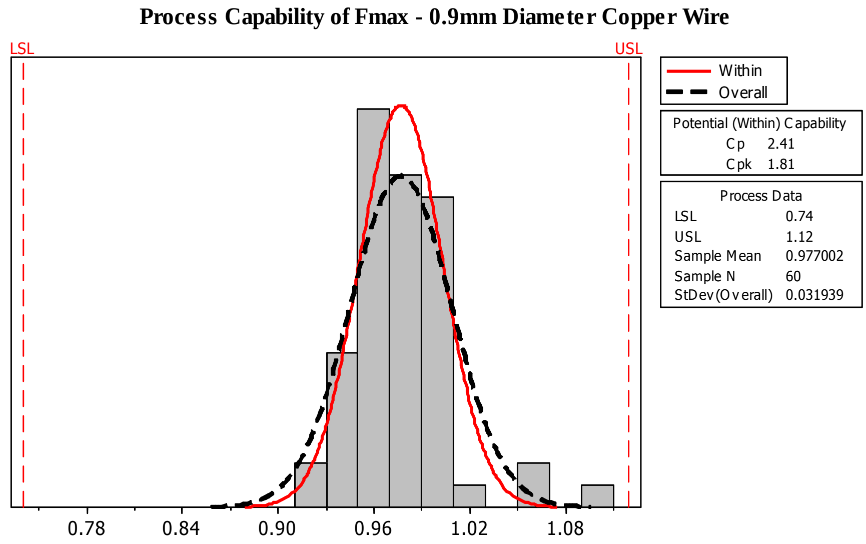

Figure 4 – Process Capability of Fmax – All other machines in lab switched off

The Cp and Cpk values of 2.41 and 1.81 were not as superior as the results got when all other machines in the laboratory were operational during the experiment, but the graphical lines for the sixty measurements were significantly more stable than previously achieved, see Figure 5. The Standard Deviation calculated also reduced significantly from 0.267mN to 0.032mN.

Comparing Figure 2 (machines powered on) to the graph in Figure 5 (machines powered off) the effect of the other equipment within the vicinity of the Wetting Balance machine caused vibrations which resulted in the ‘unstable’ lines in Figure 2. This unstableness would easily influence the force and time measurements and was certain to cause measurement errors. In order to support this theory, the Cp and Cpk values for Tb would need to be assessed to determine if there was any significant improvement.

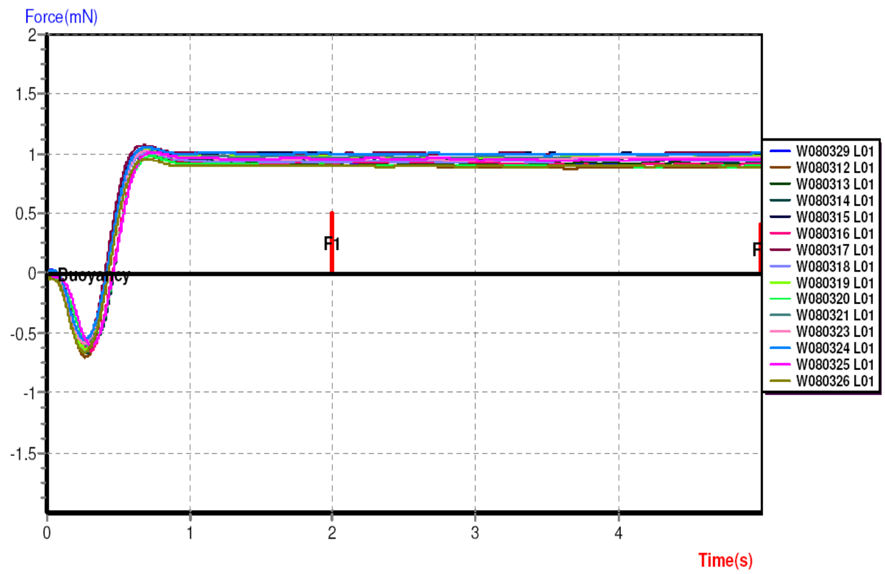

Figure 5 – Fifteen readings from the sixty measurements – Machines powered off

- Time to Buoyancy, Tb

The UCL and LCL was the same as previously used due to the fact that these limits are from the International Standard J-STD-002C. Figure 3.6 was generated by Minitab using the sixty measurements and it is evident that the Cp value of 7.30 and Cpk value of 4.41 improved significantly compared to results achieved when all other equipment within the laboratory was powered on. Again, the Standard Deviation calculated also reduced significantly from 0.413mN to 0.0149mN.

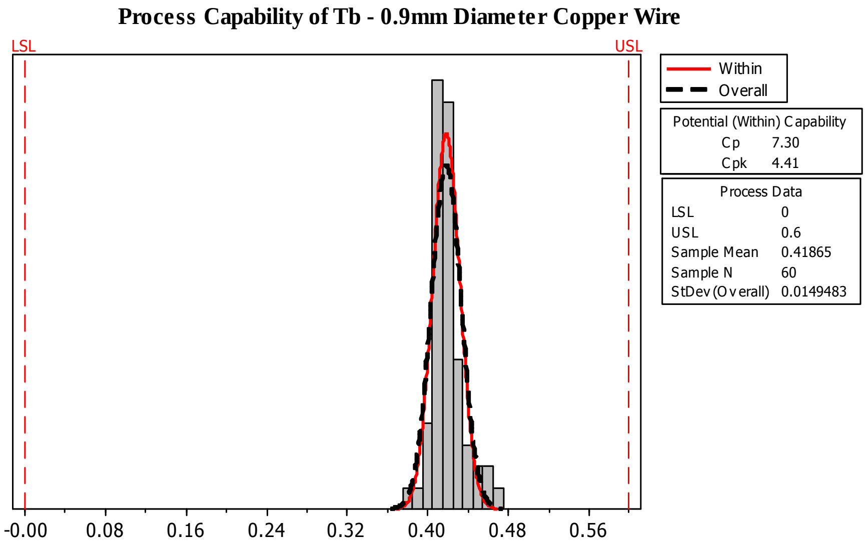

Figure 6 - Process Capability of Tb – All other machines in lab switched off

2.5 Control Phase

The experimentation into the capability of the Wetting Balance machine established that vibrations from other sources such as the X-Ray and SMT equipment within the vicinity had very significant effects on its performance in terms of accuracy and repeatability. These external influences needed to be eliminated for the duration of the testing while using the Wetting Balance machine. As mentioned earlier, the measurements for a Wetting Balance machine are miniature, milli-newtons (mN), and any error in the machines readings could have a major impact on the results, thus giving false readings and impacting on the results achieved.

In order to ensure stability and control of the results when carrying out solderability testing with a Wetting Balance machine, the main issue to be adhered to is to ensure all other equipment within the location of the Wetting Balance Machine is be powered off to avoid unnecessary influences such as vibrations.

3. Summary

The main focus of the analysis in the paper was to determine if the Wetting Balance machine was capable of providing repeatable and accurate results. It is imperative that a system has a datum to be measured against when analysing any process. In this case the Fmax was theoretically calculated for a 0.9mm diameter copper wire and the Tb, time to buoyancy, taken for the International Standard J-STD-002C as $\leq$0.6 seconds. By using these two nominals the Cp and Cpk values for the machine were calculated.

Using Fmax, a Cpk value of 4.08 and a Cp value of 3.95 provided excellent results but it was noted that there was some influence causing unstableness in the graphs. Using Tb for the same sixty measurements, Cpk and Cp values of 0.29 and 0.64 were achieved. These values are well below the Six Sigma requirement and at this point further analysis was required to understand and eliminate the unstableness in the graphs and to also determine and understand why the Cp and Cpk values for Tb gave results that were below the requirement.

The location of the Wetting Balance machine was proven to be the critical factor. Vibrations from machines such as the X-RAY and the Surface Mount Technology line affected the measurements from the Wetting Balance machine. This was verified when all other equipment within the vicinity of the Wetting Balance machine was powered off and the tests repeated.

The stableness of the graphs significantly improved but the Cp and Cpk values of 2.41 and 1.81 respectively for Fmax were not as superior as the results got when all other machines in the laboratory were operational during the experiment. The result was still excellent and the standard deviation reduced from initial 0.267mN to 0.032mN. For Tb values, the Cp value of 7.30 and Cpk value of 4.41 were a vast improvement on the initial results and the standard deviation also improved, from 0.413mN to 0.0149mN.

The elimination of vibrations is of paramount importance when developing a stabilised system for testing the solderability using a Wetting Balance machine due to the small margin for error.

4. References

9. *MUST II Wetting Balance Machine User Manual.*
10. *International Standard IEC60068-2-54: Environmental Testing – Part 2-54: Tests-Test Ta: Solderability testing of electronic components by the wetting balance method.*
11. *T. Pyzdek: The Six Sigma Handbook, 2003.*
12. *Wassink, Klein R.J., May 1989. Soldering in Electronics, 2nd Ed., Electrochemical Publications Limited.*
13. *Joint Industry Standard – Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires, J-STD-002C, December 2007.*

Appendix 11 Unpublished Journal Paper

Appendix 11.1 Materials and Manufacturing Processes

Wetting Balance Prediction Model Equations for Through-Hole Components with an SN100C Alloy

Abstract — In order to achieve a reduction in solderability related defects on components in an electronics manufacturing series production line, preventive controls such as the “Wetting Balance” test need to be fully optimised to screen out all suspect components. For the benefit of repeatability and accuracy of test results, 0.9mm diameter copper wires were used to eliminate the solderability variation that may be evident on components. Due to the variation of parameter settings within the international standards for solder temperature, immersion speed, immersion depth, removal speed and dwell time, a complete analysis was required to determine the optimum settings for the MUST II Wetting Balance machine. Prediction models were generated for each of the responses (Ta, Tb, and Fmax) and these equations were verified using the actual test results for both least stringent and most stringent settings for 0.9mm diameter copper wires. The results for both were very comparable. The relationships between the responses and the significant factors were analysed using linear equations and the accuracy of each equation was deemed an excellent mathematical model to predict the outcome. To test these models, components with a with similar diameter leads to that of the copper wires were tested and evaluated using the least stringent and most stringent settings.

The predicted values using the mathematical models provided accurate values that were comparable to the actual values achieved when testing using the Wetting Balance machine.