



IPC-TR-466

Wetting Balance Standard Weight Comparison Test

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A technical report developed by the IPC Wetting Balance
Task Group

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Any Technical Report involving a complex technology draws material from a vast number of sources. While the principal members of the Wetting

Balance Task Group (5-23c) of the IPC Assembly and Joining Processes Committee (5-20) are shown below, it is not possible to include all of

those who assisted in the evolution of this Report. To each of them, the members of the IPC extend their gratitude.

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TECHNICAL REPORT:

WETTING BALANCE STANDARD WEIGHT COMPARISON TEST

OBJECTIVES

The purposes of the Wetting Balance Standard Weight Comparison test were to:

1. Study the precision of weight measurements taken on the wetting balance.
2. Correlate weight measurements among test participants.

INTRODUCTION

The wetting balance test method was the subject of much discussion during the preparation of ANSI/J-STD-002, Solderability Tests for Components Leads, Terminations, Lugs, Terminals and Wires. Since no clear consensus was reached regarding the accept/reject criteria for the wetting balance test, the procedure was placed in a section of the standard reserved for tests without requirements. A Wetting Balance Task Group was chartered to refine the test procedure and derive acceptance test requirements.

The Wetting Balance Task Group established a four step strategy:

1. Study wetting balance weight measurement precision to establish correlation among all test users, and equipment manufacturers.
2. Develop standard test samples.

3. Study effects of surface finish and preparation, component geometry and thermal effects of fixtures.

4. Recommend a revised test procedure with acceptance test requirements.

This technical report discusses the results of the Task Group efforts to date on Step 1 of the strategy; establishing correlation among wetting balance test users.

CONCLUSIONS

1. The wetting balance weight measurement data taken during this test indicate that the total measurement variability (including repeatability and reproducibility error) would have standard deviations as shown below for the sample weights noted. That would result in the measurement precision as noted:

Sample Code	Sample Weight	Wetting Balance Measurement Capability	
		Standard Deviation	Precision
A	971	47.8	+/- 143.4
B	1965	56.8	+/- 170.4
C	5085	132.8	+/- 398.4

2. Sources of measurement variation were as follows:

- The measurement variation due to

repeated measurements on a single wetting balance (repeatability), tended to be similar for all sample sizes, and had a standard deviation of approximately 30 to 40 uN.

- The measurement variation due to measurements on different wetting balances (reproducibility) had a standard deviation similar to repeatability for smaller sample weights, but was much larger for the heaviest weight.
3. Measurement precision on the wetting balance equipment would need to improve by an order of magnitude to be acceptable for performing acceptance testing on a marginally solderable sample. Note: this work has stimulated further research by the equipment manufacturers, and the new generation balances may approach this precision.

RECOMMENDATIONS

1. Establish wetting balance calibration procedures.
2. Establish closer control of wetting balance test procedures.
3. Investigate sources of wetting balance measurement variation with equipment manufacturers.

TEST PROCEDURE

Three standard test weights were prepared. The weights were designed to simulate the range of normal wetting forces during test, approximately 1000 to 5000 micronewtons.

The three test weights were sent to each of the test participants. Each test participant performed five weight measurements with each test sample. The test participants were to calibrate the wetting

balance and perform the test using their normal procedures. Some participants repeated the measurements on Mettler balances.

The weight measurements were performed by placing a test weight on the specimen holder. The wetting balance test cycle was started. As the arm lowered towards the solder pot, the specimen holder was placed on the hook. The weight was not allowed to touch the solder. The specimen weight was recorded at the end of the test cycle.

This procedure allowed estimates of the wetting balance weight measurement precision, while ensuring isolation from other variables such as differences in sample solderability or surface preparation.

DATA ANALYSIS

The data was analyzed by statistical process control (SPC) X-bar/R charts and measurement capability analysis.

TEST PARTICIPANTS

Data were received from the following companies:

- Electronic Manufacturing Productivity Facility
- Harris Semiconductor
- Rockwell/International
Collins Avionics and Communications Group
- Robotics Process Systems
- Kester Solders
- Allied Signal
- Multicore Solders
- Texas Instruments
Defense Systems and Electronics Group
- Microelectronics and Computer Technology Corp.

Data were recorded on equipment manufac



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by the following companies:

- Mettler
- General Equipment Corporation
- Kester Solders
- Multicore Solders
- Robotics Process Systems

TEST RESULTS

In all 17 tests were performed by 10 users on wetting balances from four companies, involving six different models.

Table 1 shows a summary of the average and standard deviation of the five readings recorded on each test sample by each test participant.

Equipment	User Code	Equip. Code	Sample A		Sample B		Sample C	
			Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
Wetting Balance	A	A	938.6	15.71	1975.9	12.12	5094.5	12.12
	B	B	956.4	35.45	1918.3	38.62	5074.5	24.76
	C	C1	959.5	62.03	1936.7	29.48	5240.6	65.84
	C	C2	1023.6	37.52	2052.0	37.76	4982.6	39.52
	D	E	941.4	53.73	1961.4	0.00	5001.6	0.00
	E	B	904.0	30.34	1901.2	16.00	4984.0	21.22
	F	A	1004.0	27.01	2002.0	16.43	5042.0	8.36
	F	B	978.0	29.48	1960.8	6.05	5004.8	26.6
	F	B	974.8	23.08	1950.0	6.32	4994.4	46.32
Mettler Balance	G	D	965.0	44.97	1974.9	58.48	5084.7	61.65
	H	B	990.0	33.16	2012.2	25.86	5396.0	45.05
	I	A	992.6	54.29	1894.8	88.34	4950.6	45.48
	J		971.1	0.44	1965.3	0.00	5085.9	0.00
	C		971.4	0.06	1964.8	0.05	5086.1	0.04
	F		971.0	0.00	1965.0	0.00	5086.5	0.00
	I		971.7	0.54	1965.1	0.42	5086.4	0.81
	I		972.2	0.35	1965.7	0.43	5087.2	0.38

Note that the wetting balance results for user D show standard deviations of 0.0 for samples B and C. Most users recorded sample weight to the nearest micronewton, but user D recorded the data to the nearest millinewton. User C performed the test on two different models of the same machine. User F repeated the test twice on Balance B, with

dwelt times of 5 and 10 seconds respectively.

The Mettler balance data was recorded in a uniform manner, and results can be compared on an equal basis.

The SPC X-bar/R chart analysis is summarized in Table 2. The charts are shown in Figures 1 to 3. The data in Figures 1 to 3 are shown in the order tested.

Data	Code	Process	Process	Control Status
		Sample Mean	Sigma	X-Bar
Wetting	A	969.0	38.37	out
	in			
Balance	B	1961.7	29.36	out
	out			
	C	5070.8	36.01	out

As Table 1 shows, the average of all wetting balance weight measurements for each sample across all users tends to be very close to the average of all Mettler balance measurements for that sample. However, the dispersion of the measurements is quite different. The wetting balance measurements have an estimated measurement process standard deviation two orders of magnitude higher than the Mettler balance.

These estimated measurement process standard deviations are shown here only for comparative purposes. These estimates must be used only after careful consideration.

The measurement process standard deviations are estimated from the average of the range between the highest and lowest weight measurement on each balance. Thus the estimate here is based on with-in balance repeatability.