

# Process & Capability Manual

(Vol. 12-2015)



## 1 CHAPTER OVERVIEW

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## 2 MICROCI RTEC – A SHORT PROFILE

### 2.1 Who we are

Microcirtec is one of the leading independent companies in the PCB industry of Germany, situated in Krefeld, a 25 min. drive away from the Duesseldorf International Airport. Constantly family owned, Microcirtec`s dedicated staff grew slowly but steadily to 90 colleagues - strongly attached to the industrial tradition of the Ruhr area. Powered by one of the most modern production facilities in a charming historical industrial complex of 297.000 sqf we are capable to produce more than 1 million sqf of PCB`s per year.

### 2.2 Objectives & markets

Our main business activity is focused on the production of Multilayer boards up to twelve layers and double sided PCBs. In the chapters below we provide you with the required in-house tolerance guidelines to ensure quality manufacturing of your printed circuit boards.

A very successful service we provide since the beginning of 2003 is our RAPID MASS PRODUCTION System (RMP) that is unrivaled in our industry. It is an express production service for middle and volume quantities. The main features are:

|                                      | RMP    | normal cycle time |
|--------------------------------------|--------|-------------------|
| Standard* single/double sided boards | 3 days | ~ 12 wd           |
| Standard* Multilayer boards          | 4 days | ~ 15 wd           |

\* Standard = 1 – 4 layer PCB in Hot Air Leveling Technology, soldermask, material FR 4, conventional drilling techniques, single sided silk screen printing. Additional time necessary if other features requested.

Further more our company is known for its intense partnership with our customers and an excellent service that starts with the technical support and ends up at the integration in our customer`s supply chain management. How we handle our customer`s unique specifications or exceptions is what sets us apart.

### 2.3 Declaration of quality

Since we are not a broker, all of our boards are manufactured in our german facility with a broad range of advanced capabilities for high reliability, precision, and powerful PCB performance.

To achieve a maximum of quality we have to understand precisely the needs of our customers in order to transform them in products they really need. More than this: The results must be better than those of our competitors, therefore we are reaching for

- Superiority in technical and functional quality of the product
- Superiority in technical and economical support
- Superiority in delivery on time
- Superiority in the ability to produce with a maximum of efficiency and yield to offer our clients the most reasonable prices

## **3 PRODUCTION DATA & TRANSMISSION**

### **3.1 Production data requirements**

Our professionally trained CAM engineers assure a seamless transition of your engineering data to the manufacturing floor. Following data formats could be supplied if you want to place an order

Extended Gerber 274X  
Gerber (RS 274)  
Barco DPF  
ODB++

Mechanical drawings might be in HPGL or DXF format

Customer specifications – technical and commercial!

If you are unable to use an output file in the described data formats please contact our artwork department or sales engineer.

### **3.2 Data transmission**

The most comfortable way to send your data is by Email. It is advisable to compress them as a „zip file“ (pkzip, arj, lharc or winzip are also accepted). It prevents information from getting lost. Make sure that your data are easily recognisable, i.e. put all data of one type in one zip file. To prevent the inclusion of viruses, do not use 'self-extracting' compression software. Before sending your E-mail, please indicate the name of the zip file in the message section. Do not forget to send your commercial order (indicating the zip file name) by E-mail or fax.

### **3.3 Design rule check**

All CAD data supplied to us are checked using a standard design rule check and customized DFM-functions, which has been drawn up in accordance with the required IPC guidelines, our capability matrix and customer's engineers. If you have any questions regarding this issue, please contact the head of our pre-production office, Mr. Vornholt. Should the CAD data prove not to be suitable for production, the person responsible for the data will be contacted by the pre-production engineer dealing with the order.

### **3.4 Order confirmation**

After the clearance of all technical and commercial details, an order confirmation is sent to the customer. The order confirmation contains the following details (rough outline):

1. Basic technical data (dimensions of pcb; type of multilayer construction etc.)
2. Basic commercial data (ordered quantities; delivery time; pricing etc.)
3. Electrically tested or not electrically tested
4. Terms of delivery
5. Terms of payment.
6. Reference to our Terms of Trade in the Internet

When the order confirmation is completed, the preparation of the production process is finished and production will be started.

## 4 QUALITY

### 4.1 Quality Standards

All boards are produced according to the standard IPC-A-600 Class 2 or class 3, if shown separately both in the procurement documents and in our order confirmation. Following standards are also in the range of our production capabilities:

PERFAG 1  
PERFAG 2  
PERFAG 3  
IPC-SM-840  
IPC-R-700  
IPC-A-600  
IPC-6012  
IPC-2221

### 4.2 Quality procedures

Microcirtec follows the standards of DIN/ISO 9001. Production parameters, conditions of production and raw materials are evaluated and registered by the use of calibrated measuring equipment.

#### non-destructive testing

Automatic and optical inspection routines follow the guidelines of IPC-A 600, class 2. Specific inspection procedures can be adapted to other specifications on demand.

#### destructive testing

Microsection to ascertain plating precipitation and surface protection thickness  
plating adhesion tests  
Multilayer boards are submitted to regular and steady thermal shock tests

#### Documentation of parameters

- Production parameters
- time-stamps, involved staff members
- and quality linked results

are automatically documented and electronically recorded for at least 10 years.

### 4.3 Electrical testing

The final test procedure of a PCB is the electrical testing to detect cuts and shorts. Our engineers generate a test program defining a netlist of all start and ending points generated out of the gerber data of the customer. As a middle and high volume manufacturer we use a fixture testing system that simultaneously tests all nets against each other. The basic technology of fixture testing is, that conductive needles linked to the test machine are lead by a fixture to the test points of the PCB. The test result is then compared to the electrical netlist. A failure is detected if a net resistance is measured

- **bigger than 50 Ohm (cut)**
- **smaller 10 MOhm (short)**

Alternatively the electrical test can be performed by flying probe systems. Bare board testing involves using capacitance and resistance tests; each of our machines uses a combination of both.

Capacitance testing for a bare board involves testing for opens and shorts by "charging" a net or plane and then probing each net to measure the induced capacity. Inaccuracies occur with this method because of the inherent variability in producing circuit boards. However field measurement or field effect testing for shorts uses a very similar approach.

Resistance testing measures the resistance found in the net. As electric current flows through a conductor collisions between electrons and atoms interfere with the flow of the electrons. This is known as resistance and it's measured in ohms.

Rejected PCBs are separated, repaired and retested or finally rejected if repair is not feasible.

## 5 RANGE OF PRODUCTION FACILITIES

### 5.1 Laminates (base materials)

The following table includes the most common required laminates used in thicknesses from 0,50 mm to 3,2 mm. Further qualities are available on request, eg. CTI >400.

All properties available for material thickness above 0,5 mm

| Designation        | NEMA       | IPC-4101  | Tg C°      | CTE < Tg<br>ppm/K | CTE > Tg<br>ppm/K | Decomposition<br>Temperature C° | T260<br>min | T288<br>min | feature         |
|--------------------|------------|-----------|------------|-------------------|-------------------|---------------------------------|-------------|-------------|-----------------|
| epoxy-paper-glass  | CEM1       | 10        | 100        | -                 | -                 | -                               | -           | -           |                 |
| <b>epoxy-glass</b> | <b>FR4</b> | <b>21</b> | <b>135</b> | <b>70</b>         | <b>270</b>        | <b>310</b>                      | <b>20</b>   | <b>3</b>    | <b>standard</b> |
| epoxy-glass        | FR4        | 24        | 150        | 70                | 270               | 310                             | 20          | 3           | higher Tg       |
| epoxy-glass        | FR4        | 94        | 150-200    | 70                | 270               | 310                             | 20          | 3           | low halogen     |
| epoxy-glass        | FR4        | 99        | 150        | 45                | 240               | 325                             | 30          | 5           | therm. Filler   |
| epoxy-glass        | FR4        | 124       | 150        | 45                | 230               | 325                             | 30          | 5           | therm. Filler   |

**Thicknesses of copper foils (before plating):**

- 18  $\mu$
- 35  $\mu$
- 50  $\mu$
- 70  $\mu$
- 85  $\mu$
- 105  $\mu$

**Copper Clad Laminates** (\*Multilayer core material thickness is exclusive copper thickness)

| FR 4 in mm     |
|----------------|
| 0,10*          |
| 0,20*          |
| 0,25*          |
| 0,36*          |
| 0,41*          |
| 0,50*          |
| 0,71*          |
| 0,80           |
| 1,00           |
| 1,08*          |
| 1,55           |
| 2,00           |
| 2,40           |
| 3,00           |
| FR 4 CTI > 400 |
| 1,00           |
| 1,55           |
| CEM 1          |
| 1,00           |
| 1,55           |
| CEM 3          |
| 1,55           |

If other materials are requested please contact our customer service.

**Tolerances of bow and twist**

| Single Sided | Double Sided | Multilayer |
|--------------|--------------|------------|
| 1,5 %        | 1 %          | 1%         |

It has to be pointed out that the phenomenon of bow and twist strongly depends on the copper balance of the layout and/or build-up of a multilayer board. Especially if the PCB layout consists of unequally dispersed mass and line structures or the build-up of a multilayer is asymmetrical, twist and bow values within the mentioned tolerances are sometimes not feasible. In this case please contact our customer service to get advise.

## 5.2 Available production panel sizes

With the objective in mind to handle as little different panel formats as possible (less machine set ups and stock costs) and to avoid material waste, we apply a continuous review of the most used panel sizes with regard to the degree of utilization.

|              | Single sided boards  |            | Double sided boards  |            | 4-Layer boards<br>Standard build-up<br>MassLam |            | 4-Layer with more than<br>6 Prepregs and<br>6-Layer to 24 Layer<br>PinLam |            |
|--------------|----------------------|------------|----------------------|------------|--|------------|---|------------|
|              | Length               | Width      | Length               | Width      | Length   | Width      | Length  | Width      |
| Panel size 1 | <b>618</b>           | <b>512</b> | <b>614</b>           | <b>512</b> | <b>614</b>                                     | <b>512</b> | <b>600</b>  | <b>499</b> |
| Panel size 2 | <b>not available</b> |            | <b>584</b>           | <b>512</b> | <b>584</b>                                     | <b>512</b> | <b>not available</b>  |            |
| Panel size 3 | <b>584</b>           | <b>436</b> | <b>not available</b> |            | <b>not available</b>                           |            | <b>not available</b>  |            |

### Panel thickness

We accept a range of different board thicknesses irrespective of the number of layers. But be aware of the fact that due to the „exotic“ character of different thicknesses some of them need a longer lead time as they are not always on stock.

|                             | Standard (mm) | Special (mm) | Technical limit<br>single & double<br>sided boards | Technical limit<br>Multilayer |
|-----------------------------|---------------|--------------|--|-------------------------------|
| <b>Max. panel thickness</b> | 1,55          | 2,4          | 3,2  | 3,2                           |
| <b>Min. panel thickness</b> | 1,55          | 0,8          | 0,4  | 0,4                           |

### Maximum number of layers

Our multilayer production line is designed to manufacture up to 24 layers. The most applied build-ups are highlighted on our web-side in the topic „Technologies & Processes“.



## 5.3 Drilling

If different or tighter tolerances are required, please contact our customer service.

| Plated Through Holes                              | Standard        | Special         | Technical limit |
|---|-----------------|-----------------|-----------------|
| Min. drill size                                   | 0,35 mm         | 0,15 mm         | 0,10 mm         |
| Max. drilled hole size                            | 6,40 mm         | 6,40 mm         | 6,40 mm         |
| Min. spacing drill edge to drill edge*            | 0,20 mm         | 0,15 mm*        | 0,075 mm        |
| Min. spacing drill edge to track/Pad outer layer* | 0,20 mm         | 0,15 mm         | 0,075 mm        |
| Min. spacing drill edge to track/Pad inner layer* | 0,25 mm         | 0,20 mm*        | 0,10 mm         |
| Surface Hot Air Leveling                          |                 |                 |                 |
| Finished size $\leq$ 6,4 mm tolerance             | +0,10/- 0,05 mm | +0,09/- 0,06 mm | +0,08/- 0,05 mm |
| Finished size $>$ 6,4 mm routing tolerance        | + 0,14/-0,05 mm | + 0,10/-0,05 mm | +0,08/- 0,05 mm |
| Surface OSP or immersion Sn/Au/Ag                 |                 |                 |                 |
| Finished size $\leq$ 6,4 mm tolerance             | + 0,10 mm       | +0,05/- 0,05 mm | + 0,10 mm       |
| Finished size $>$ 6,4 mm routing tolerance        | + 0,12/-0,02 mm | +0,06/- 0,06 mm | + 0,10 mm       |

\*Please consider that a plated through hole should be drilled with an oversize of 150  $\mu$  to compensate the plating within the hole. E.g. if you wish a finished plated through hole size of 0,6 mm, the applied drill tool is 0,75 mm, unless otherwise tolerated.

| Not Plated Through Holes                         | Standard       | Special     | Technical limit |
|--|----------------|-------------|-----------------|
| Min. drill size                                  | 0,40 mm        | 0,20 mm     | 0,15 mm         |
| Max. drilled hole size                           | 6,40 mm        | 6,40 mm     | 6,40 mm         |
| Min. spacing drill edge to drill edge**          | 0,20 mm        | 0,15 mm     | 0,10 mm         |
| Min. spacing drill edge to track/Pad outer layer | 0,20 mm        | 0,15 mm     | 0,05 mm         |
| Min. spacing drill edge to track/Pad inner layer | 0,25 mm        | 0,20 mm     | 0,10 mm         |
| Finished size $\leq$ 2,0 mm tolerance            | +/- 0,05 mm    | +/- 0,03 mm | +/- 0,03 mm     |
| Finished size $\leq$ 6,4 mm tolerance            | + 0,1/-0,05 mm | +/- 0,05 mm | +/- 0,03 mm     |
| Finished size $>$ 6,4 mm routing tolerance       | + 0,1/-0,05 mm | +/- 0,06 mm | +/- 0,04 mm     |

\*\*depending on drill size

|                           |             |               |            |
|---------------------------|-------------|---------------|------------|
| <b>Offset PTH to NPTH</b> | +/- 0,20 mm | +/-0,07 mm*** | 0,05 mm*** |
|---------------------------|-------------|---------------|------------|

\*\*\*Provided that the drilling process is performed in one machine set up (tenting)

## 5.4 Plating and aspect ratio

The thickness of copper plating is a result of exposure time and amperage in the electrolytic plating process. Basically a deposit thickness of 20 to 25  $\mu$  of copper are plated during the process on surface and in hole. Plating of thicker copper is possible for e.g. if the board needs to meet IPC class 3.

| Copper clad laminate | Electrolytic copper plating | Final copper thickness |
|----------------------|-----------------------------|------------------------|
| 18 $\mu$             | ca. 20 $\mu$                | ca. 35 $\mu$           |
| 35 $\mu$             | ca. 20 $\mu$                | ca. 55 $\mu$           |
| 50 $\mu$             | ca. 20 $\mu$                | ca. 70 $\mu$           |
| 70 $\mu$             | ca. 20 $\mu$                | ca. 90 $\mu$           |
| 85 $\mu$             | ca. 20 $\mu$                | ca. 105 $\mu$          |
| 105 $\mu$            | ca. 20 $\mu$                | ca. 125 $\mu$          |

The capability of the electrolytic plating process is expressed in aspect ratio = maximum aspect ratio of board thickness/smallest drilled hole diameter that can be plated.

| Standard | Special | technical limit |
|----------|---------|-----------------|
| 6        | 8       | 10              |

## 5.5 Exposure

Our technical range of line structuring theoretically reaches the level of 50  $\mu$  track width due to collimated light exposure systems. But with regard to the restrictions of material quality and the copper balance of the PCB-design we have to distinguish three levels of capability: Standard, special and technical limit

### 5.5.1 final copper thickness 18 $\mu$

|                        | Standard ( $\mu$ )        |                           | Special ( $\mu$ )         |                           | Technical limit ( $\mu$ ) |                           |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|                        | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer |
| Track width            | 130                       | 130                       | 100                       | 100                       | 60                        | 80                        |
| Track to track spacing | 120                       | 120                       | 85                        | 85                        | 50                        | 60                        |
| Annular ring           | 150                       | 180                       | 100                       | 120                       | 50                        | 75                        |

### 5.5.2 final copper thickness 35 $\mu$

|                        | Standard ( $\mu$ )        |                           | Special ( $\mu$ )         |                           | Technical limit ( $\mu$ ) |                           |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|                        | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer |
| Track width            | 150                       | 150                       | 125                       | 125                       | 100                       | 100                       |
| Track to track spacing | 170                       | 170                       | 140                       | 150                       | 100                       | 115                       |
| Annular ring           | 200                       | 225                       | 150                       | 170                       | 100                       | 130                       |

### 5.5.3 final copper thickness 70 $\mu$

|                        | Standard ( $\mu$ )        |                           | Special ( $\mu$ )         |                           | Technical limit ( $\mu$ ) |                           |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|                        | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer |
| Track width            | 200                       | 200                       | 150                       | 150                       | 120                       | 130                       |
| Track to track spacing | 250                       | 300                       | 200                       | 250                       | 180                       | 220                       |
| Annular ring           | 250                       | 300                       | 200                       | 250                       | 150                       | 150                       |

### 5.5.4 final copper thickness 105 $\mu$

|                        | Standard ( $\mu$ )        |                           | Special ( $\mu$ )         |                           | Technical limit ( $\mu$ ) |                           |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|                        | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer |
| Track width            | 300                       | 300                       | 250                       | 250                       | 180                       | 180                       |
| Track to track spacing | 360                       | 360                       | 280                       | 280                       | 250                       | 250                       |
| Annular ring           | 300                       | 300                       | 250                       | 250                       | 200                       | 200                       |

### 5.5.5 final copper thickness 140 $\mu$

|                        | Standard ( $\mu$ )        |                           | Special ( $\mu$ )         |                           | Technical limit ( $\mu$ ) |                           |
|------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
|                        | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer | Outer layer / Inner Layer |
| Track width            | 350                       | 350                       | 300                       | 300                       | 250                       | 250                       |
| Track to track spacing | 400                       | 400                       | 360                       | 360                       | 320                       | 320                       |
| Annular ring           | 350                       | 350                       | 300                       | 300                       | 250                       | 250                       |

## 5.6 Soldermask (values refer only to green solder mask)

|                          | Standard ( $\mu$ ) | Special ( $\mu$ ) | Technical limit ( $\mu$ ) |
|--------------------------|--------------------|-------------------|---------------------------|
| Annular oversize of Pads | 70                 | 50                | 30                        |
| Minimum (mask) dam width | 80                 | 60                | 50                        |
| Min. SMD to SMD spacing* | 200                | 170               | 150                       |

\* Minimum spacing between Pads or SMD`s required to print a solder mask bridge

## 5.7 Metallic finishing techniques

|                                  | Thickness                   | characteristics          |
|----------------------------------|-----------------------------|--------------------------|
| Electrolytic copper              | 20 $\mu$ - 30 $\mu$         | depends on exposure time |
| Hot air leveling                 | 2 $\mu$ – 30 $\mu$          | leadfree                 |
| Electrolytic nickel/gold*        | 1 $\mu$ – 3 $\mu$ gold      | up to 8 $\mu$ nickel     |
| Immersion nickel/ (flash) gold*  | 0,05 $\mu$ – 0,1 $\mu$ gold | up to 8 $\mu$ nickel     |
| Immersion nickel/ (bond) gold*   | 0,3 $\mu$ gold              | up to 8 $\mu$ nickel     |
| Immersion chemical tin*          | 1 $\mu$                     | very high planarity      |
| Organic surface protection (OSP) | organic coating of copper   | ENTEK PLUS Cu - 106      |

## 5.8 Text printing, additional printing techniques

### Silk screen printing

|                             | Standard $\mu$ | Special $\mu$ | Technical limit $\mu$ |
|-----------------------------|----------------|---------------|-----------------------|
| Silk screen to Pads spacing | 300            | 250           | 200                   |
| Silk screen to PTH spacing  | 300            | 250           | 200                   |
| Line width                  | 200            | 175           | 140                   |
| Minimum size of letters     | 1250           | 1000          | 800                   |

### Carbon key pad printing

|                        | Standard ( $\mu$ ) | Special ( $\mu$ ) | Technical limit ( $\mu$ ) |
|------------------------|--------------------|-------------------|---------------------------|
| Track to track spacing | 500                | 400               | 400                       |
| Minimum track width    | 500                | 400               | 300                       |

### Peelable mask

|                               | Standard  | Special   | Technical limit |
|-------------------------------|-----------|-----------|-----------------|
| Max diameter of covered holes | 1,8 mm    | 2,0 mm    | 2,6*mm          |
| Thickness of peelable mask    | 300 $\mu$ | 400 $\mu$ | 500 $\mu$       |

\*coverage cannot be guaranteed

## 5.9 Contour machining

Outerline-Contouring is performed by routing or V-cutting.

These techniques allow contouring within the standard „DIN 7168 mittel“ (medium accuracy) and „fein“ (precise accuracy). Dependant on the size of the board following tolerances are given:

| Board size: |       |         | fine        | standard    |
|-------------|-------|---------|-------------|-------------|
| 0,5 mm      | up to | 6 mm    | +/- 0,05 mm | +/- 0,10 mm |
| 6 mm        | up to | 30 mm   | +/- 0,10 mm | +/- 0,20 mm |
| 30 mm       | up to | 120 mm  | +/- 0,15 mm | +/- 0,30 mm |
| 120 mm      | up to | 400 mm  | +/- 0,20 mm | +/- 0,50 mm |
| 400 mm      | up to | 1000 mm | +/- 0,30 mm | +/- 0,80 mm |
| 1000 mm     | up to | 2000 mm | +/- 0,50 mm | +/- 1,20 mm |

## 5.10 Offset drilling and routing

As a result of separate machine set-ups and the given Coefficient of Thermal Expansion (CTE) of the laminate a certain offset from the PTH-drill to the NPTH-drill or routing is inevitably, since the material has been exposed several times to thermal procedures like solder mask thermal curing, HAL etc.

|                                 | Standard $\mu$ | Special $\mu$ | Technical limit $\mu$ |
|---------------------------------|----------------|---------------|-----------------------|
| Offset PTH-drill to contouring* | +/- 200        | +/- 130       | +/- 50                |
| Offset layout to contouring     | +/- 200        | +/- 130       | +/- 50                |

## 5.11 V-cutting (scoring)

Regarding V-cutting the same dimension tolerances are to be considered as for routing. Please pay attention to the fact that a certain circuit-free space depending on material thickness must be available around the outlines.

E.g. using material of 1,5 mm thickness by considering a dimension tolerance of +/- 0,2 mm tracks/pads etc. must have a spacing around the outlines of 0,40 mm. If the dimension tolerance is required to be without plus values the applied minus tolerance has to be added to the respective circuit-free spacing.

| Material Thickness | circuit-free spacing at the outlines |
|--------------------|--------------------------------------|
| up to 1,00 mm      | 0,45 mm                              |
| 1,10 mm to 1,60 mm | 0,50 mm                              |
| 1,70 mm to 2,00 mm | 0,70 mm                              |
| 2,10 mm to 2,50 mm | 0,80 mm                              |
| 2,60 mm to 3,20 mm | 1,00 mm                              |