Contents

1. Version....2
2. File format....3
   2.1. .HEADER Section....4
   2.2. .BOARD_OUTLINE Section....4
   2.3. .PLACEMENT Section....5
   2.4. .MECHANICAL Section....6
3. Origin of loops....7
   3.1. Origin of a glass substrate....7
   3.2. Origin of a string....8
   3.3. Origin of a busbar....9
4. Example....10
5. APPENDIX 1....11
6. APPENDIX 2....16

1. Version

0.1	Dr. Robert Hudjakov	Initial version
0.2	Dr. Robert Hudjakov	Revisited substrate and component origins

2. File format

The file format is based on IDF 3.0 standard document format. It specifies substrate (glass) and components (string, busbar). The IDF 3.0 document shall be distributed together with this specification.

An IDF 3.0 document can be made up from multiple files. The board file can but does not have to contain definitions of components. There can, however, be separate component library files. This document assumes the relevant components are defined within board file.

Lists important parameters for solar panel assembly are defined below. Unlisted sections can be skipped. Critical parameters are emphasized in bold.

2.1. .HEADER Section

File header defining data. It has to be a board file with IDF version 3.0 and units in millimeters. Other parameters are not critical.

Field	Value	Comment
File type	**BOARD_FILE**	**Constant**
IDF version number	**3.0**	**Constant**
Source system identification	IPTE TS1 1.0	Creating software name and version
Date	yyyy/mm/dd.hh:mm:ss	Document generation date
Board File version #	1	Free to define
Board name	Any	Free to define
Units definition	**MM**	**Millimeters**

2.2. .BOARD_OUTLINE Section

Defines the glass substrate for components. The section must define glass substrate thickness. Origin of the loops is important (see also chapter 3).

Outline owner	UNOWNED	
Thickness	**float**	**Glass substrate thickness in mm**
(loops)	**(loops)**	**Glass outline**

2.3. .PLACEMENT Section

Each .PLACEMENT section defines a XYZW location of a component on the glass substrate. The component itself is defined within .MECHANICAL Section.

NB! The components shall appear in the file in the same order as they are mounted to the glass substrate e.g. strings shall appear in the order they are to be placed on glass by mounting machine.

Package name	**string**	**Name of the component. In case of string it's stringer machine recipe name**
Part number	**string|busbar**	**Type of component. Used by layout our autobussing machine for filtering out relevant components**
Reference designator		tbd
X coordinate of location	**float**	**X position of the component**
Y coordinate of location	**float**	**Y position oft he component**
Mounting offset	**float > 0**	**Z offset from glass substrate e.g. EVA thickness compensation for a string**
Rotation angle (degrees)	**float**	**Angle of component. Should be integer multiple of 90 degrees**
Side of board	**TOP**	**constant**
Placement status	**PLACED**	**constant**

2.4..MECHANICAL Section

This section defines the components used in .PLACEMENT sections. For each component in component library there's a separate .MECHANICAL section record.

NB! The loops are defined relative to some origin. This origin is also used as reference position in .PLACEMENT section. See also chapter 3.

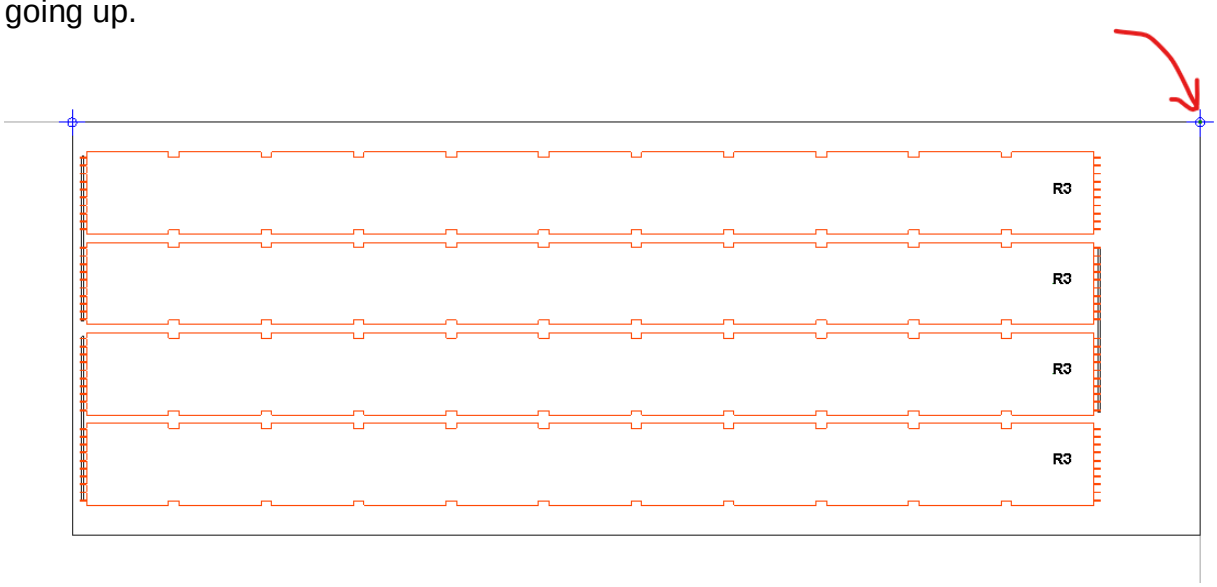
Geometry name	**string**	**Comparable to Package name in .PLACEMENT section. Name of the component. In case of string it's stringer machine recipe name**
Part number	**string|busbar**	**Type of component. Used by layout our autobussing machine for filtering out relevant components**
Units definition	**MM**	
Component height	float	Height of the component
Loops	**(loops)**	**Component outline**

3. Origin of loops

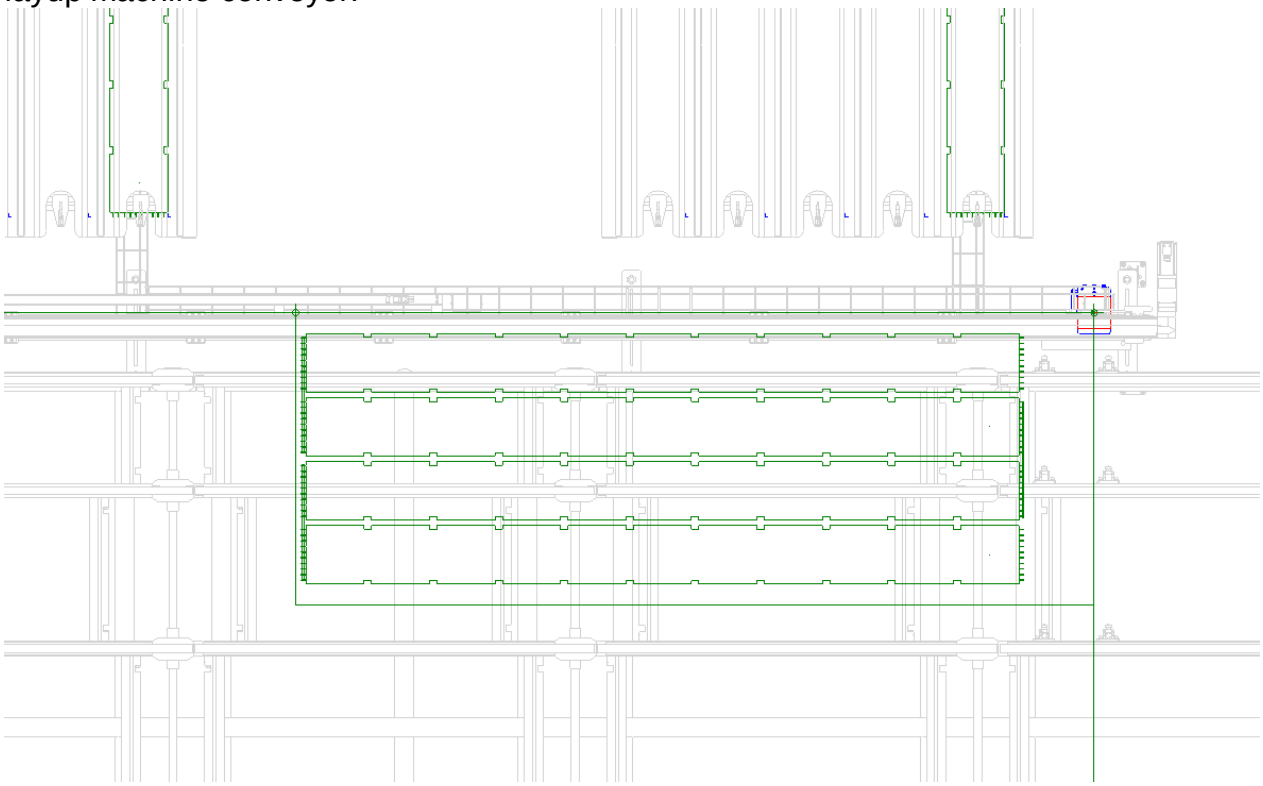
The coordinate origin of the loops (both substrate and components) is a critical parameter that simplifies converting drawing data into machine recipe.

3.1. Origin of a glass substrate

The glass substrate layout shall be horizontal e.g. length in x direction is longer than width in Y direction. The origin shall be at top right corner with x axis going to right and y axis going up.



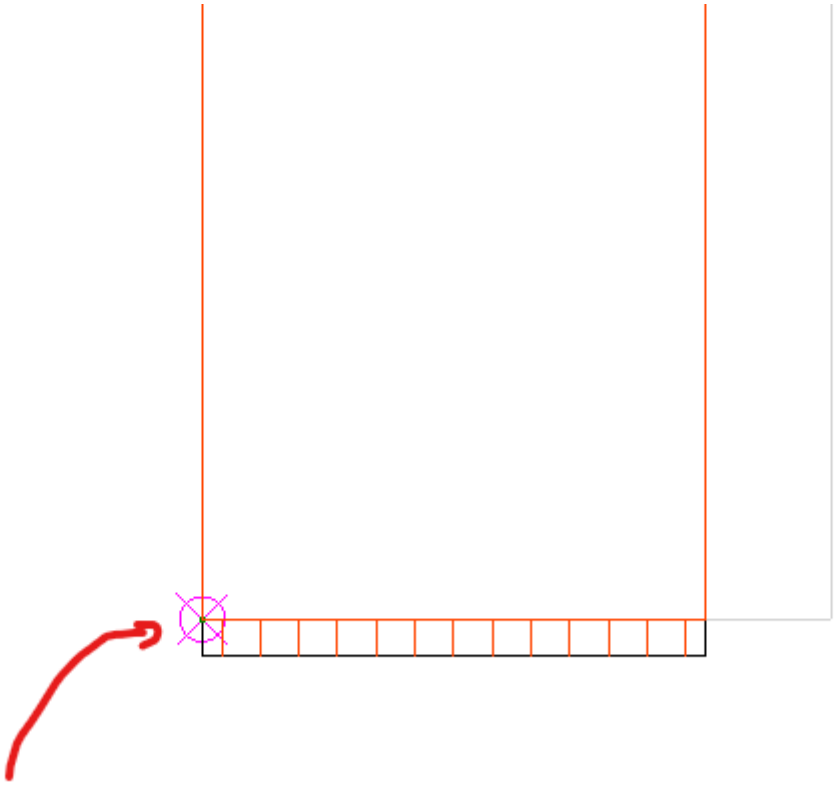
This choice is made to allow natural alignment of the glass substrate relative to string layup machine conveyor:



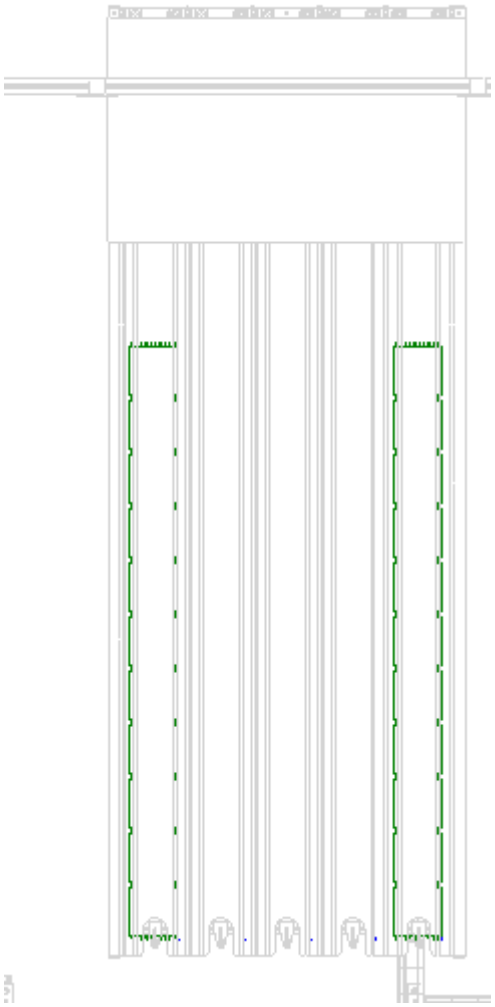
3.2. Origin of a string

String origin shall be at the bottom left corner of the bounding box of cells (ignoring ribbons).

- The top edge position is to be fixed on stringer machine outfeed conveyor independent of the string length.
- The mounting machine shall use constant picking position which fixes the string location in gripper.
    - The exact location of string in gripper can be further corrected by a camera.
- The mounting machine shall place the string on substrate to position defined in .PLACEMENT section.
    - The location of substrate in machine can be corrected by camera
    - The placement location shall be corrected by substrate position correction



This way the components align with feeders without additional adjustment. The x axis goes to right and y axis up.



3.3. Origin of a busbar

The busbar component shall be defined by a simple rectangular loop with origin at the bottom left corner. Just like with string.

- The busbar length is represented in X axis and width in Y axis.

4. Example

The file in APPENDIX 1 should produce output pictured in APPENDIX 2.

NB! Appendix is not updated and has component origins in wrong positions!

5. APPENDIX 1

```
.HEADER
BOARD_FILE 3.0 "IPTE TS1 1.0" 2023/03/23.15:45:06 1
"Layup Machine IDF file format" MM
.END_HEADER
.BOARD_OUTLINE UNOWNED
2.0
0 0.0 0.0 0.0
0 914.0 0.0 0.0
0 914.0 2500.0 0.0
0 0.0 2500.0 0.0
0 0.0 0.0 0.0
.END_BOARD_OUTLINE
.PLACEMENT
"String11" "string" R3
66.0 236.0 0.0 0.0 TOP PLACED
"String11" "string" R3
266.0 236.0 0.0 0.0 TOP PLACED
"String11" "string" R3
466.0 236.0 0.0 0.0 TOP PLACED
"String11" "string" R3
666.0 236.0 0.0 0.0 TOP PLACED
"sbar364" "busbar" R5
74.0 2474.0 0.0 0.0 TOP PLACED
"sbar364" "busbar" R5
474.0 2474.0 0.0 0.0 TOP PLACED
"sbar364" "busbar" R6
274 224.0 0.0 0.0 TOP PLACED
.END_PLACEMENT
.MECHANICAL
"sbar364" "busbar" MM 0.3
0 0 0 0
0 364.4 0 0
0 364.4 5 0
0 0 5 0
0 0 0 0
.END_MECHANICAL
.MECHANICAL
"String11" "string" MM 1.0
0 0 2232 0
0 0 2050 0
0 10.05 2050 0
0 10.05 2027 0
0 0 2027 0
0 0 1845 0
0 10.05 1845 0
0 10.05 1822 0
0 0 1822 0
```

0 0 1640 0
0 10.05 1640 0
0 10.05 1617 0
0 0 1617 0
0 0 1435 0
0 10.05 1435 0
0 10.05 1412 0
0 0 1412 0
0 0 1230 0
0 10.05 1230 0
0 10.05 1207 0
0 0 1207 0
0 0 1025 0
0 10.05 1025 0
0 10.05 1002 0
0 0 1002 0
0 0 820 0
0 10.05 820 0
0 10.05 797 0
0 0 797 0
0 0 615 0
0 10.05 615 0
0 10.05 592 0
0 0 592 0
0 0 410 0
0 10.05 410 0
0 10.05 387 0
0 0 387 0
0 0 205 0
0 10.05 205 0
0 10.05 182 0
0 0 182 0
0 0 0 0
0 10.05 0 0
0 10.05 -15 0
0 12.05 -15 0
0 12.05 0 0
0 27.65 0 0
0 27.65 -15 0
0 29.65 -15 0
0 29.65 0 0
0 45.25 0 0
0 45.25 -15 0
0 47.25 -15 0
0 47.25 0 0
0 62.85 0 0
0 62.85 -15 0
0 64.85 -15 0

0 64.85 0 0
0 80.45 0 0
0 80.45 -15 0
0 82.45 -15 0
0 82.45 0 0
0 98.05 0 0
0 98.05 -15 0
0 100.05 -15 0
0 100.05 0 0
0 115.65 0 0
0 115.65 -15 0
0 117.65 -15 0
0 117.65 0 0
0 133.25 0 0
0 133.25 -15 0
0 135.25 -15 0
0 135.25 0 0
0 150.85 0 0
0 150.85 -15 0
0 152.85 -15 0
0 152.85 0 0
0 168.45 0 0
0 168.45 -15 0
0 170.45 -15 0
0 170.45 0 0
0 182 0 0
0 182 182 0
0 170.45 182 0
0 170.45 205 0
0 182 205 0
0 182 387 0
0 170.45 387 0
0 170.45 410 0
0 182 410 0
0 182 592 0
0 170.45 592 0
0 170.45 615 0
0 182 615 0
0 182 797 0
0 170.45 797 0
0 170.45 820 0
0 182 820 0
0 182 1002 0
0 170.45 1002 0
0 170.45 1025 0
0 182 1025 0
0 182 1207 0
0 170.45 1207 0

0 170.45 1230 0
0 182 1230 0
0 182 1412 0
0 170.45 1412 0
0 170.45 1435 0
0 182 1435 0
0 182 1617 0
0 170.45 1617 0
0 170.45 1640 0
0 182 1640 0
0 182 1822 0
0 170.45 1822 0
0 170.45 1845 0
0 182 1845 0
0 182 2027 0
0 170.45 2027 0
0 170.45 2050 0
0 182 2050 0
0 182 2232 0
0 170.45 2232 0
0 170.45 2247 0
0 168.45 2247 0
0 168.45 2232 0
0 152.85 2232 0
0 152.85 2247 0
0 150.85 2247 0
0 150.85 2232 0
0 135.25 2232 0
0 135.25 2247 0
0 133.25 2247 0
0 133.25 2232 0
0 117.65 2232 0
0 117.65 2247 0
0 115.65 2247 0
0 115.65 2232 0
0 100.05 2232 0
0 100.05 2247 0
0 98.05 2247 0
0 98.05 2232 0
0 82.45 2232 0
0 82.45 2247 0
0 80.45 2247 0
0 80.45 2232 0
0 64.85 2232 0
0 64.85 2247 0
0 62.85 2247 0
0 62.85 2232 0
0 47.25 2232 0

0 47.25 2247 0
0 45.25 2247 0
0 45.25 2232 0
0 29.65 2232 0
0 29.65 2247 0
0 27.65 2247 0
0 27.65 2232 0
0 12.05 2232 0
0 12.05 2247 0
0 10.05 2247 0
0 10.05 2232 0
0 0 2232 0
.END_MECHANICAL

6. APPENDIX 2