A proposal to identify impedance controlled structures in Gerber fabricaton data.

Rev 2016.08

Draft for review only

Please send your comments to gerber@ucamco.com

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1 Preface

Part of the challenge of specifying and fabricating impedance controlled PCBs is to locate the traces that are critical for impedance control. Good practice is to draw the critical traces with a separate D-code and identifying the D-code in a separate ancillary document.

This draft specification formalizes the separate D-code and defines a formal, standardized way to identify them by attributes included in Gerber file. Thus it standardized current informal good practice. (For impedance controlled job this relates to the current method as Extended Gerber to Standard Gerber. In Standard Gerber the meaning of the D-codes is informally defined in a separate wheel file. In Extended Gerber it is defined in a standard manner inside the file.)

This specification does not define the stackup needed to achieve a given impedance. The stackup can be defined in e.g. the Polar format.

The common impedance structures are supported, and different impedance structures can be present in the same file and still be separately identified.

We publish this draft specification to allow the Gerber user community to review the new feature before it is cast in concrete. Please send your comments and criticism to gerber@ucamco.com .

Thank you

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2 Impedance Controlled Structures

The attributes in this section identifies the copper tracks and planes constituting impedance controlled structures as well as the target impedance. This is important information for the manufacturer as these objects are subject to tight specifications. Communication about these structures become easier as Gerber viewers can display them.

A PCB can contain several impedance-controlled structures. Each structure is identified by a name. The name indicates which copper object together form a structure. The name is the reference in other documents with information about the structure.

These attributes are about the copper structures only. To calculate and implement impedance controlled attributes the complete stackup information is needed. The stackup is not part of the current Gerber specification.

The layers with impedance-controlled copper are identified by the presence of these aperture attributes in that layer. Do not put unused .Impedance attributes.

2.1 .AperImpedance attribute

The .Impedance aperture attribute identifies the tracks, guides and planes creating an impedance controlled structure by adding attributes to the apertures used to define them.

It has the following syntax:

<.AperImpedance Attribute> = .AperImpedance,

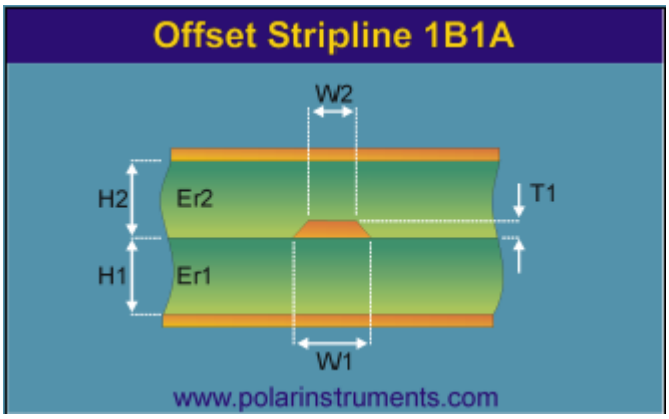
(Guide,<name>|Track,<name>[,<Ohm>[,<mode>]]|Plane,<name>{,<name>})

Field	Usage
`Track, Guide or Plane`	Identifies whether the aperture creates impedance controlled tracks, coplanar waveguides or the reference plane.
`<name>`	This field identifies the impedance structure. It can occur multiple times on a plane as the plane can be part of different impedance structures
`<Ohm>`	A decimal specifying the target impedance. It is optional, on tracks only.
`<mode> = (Zo|Zdiff|Zoo| Zcm|Zoe|Zother)`	A field specifying the impedance mode, using Polar conventions. It is optional, on tracks only. Zo single ended Zdiff differential Zoo odd mode Zcm common Zoe even mode Zother something else

Example:

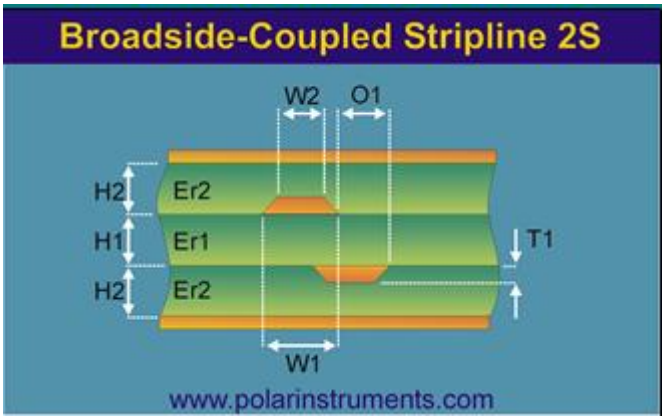
```
G04 Example of a simple layer with impedance controlled tracks*
%FSLAX35Y35*%
%MOMM*%
%TF.FileFunction,Copper,L4,Bot,Signal*%
%TF.FilePolarity,Negative*%
%TF.Part,Single*%
%TA.AperFunction,Conductor*%
G04 Define aperture for the impedance controlled tracks*
%TA.AperImpedance,Track,ENCX24J600,100,Zo*%
%ADD101C,0.15000*%
G04 Define aperture for the waveguides
%TA.AperImpedance,Guide,ENCX24J600,
%ADD102C,1.0*%*%
G04 Define aperture for the non-controlled tracks*
$TD.AperImpedance*%
%ADD10C,0.15000*
%ADD11C,0.2*%
X700000D01*
X500000Y120000D02*
X700000D01*
M02*
G75*
%LPD*%
G04 Standard tracks*
D10*
X7664999Y3689998D02*
X8394995D01*
X8439999Y3734999D01*
X9369999D01*
G04 Two Impedance controlled tracks*
D101*
X500000Y100000D02*
```

Note that it is possible to add attributes for the same <name> on an unlimited number of layers to handle more complex impedance structures. Here are two examples, images courtesy Polar Instruments Ltd.):



Suppose the name of the structure is Ex1. Then files with the top and the bottom planes will contain %TA.AperImpedance,Plane,Ex1*% and the file with the track file%TA.AperImpedance,Track,Ex1*%. What is top and bottom is defined by the layer structure.

Here is another example with structure name Ex2:



Both file with the top and bottom plane will contain %TA.AperImpedance,Plane,Ex2*% and both files with the tracks will contain %TA.AperImpedance,Track,Ex1*%.

2.2 Negative plane layers

The problem with negative copper planes also appear here. The issue is that there is no object in the Gerber file that represents the copper pour. The copper pour is defined implicitly and only appears when the image is converted to positive. One consequence is that it is not possible to specify how close the copper plane comes to the PCB profile.

Another consequence is that the normal method to attach attributes fail for the implicit copper pour. The attributes in the dictionary are attached to an aperture when it defined by the %AD command. Here there is no %AD. We need a special convention to attach attributes to the

Here is how it works: the aperture attributes then in the aperture dictionary are attached to the implicit copper pour when it is implicitly defined by the %.FilePolarity,Negative*%.

Example:

```
G04 Define a negative layer as the impedance reference plane*
%FSLAX35Y35*%
%MOMM*%
%TF.FileFunction,Copper,L4,Bot,Signal*%
%TA.AperImpedance,Plane,ENCX24J600*%
%TF.FilePolarity,Negative*%
%TF.Part,Single*%
%TA.AperFunction,Conductor*%
%ADD10C,10*%
…
```

Of course this is rather artificial. The way to avoid this is simple: express copper layers in positive. Then there are no problems.

3 **Revisions**

Rev 2016.07 Initial version, created by Karel Tavernier and Sylvia Liemer triggered by a request by Carsten Kindler and Muhammad Afzal.

Rev 2016.08 Minor corrections. Clarifications triggered by remarks from Richard Attrill.

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