Technical Report

MOLEX AND SAMTEC
High Density Mezzanine
(HDM-Plug/HDM-Receptacle)
Connector Processing Trial
SMT Assembly Report

Project Leader: Ron Hodge - Molex

Project Team:  Rasec Barrientos - Solectron
               George Skevofilax - Solectron
               Peter Thune - Solectron
               Tim Lippe - Solectron
               John Zembo - Solectron
# Table of Contents

Table of Contents .....................................................................................................................................2

List of Figures...........................................................................................................................................3

List of Tables ............................................................................................................................................3

1. Purpose............................................................................................................................................4
2. Background ....................................................................................................................................4
3. Assembly Materials ........................................................................................................................5
4. SMT Equipment .............................................................................................................................5
5. Environmental Conditions .............................................................................................................5
6. Test Vehicle Components ..............................................................................................................6
7. Reflow Profile.................................................................................................................................6
8. Solder Paste Printer, Squegee and Stencil......................................................................................7
9. Paste Volume measurements .........................................................................................................8
10. Misprint Wash Process ..................................................................................................................9
11. SMD Placement ............................................................................................................................9
12. Rework / Repair Process .............................................................................................................10
13. SMT Inspection and X-Ray Results ...........................................................................................12
List of Figures

Figure 1: HDM-Receptacle / HDM-Plug Conn .........................................................................................6
Figure 2: Profile Cards - Receptacle / Plug : .............................................................................................6
Figure 3: Reflow Oven Profile - Plug / Receptacle ..................................................................................7
Figure 4: Paste volume histogram Receptacle-TOP ..................................................................................8
Figure 5: Paste volume histogram Plug-BOT ............................................................................................8
Figure 6: Trays for Placement ..................................................................................................................10
Figure 7; Mini Stencil Plug/Receptacle for Repair (6 mil) .......................................................................10
Figure 8; Rework Profile for Receptacle .................................................................................................11
Figure 9; Rework Profile for Plug ..........................................................................................................11
Figure 10; Good Solder Joints .................................................................................................................13
Figure 11: X-Ray Image Good Solder Joints ...........................................................................................13
Figure 12; Bad Solder Joints ....................................................................................................................14
Figure 13; Bad Solder Joint X-Ray Image .................................................................................................14

List of Tables

Table 1: Environmental Conditions ...........................................................................................................5
Table 2; GSM Parameters ........................................................................................................................9
Table 3: 5DX results by serial number for SnPb Paste .............................................................................12
1. **Purpose**

This run was to verify process ability of Lead option for the High Density Mezzanine (HDM-Plug/HDM-Receptacle) series connectors.

This report documents the surface mount assembly process activities, observations and results for the High Density Mezzanine (HDM-Plug/HDM-Receptacle) connector test vehicle build in the New Products Introduction (NPI) assembly area of the Solectron plant in Austin, Texas.

The intent of the build activity was to analyze and note build material conditions prior to assembly, assess assembly conditions and impediments during the build, and submit the samples to MOLEX for subsequent reliability testing.

2. **Background**

MOLEX first engaged Solectron – Austin regarding the High Density Mezzanine (HDM-Plug/HDM-Receptacle) connectors that are intermateable with SAMTEC HDAM/HDAF Series connectors with a quote request submitted in February 2007. During that meeting, Solectron was introduced to the connectors that were to be used for the run and asked to freely comment and provide suggestions.

As a result of that session and lessons learned on previous MOLEX Runs, Solectron provided the following list of items for possible consideration by MOLEX:

1. Test card design
2. Recommended pad size
3. Stencil thickness
4. Inspection of unique solder terminal design - what type of inspection machine
5. Universal GSM recognition of unique terminals
6. 5DX x-ray program
7. Solder terminal coplanarity
8. Profile requirements
9. Vacuum pickup cap rigidity and clearance above housing
10. Placement accuracy for plugging of multiple connectors on an assembly - possibly up to 4
11. No lead compatibility
12. Connector settling during reflow due to unique solder terminal
13. Card edge clearance for test card
14. Connector Self-centering during reflow

The assembly activity took place on March 14, 2007. 68 (sixty eight) connectors were installed on individual printed circuit boards for both HDM-Plug and HDM-Receptacle. The boards consisted of 1 FAB with the top side to be used for HDM-Receptacle connectors. The bottom side to be used for HDM-Plug. The boards are OSP finish. All Fabs and connectors were provided by MOLEX.
3. **Assembly Materials**

PCB: PCTB #251 RevA  
SIDE 1 – TOP (Receptacle)  
SIDE 2 – Bottom (PLUG)

Components: Connectors and FABS supplied by MOLEX.

Solder Paste: (SnPb) Kester HM531, **Water Soluble**

Assembly Part #’s:  
SnPb HDM-Receptacle: 1001-0002-3121  
SnPb HDM-Plug: 1001-0002-3120

4. **SMT Equipment**

Screener Printer: MPM UP3000  
Paste Inspection: Koh Young KY3030VAXL  
Fine Pitch Placement: Universal GSM  
Reflow Oven: BTU Pyramax 150N (10 zone)  
Temperature Profiler: Datapaq 9000  
X-Ray: Agilent 5DX Series 5000  
Hydro-wash: Stoelting  
Stencil/ Wash: AAT-X40A

5. **Environmental Conditions**

The following info is from the Site Wide Humidity and temp sensors  
That is in each MFG module;

<table>
<thead>
<tr>
<th>Date:</th>
<th>3/14/07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature in Assembly Area</td>
<td></td>
</tr>
</tbody>
</table>
| Beginning of Build | 73 deg F  
| End of Build | 73 deg F |
| Relative Humidity in Assembly Area |  
| Beginning of Build | 23%  
| End of Build | 23% |

Table 1: Environmental Conditions
6. Test Vehicle Components

Figure 1: HDM-Receptacle / HDM-Plug Conn

7. Reflow Profile

Type K, special limits of error (+/- 1.1° C @ 200°C), thermocouples were used. Thermocouples were attached by first drilling down through the pads of a bare board using a 13-mil drill bit. Care was taken to not sever the trace connections to the associated fan-out vias. Backside counter bore holes were drilled to provide clearance for the thermocouple insulation. Thermocouples were inserted and secured with thermal epoxy; welds positioned 5-6 mils above the fab top surface. Solder paste was then screened onto the board and components were placed and reflowed. Using this method ensures that the thermocouple weld is in contact with the solder joint precisely at the contact-pad interface. Three thermocouples were attached in this manner—leading corner, middle or the array, and trailing corner. Dage transmissive X-Ray is then used to verify that the thermocouple weld has remained in position.

Figure 2: Profile Cards - Receptacle / Plug :
8. Solder Paste Printer, Squeegee and Stencil

Effective settings for the MPM UP3000 screener were found to be as follows:

- **Squeegee:** 10-mil thickness JNJ metal, 12 inches in length
- **Blade Angle:** 60º
- **Total Force:** 14 lbs. (1.1 lb per blade inch)
- **Downstop:** 0.070
- **Print Speed:** 1.5 inches/sec
- **Snap-off Speed:** 0.010 inch/sec

A laser-cut, electro-polished, single thickness stencil was designed—apertures 35-mil diameter;

**RECEPTACLE:**
We used both a foil thickness of 5-mils and 6-mils on the Receptacle (top side).
The 5mil foil was initially used for the first 5 cards which produced less than desirable yields. We then switched over to the 6 mil which ran very well.

**PLUG:**
Since the 6 mil stencil gave us better yields on the Receptacle it was determined to use the 6 mil stencil made for the Plug which ran very well with it.
9. Paste Volume Measurements

Assessment of volumetric data is typically based upon an idealized view of stencil apertures, regarding both board side and squeegee side dimensions as the same. The true volume capability of stencil apertures should be based upon lab measurements and take into account the trapezoidal characteristics of the apertures. Delivered volume also assumes a perfectly flat and smooth board surface. As shown in Section 7, this was not the case for this test vehicle.

Full 3D paste volume measurement was performed on 100% of the paste deposits on all boards using a Koh Young in-line solder 3D solder paste inspection system. The system uses bi-directional, white light, phase shift interferometry to provide true 3D volumetric results. A fab surface pre-scan is used to collect data on the fab topography prior to the inspection of pasted boards. The pre-scan allows the system to effectively “map” the solder mask reference plane to pad relationship. The system provides results on volume, height, offset, bridging, and shape of each paste deposit. Since volume data is the most pertinent print attribute and volume data was readily available, paste volume for all deposits is typically presented.

Stencil # 11452 5 mil
Nominal Volume 6185.5
Max printed 9217 (149%)
Min printed 4082 (76%)

Figure 4: Paste volume histogram Receptacle-TOP Stencil# 11446 6 mil

Stencil # 11446 6 mil
Nominal volume 7422.5
Max printed 9946 (134%)
Min printed 6532 (88%)

Figure 5: Paste volume histogram Plug-BOT Stencil# 11447 6 mil

Stencil # 11447 6 mil
Nominal volume 7422.5
Max printed 9946 (134%)
Min printed 6532 (88%)
10. Wash Process

Misprint Process;

Solder paste applied to boards used while determining optimum printer parameters must be removed at some point. The same is true of any board that fails to meet 3D in-line solder paste inspection limits. There were no miss-print washes recorded during this build.

After SMT placement all cards are taken thru Wash Process. Cards are loaded on to the conveyor and washed.

11. SMD Placement

Placement was isolated to the use of Universal GSM fine pitch placement equipment. A sturdy 0.5 inch cap is needed to allow the use of a 0.4 inch nozzle. We used a 400XF nozzle (0.4 inch).

Parts were received from MOLEX with pick up covers. However, modification will need to be made to the Receptacle Component’s vacuum cap due to the fact that the height of this connector is outside of the machine limits and during pick and place the component was picked up slightly off-center. With the vac caps having only solid metal in the center of the connector we had to add tape to these covers. The Plug Connector worked fine as is.

Connector Self-Centering and Orientation Control:
The locator pins do provide orientation control. One of the two locator pins is elongated in the long axis to allow for thermal expansion during reflow. The locator pegs on these connectors were off center of each other (one peg in one corner with the other being in the opposite corner on the other end) this did not appear to be a problem for machine placement. Self-Centering is not a problem on this connector due to the locator pins being present.

Placement accuracy:
During the initial placement of the connectors on the first several cards of the HDMezz-Receptacle Connector there were many problems with the rejection rate and placement. At the time we were running with a BGA camera profile. Adjustment were made and the remainder of the run was without issues. There were no issues with the subsequent HDMezz-Plug placement.

Placement pressure was also set to 300 grams as specified in the original quote for the outline of the run.

Trays used for pick up of parts were built by machine shop; 1 tray for each style of conn. Each tray held 16 connectors and were set up for proper orientation. Parts were loaded into trays and then set into the GSM placement Machine. Attention was given to insure that connectors were picked up using proper orientation according to how the program was written.

Table 2: GSM Parameters

<table>
<thead>
<tr>
<th>Machine Type: Universal GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozzle Type: 400XF (0.4 in)</td>
</tr>
<tr>
<td>Force:</td>
</tr>
<tr>
<td>300 Grams</td>
</tr>
</tbody>
</table>

Table 2: GSM Parameters
12. Rework / Repair Process;

It was requested to take 20 Receptacle Connectors and 20 Plug Connectors thru the Removal/Replace Repair Process in the BGA REPAIR AREA; The following picture (Figure 8) are the Mini Stencils used; Also below (Figure 9 & 10) are the profiles used for the Connectors. We also used a nozzle for this part;

Placement machine is: SRT 1100 LX;

Cards/Connectors were taken thru the Repair process for Removal and Replacement of the connectors. All connectors are then taken thru the X-Ray process to insure proper pin to pad solder.

Process is as follows;
Run profile – Remove part – Inspect site - paste card using mini stencil-inspect – place new part on card – X-ray

All repaired cards went back thru X-RAY; (Cards do not go back thru wash since no clean flux is used)

These cards ran fine thru the BGA rework Process;

Figure 7; Mini Stencil Plug/Receptacle for Repair (6 mil)
Figure 8: Rework Profile for Receptacle

Figure 9: Rework Profile for Plug
13. SMT Inspection and X-Ray Results

X-Ray inspection was performed using an Agilent 5DX, Series 5000. The program used a CCGA algorithm, which compares each pin to its nearest neighbors within the field-of-view. A single slice was taken of each pin, seven mils above the board top surface.

5DX results overall were good.

X-ray can be very effective, but it is only as good as the program it is given. More work with the 5DX program would be needed in a MFG environment. In order to program the X-Ray machine Solectron Would need an “ODB+ or .brd” file for programming.

Table 3: 5DX results by serial number for SnPb Paste

<table>
<thead>
<tr>
<th>Receptacle</th>
<th>1001-0002-3821</th>
<th>QTY = 17</th>
<th>Plug</th>
<th>1001-0002-3820</th>
<th>QTY = 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERIAL # :</td>
<td>X-RAY:</td>
<td>BGA</td>
<td>SERIAL # :</td>
<td>X-RAY:</td>
<td>BGA</td>
</tr>
<tr>
<td>1</td>
<td>SAD111100XB</td>
<td>FAIL-5mil</td>
<td>Repair</td>
<td>SAD111100WU</td>
<td>PASS</td>
</tr>
<tr>
<td>2</td>
<td>SAD111100WX</td>
<td>FAIL-5mil</td>
<td>Repair</td>
<td>SAD111100WD</td>
<td>PASS</td>
</tr>
<tr>
<td>3</td>
<td>SAD111100X6</td>
<td>FAIL-5mil</td>
<td>Repair</td>
<td>SAD111100WN</td>
<td>PASS</td>
</tr>
<tr>
<td>4</td>
<td>SAD111100XC</td>
<td>FAIL-5mil</td>
<td>Repair</td>
<td>SAD111100WV</td>
<td>PASS</td>
</tr>
<tr>
<td>5</td>
<td>SAD111100X2</td>
<td>FAIL-5mil</td>
<td>Repair</td>
<td>SAD111100WJ</td>
<td>PASS</td>
</tr>
<tr>
<td>6</td>
<td>SAD111100X1</td>
<td>PASS</td>
<td></td>
<td>SAD111100WH</td>
<td>PASS</td>
</tr>
<tr>
<td>7</td>
<td>SAD111100WW</td>
<td>PASS</td>
<td></td>
<td>SAD111100WC</td>
<td>PASS</td>
</tr>
<tr>
<td>8</td>
<td>SAD111100X3</td>
<td>PASS</td>
<td></td>
<td>SAD111100WK</td>
<td>PASS</td>
</tr>
<tr>
<td>9</td>
<td>SAD111100X4</td>
<td>PASS</td>
<td></td>
<td>SAD111100WL</td>
<td>PASS</td>
</tr>
<tr>
<td>10</td>
<td>SAD111100X5</td>
<td>PASS</td>
<td>Repair</td>
<td>SAD111100WM</td>
<td>PASS</td>
</tr>
<tr>
<td>11</td>
<td>SAD111100WZ</td>
<td>PASS</td>
<td></td>
<td>SAD111100WF</td>
<td>PASS</td>
</tr>
<tr>
<td>12</td>
<td>SAD111100X7</td>
<td>PASS</td>
<td>Repair</td>
<td>SAD111100WP</td>
<td>PASS</td>
</tr>
<tr>
<td>13</td>
<td>SAD111100X8</td>
<td>PASS</td>
<td></td>
<td>SAD111100WR</td>
<td>PASS</td>
</tr>
<tr>
<td>14</td>
<td>SAD111100X9</td>
<td>PASS</td>
<td></td>
<td>SAD111100WS</td>
<td>PASS</td>
</tr>
<tr>
<td>15</td>
<td>SAD111100XA</td>
<td>PASS</td>
<td></td>
<td>SAD111100WT</td>
<td>PASS</td>
</tr>
<tr>
<td>16</td>
<td>SAD111100WY</td>
<td>PASS</td>
<td></td>
<td>SAD111100WE</td>
<td>PASS</td>
</tr>
<tr>
<td>17</td>
<td>SAD111100X0</td>
<td>PASS</td>
<td></td>
<td>SAD111100WG</td>
<td>PASS</td>
</tr>
</tbody>
</table>

Note:
1. On the RECEPTACLE cards we started off with a 5mil stencil. The first 5 cards (4 connectors per card) had some, but not all connectors, with visually identified failed solder joints. We switched to a 6mil stencil on the remaining Receptacles as well as a 6mil on all PLUG Connectors.
Figure 10; Good Solder Joints

Figure 11: X-Ray Image Good Solder Joints
Figure 12: Bad Solder Joints

Figure 13: Bad Solder Joint X-Ray Image