Design guidelines for microelectronics manufacturing
About BAE Systems

BAE Systems is a global defence, security and aerospace company delivering a full range of products and services for air, land and naval forces, as well as advanced electronics, security, information technology solutions and customer support services.

Mission Systems aims to be the dependable partner of choice proud to use its expertise in radar, torpedoes and naval command & information systems to give its UK and international customers the best in cost effective operational advantage from through-life partnerships in mission systems and services. It has proven capabilities in systems, software, hardware engineering, manufacturing, assembly, integration and test.

Manufacturing

Microwave and microelectronics
The microwave manufacturing facility has 30 years of expertise in producing highly demanding, complex microwave modules for avionics defence systems, missile seekers, decoy systems and phased array radar systems.

Our manufacturing team provides microwave technology from rapid prototyping through to high volume production. We work in close partnerships with our customers. Early design stages provide a design for manufacture capability that ensures a smooth transition into production. Our world-class microwave core capabilities and technologies include the following areas of expertise:

Substrate metallisation
Our facility includes a custom built vacuum sputtering station, capable of depositing the following metallisations, Nichrome, Gold, Copper, TiW, TaN, in addition to Copper, Nickel and Gold deposited by electroplating. To ensure product accuracy and quality, we have in-line ion beam etching and plasma cleaning stages.

Thin film machining
Our extensive experience in the machining of thin film materials includes Aluminium Oxide, Aluminium Nitride, Sapphire, Quartz and Copper clad materials such as Duroid and FR4. Our processes range from the surface grinding and lapping of material through to CNC 3D machining and a world class laser machining facility.
Photolith and etching
Our processes create track and gap widths down to a size of 20 μm with a tolerance of +/- 5 μm as part of our standard process using glass masks. Smaller features can be processed depending on customer requirements. Our pattern to profile accuracy is 25 μm and front to back is 50 μm. For rapid turn around of prototype circuits, we can process substrates using polyester film masks.

Microelectronic assembly
Our highly trained manual assembly personnel can carry out a range of component placement and fine wire bonding attachment techniques. This is complimented by automated assembly and fine wire bonding facilities.

Module assembly
Tested substrate assemblies are integrated into a sub assembly with the relevant PEC assemblies and connectors. We can continue integrating and testing sub assemblies up to sub system level if required by our customers.

Laser welding
Our YAG laser facility creates hermetic seals on connectors and lids in order to preserve the integrity of the fully tested modules.
Design guidelines for microelectronics manufacturing

Testing
Our highly professional test team is experienced in diagnostic test techniques and equipment used on products ranging from 500MHz through to 100GHz.

Test Solutions
We have an in-house test solutions design group. They are experienced in the design of both manual and automated test solutions using a range of mechanical and RF design tools. They design and build test equipment for external and internal customer products.

Manufacturing support
Our extensive inspection facilities include:
- 3D/2D dimensional measurement with automatic edge recognition with an accuracy of <0.5 μm and a repeatability of ~+/−1 μm.
- 4 point probe, sheet resistivity measurement.
- Non-destructive plating thickness measurement using XRF techniques.
- Surface metrology.
- Resistor probing.
- Metallisation adhesion testing.

Design guidelines around our core microwave processes
The following design guidelines, when used with our process engineers during the early stages of design activity, help our customers achieve the most cost-effective design solutions.

Design data
The CAE/CAD system accepts design data in various formats and is used to produce photomasks, NC machining data files etc. All CAD dimensions should be nominal. We then add any process factoring.

Design guidelines

Design data
Hard substrate based circuits

Thin Film processes

Mask design
Masks are designed in-house using single image circuit design data supplied by the customer.

Wherever possible, multiple image masks are produced.

Considerable cost savings can be realised by ensuring the individual substrate size is optimised for multiple imaging (See the “Ready Reckoner” on Page 15).

Circuit features are to be drawn as closed polygons or lines with a set width.

The design information for each layer should be specified individually.

Material

Alumina
The standard alumina material used is Coors ADS995. This is purchased in the as-fired condition at a thickness of ~1 mm and subsequently ground in house to the desired thickness.

Standard thicknesses and blank sizes:
- 0.635 mm x 104.14 mm x 104.14 mm.
- 0.508 mm x 104.14 mm x 104.14 mm.
- 0.254 mm x 50 mm x 50 mm.
- 0.127 mm x 50 mm x 50 mm *.
- Surface finish 0.15 - 0.2 μm.
- Bow (flatness) <0.127 mm per 25 mm length.
- Thickness tolerance +/- 25 μm.
- +/−12.5 μm for 0.127 mm thick mtl.

Aluminium Nitride
This material is purchased at the required size and thickness as specified by the design.

Quartz
Standard material is Sawyer’s Electronic Grade, single crystal z-cut quartz. This is purchased at a thickness of 0.25 mm and a maximum substrate size of 50 mm x 50 mm.

This material can be lapped in-house to a minimum thickness of 0.12 mm +/- 10 μm.

Note: This is not a complete list of materials that can be processed. Please discuss any different material requirements with the Process Engineering Department.

Metallisation

Adhesion/ Resistive layer
Sputtered Nichrome
Resistors should be designed working on a standard sheet resistivity of 80 Ohms/Sq. with a tolerance of +/-15%.

Close tolerance resistors can be obtained using trimming techniques, however this will increase production times and costs.

Conductor layers
The preferred conductor metallisation will vary depending on the circuit design and the subsequent assembly techniques that will be applied to the circuit.

Generally the following guidelines apply:
For circuits without integrated resistors, plated via or edge plating:
- Sputtered Nichrome: 80 Ohms/sq. +/-15%.
- Sputtered Gold: 6000 - 8000 Angstroms.
- Electroplated Gold: 3 μm minimum.

Metallisation schemes of this type are suitable if gold, fine wire and tape bonding assembly techniques are to be used.

If Tin/Lead soldering is required Nickel barrier pads can be selectively applied to either metallisation scheme.

Standard thickness range of Nickel pads:
- 5 to 15 μm.

The pads will be Gold plated to a maximum thickness of <1 μm to preserve solderability after short-term storage.

Nickel barriers must terminate a minimum of 100 μm from any integrated resistor.

For all other circuits:
- Sputtered Nichrome: 80 Ohms/sq. +/-15%.
- Sputtered Copper: 6000 - 8000 Angstroms.
- Electroplated Gold: 3 μm minimum.
Specific guidelines and tolerances

Conductor patterns
- Preferred minimum track width 20 μm.
- Preferred minimum gap width 20 μm.

Note: The above dimensions refer to an ‘off the shelf’ capable process, smaller Track and Gap widths can be processed but this has an effect on times and costs. Please speak to our process engineering department for specific requirements.
- Preferred minimum tolerance +/-5 μm.
- Conductor tracks should terminate 50 μm short of a post process machined edge.
- Pattern to profile registration: +/- 25 μm.
- Pattern to via registration: +/- 50 μm.
- Pattern to pattern alignment +/- 12.5 μm.
- Front to back pattern registration +/- 50 μm.

Resistor patterns
- Minimum resistor width 50 μm.
- Minimum resistor length 50 μm.

Resistor value tolerance
- (standard) +/-15%.
- (minimum) +/-5%.

* Resistors with a specified tolerance of +/- 5% will require trimming to value, however this will increase production times and costs.

A test resistor with a minimum length and width of 3 mm should be included on the circuit.

Mask features which are used to define resistors should over-lap connecting conductor tracks by a minimum of 50 μm at each end and should be inset (narrower) by a minimum of 25 μm at each edge.

Resistors should not be positioned within 0.25 mm of a laser-machined feature.

Conductive interconnection to ground
Metallised Via
The preferred method of producing a conductive interconnection between the “A” face circuitry and the “B” face is:
- Minimum land area around via 125 μm.
- Via to Via proximity ≥ Substrate thickness (via edge to via edge).
- Via to Edge proximity ≥ Substrate thickness (via edge to edge).

Alternative methods of obtaining a conductive interconnection between the “A” face circuitry and the “B” face are:
Half Via or Slotted Edge Wrap.
Straight edge wrap.

However, these methods can either inhibit or severely limit multiple imaging on a tile.
Please discuss any design requiring these methods with our Process Engineering Department.

Substrate profiling and post process machining
Straight portions of the overall substrate profile are machined using the dicing equipment which utilise a diamond-impregnated wheel.

The irregular portions of the substrate profile are formed using laser machining techniques.
Manufacturing will apply the offset required to account for the kerf widths of these processes.
It is good practice to apply a radius to laser machined corners of the substrate profile. Note: A radius is required for internal corners of the profile – 0.25 mm rad. minimum.

A diced substrate edge is the preferred edge at which to terminate a launch, as opposed to a laser-machined edge. This is performance related and does not affect producibility.

- Tolerance on diced and laser profiled: +/-25 μm.
- Shell out on diced edges: <75 μm.

Non-metallised via and slots are produced during post process laser machining.

The guidelines for these features are identical to those for metallised via (ignoring minimum land area around via.)

Exceptions:
- Minimum via diameter 0.08 mm (single pulse).
- Minimum via diameter 0.125 mm (interpolated cut).
- Minimum slot width 0.08 mm.
- A machined feature that is to contain a component should be of a size so that there is a minimum clearance between the component and all machined edges of 25 μm. This should apply when the machined feature is at its smallest and the component is at its largest i.e. accounting for tolerancing.
Print and etch processes

Mask design
Masks are designed in-house using single image circuit design data supplied by the customer. Wherever possible multiple image masks are produced.

Circuits with track and gap widths in excess of 125 μm can be produced using plastic film masks. In this instance the maximum substrate blank size is restricted to 250 mm x 250 mm.

In order to produce fine line circuits (line and track widths <125 μm) it is necessary to use glass masks. In this instance the maximum substrate blank size is restricted to 104 mm x 104 mm.

Unlike thin film processing there is no standard size material blank.

Circuit features must be drawn as closed polygons or lines with a set width.

The design information for each layer should be specified individually.

Material
PTFE composite laminates
The standard material of this type used within the processing area is Rogers’ RT Duroid.

Glass/ Epoxy composite laminates
This is standard FR4 material used in the PCB industry.

Note: This is not a complete list of materials that can be processed. Please discuss any different material requirements with our Process Engineering Department.

The copper cladding for the above materials is usually used to define the circuitry and can be specified in a variety of thicknesses. This is usually expressed as Oz/Sq. foot or Gms/Sq./M, please see below for a guide on copper thickness. i.e.

$\frac{1}{4}$ oz = 77g/Sq/M = 8.75 μm thick.
$rac{1}{2}$ oz = 154g/Sq/M = 17.5 μm thick.
1 oz = 308g/Sq/M = 35 μm thick.

Electrodeposited copper is preferred due to its greater adhesion.

Conductor layers
As mentioned previously the conductor circuitry is formed from the copper cladding using “print and etch” techniques.

Two standard metallisation schemes (plating layers on top of the etched copper cladding) are in common usage:

1. Nickel 1-2 μm/Gold 3-5 μm.

This metallisation scheme is suitable if gold, fine wire and tape bonding assembly techniques are to be used.

2. Gold <1.25 μm.

This metallisation scheme is suitable if Tin/Lead soldering is required.

Please note that soldering is a non-preferred assembly technique.

As these layers are applied using electroplating techniques after defining the circuitry it is essential that all isolated area are designed so as to be joined by a thin copper cladding interconnect to a plating bar. These interconnects will be mechanically removed after plating.

Note: Placing the interconnect in an area of the substrate so that it will be removed during any subsequent machining process is the preferred option.

Conductor tracks should terminate 50 μm short of a post process machined edge.

Pattern to profile registration: +/- 25 μm.
Pattern to via registration: +/- 50 μm.
Pattern to pattern alignment: +/- 12.5 μm.
Front to back pattern registration: +/- 50 μm.

Specific guidelines and tolerances
Conductor patterns
Minimum geometric dimensions and tolerances for the various copper cladding thicknesses can be seen below.

<table>
<thead>
<tr>
<th>Copper Weight</th>
<th>Copper Thickness</th>
<th>Minimum Geometric Dimensions</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{1}{4}$ oz</td>
<td>4 μm</td>
<td>35 μm</td>
<td>+/- 15 μm</td>
</tr>
<tr>
<td>$\frac{1}{2}$ oz</td>
<td>8 μm</td>
<td>50 μm</td>
<td>+/- 20 μm</td>
</tr>
<tr>
<td>1 oz</td>
<td>17 μm</td>
<td>50 μm</td>
<td>+/- 25 μm</td>
</tr>
<tr>
<td>1 oz</td>
<td>35 μm</td>
<td>75 μm</td>
<td>+/- 25 μm</td>
</tr>
</tbody>
</table>
Conductive interconnection to ground

**Metallised Via**

The preferred method of producing a conductive interconnection between the “A” face circuitry and the “B” face (generally the ground plane) is to use a metallised via.

BAE Systems produce metallised via using novel plasma processing techniques.

Substrate profiling and post process machining

Profiling of the substrates is achieved using dicing, routing or laser machining techniques.

Note: The CO2 laser beam will not cut through the copper cladding.

If required thick metal backed circuits can be manufactured using conventional high speed machining equipment to include pockets, plain and tapped holes etc.

Tolerance on profile dimensions:
- Minimum: +/-25 μm.
- Preferred: +/-50 μm.

Tolerance on machined pocket dimensions:
- Minimum: +/-25 μm.
- Preferred: +/-50 μm.

Surface finish:
- Minimum: 0.6 μm RA.

Plating finishes on metal backing

- Brass backing
  - 3.5 μm Gold (bondable)
  - 2.25 μm Gold (solderable).
- Aluminium backing
  - 7.9 μm Nickel/2-3 μm Gold.

---

<table>
<thead>
<tr>
<th>Width</th>
<th>5</th>
<th>5.1</th>
<th>5.4</th>
<th>5.7</th>
<th>6.1</th>
<th>6.5</th>
<th>7</th>
<th>7.6</th>
<th>8.2</th>
<th>9</th>
<th>9.9</th>
<th>11</th>
<th>12.5</th>
<th>14.3</th>
<th>16.7</th>
<th>20.1</th>
<th>25.2</th>
<th>33.7</th>
<th>50.6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400</td>
<td>380</td>
<td>360</td>
<td>340</td>
<td>320</td>
<td>300</td>
<td>290</td>
<td>260</td>
<td>240</td>
<td>220</td>
<td>200</td>
<td>180</td>
<td>160</td>
<td>140</td>
<td>120</td>
<td>100</td>
<td>80</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>380</td>
<td>361</td>
<td>342</td>
<td>323</td>
<td>304</td>
<td>285</td>
<td>266</td>
<td>247</td>
<td>228</td>
<td>209</td>
<td>190</td>
<td>171</td>
<td>152</td>
<td>133</td>
<td>114</td>
<td>95</td>
<td>76</td>
<td>57</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>360</td>
<td>342</td>
<td>324</td>
<td>306</td>
<td>288</td>
<td>270</td>
<td>252</td>
<td>234</td>
<td>216</td>
<td>198</td>
<td>180</td>
<td>162</td>
<td>144</td>
<td>128</td>
<td>108</td>
<td>90</td>
<td>72</td>
<td>54</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>340</td>
<td>323</td>
<td>306</td>
<td>289</td>
<td>272</td>
<td>255</td>
<td>238</td>
<td>221</td>
<td>204</td>
<td>187</td>
<td>170</td>
<td>153</td>
<td>136</td>
<td>119</td>
<td>102</td>
<td>85</td>
<td>68</td>
<td>51</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>320</td>
<td>304</td>
<td>288</td>
<td>272</td>
<td>256</td>
<td>240</td>
<td>224</td>
<td>208</td>
<td>192</td>
<td>176</td>
<td>160</td>
<td>144</td>
<td>128</td>
<td>112</td>
<td>96</td>
<td>80</td>
<td>64</td>
<td>48</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>305</td>
<td>285</td>
<td>270</td>
<td>255</td>
<td>240</td>
<td>225</td>
<td>210</td>
<td>195</td>
<td>180</td>
<td>165</td>
<td>150</td>
<td>135</td>
<td>120</td>
<td>105</td>
<td>90</td>
<td>75</td>
<td>60</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>280</td>
<td>266</td>
<td>252</td>
<td>238</td>
<td>224</td>
<td>210</td>
<td>196</td>
<td>182</td>
<td>168</td>
<td>154</td>
<td>140</td>
<td>126</td>
<td>112</td>
<td>98</td>
<td>84</td>
<td>70</td>
<td>56</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>260</td>
<td>247</td>
<td>234</td>
<td>221</td>
<td>208</td>
<td>195</td>
<td>182</td>
<td>169</td>
<td>156</td>
<td>143</td>
<td>130</td>
<td>117</td>
<td>104</td>
<td>91</td>
<td>78</td>
<td>65</td>
<td>52</td>
<td>39</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>240</td>
<td>228</td>
<td>216</td>
<td>204</td>
<td>192</td>
<td>180</td>
<td>168</td>
<td>156</td>
<td>144</td>
<td>132</td>
<td>120</td>
<td>108</td>
<td>96</td>
<td>84</td>
<td>72</td>
<td>60</td>
<td>48</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>220</td>
<td>209</td>
<td>198</td>
<td>187</td>
<td>176</td>
<td>165</td>
<td>154</td>
<td>143</td>
<td>132</td>
<td>121</td>
<td>110</td>
<td>99</td>
<td>88</td>
<td>77</td>
<td>66</td>
<td>55</td>
<td>44</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>190</td>
<td>180</td>
<td>170</td>
<td>160</td>
<td>150</td>
<td>140</td>
<td>130</td>
<td>120</td>
<td>110</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td>171</td>
<td>162</td>
<td>153</td>
<td>144</td>
<td>135</td>
<td>126</td>
<td>117</td>
<td>108</td>
<td>99</td>
<td>89</td>
<td>81</td>
<td>72</td>
<td>63</td>
<td>54</td>
<td>45</td>
<td>36</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>152</td>
<td>144</td>
<td>136</td>
<td>128</td>
<td>120</td>
<td>112</td>
<td>104</td>
<td>96</td>
<td>88</td>
<td>80</td>
<td>72</td>
<td>64</td>
<td>56</td>
<td>48</td>
<td>40</td>
<td>32</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>133</td>
<td>126</td>
<td>119</td>
<td>112</td>
<td>105</td>
<td>98</td>
<td>91</td>
<td>84</td>
<td>77</td>
<td>70</td>
<td>63</td>
<td>56</td>
<td>49</td>
<td>42</td>
<td>35</td>
<td>28</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>114</td>
<td>108</td>
<td>102</td>
<td>96</td>
<td>90</td>
<td>84</td>
<td>78</td>
<td>72</td>
<td>66</td>
<td>60</td>
<td>54</td>
<td>48</td>
<td>42</td>
<td>36</td>
<td>30</td>
<td>24</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>95</td>
<td>90</td>
<td>85</td>
<td>80</td>
<td>75</td>
<td>70</td>
<td>65</td>
<td>60</td>
<td>55</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>76</td>
<td>72</td>
<td>68</td>
<td>64</td>
<td>60</td>
<td>56</td>
<td>52</td>
<td>48</td>
<td>44</td>
<td>40</td>
<td>36</td>
<td>32</td>
<td>28</td>
<td>24</td>
<td>20</td>
<td>16</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>57</td>
<td>54</td>
<td>51</td>
<td>48</td>
<td>45</td>
<td>42</td>
<td>39</td>
<td>36</td>
<td>33</td>
<td>30</td>
<td>27</td>
<td>24</td>
<td>21</td>
<td>18</td>
<td>15</td>
<td>12</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>38</td>
<td>36</td>
<td>34</td>
<td>32</td>
<td>30</td>
<td>28</td>
<td>26</td>
<td>24</td>
<td>22</td>
<td>20</td>
<td>18</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

"Ready Reckoner" - Optimum substrate sizes

For optimisation of substrate sizes. Choose the next higher number for both width and length; where the lines join is the number of substrates that can be made on a standard 104 mm x 104 mm substrate (including saw kerf allowance).
Design guidelines

Design guidelines - Conductor patterns

Note: All alignment tolerances are a preferred minimum and apply in both the X and Y-axis.

Design guidelines - Interconnection and machining
Design guidelines - Resistor patterns

- Length 50 μm Min.
- Width 50 μm Min.
- Conductor to Resistor Pad Overlap 50 μm Min.
- Mask Resistor Pad Overlap 50 μm Min.
- Laser Machined Via
- Min. Distance between Resistor and Laser Machined Feature 250 μm.

Resistor Values
Standard Tol. +/- 15%
Min. Tol. +/- 5%

Design guidelines - Nichrome/Gold metallisation scheme

- Gold 3 μm Min.
- Conductor
- Substrate
- Nichrome
- 80 Ohms/Sq +/- 15%

(For substrates with no integrated resistors, plated via or edge plating.)
Design guidelines - Nichrome/ Copper/ Gold metallisation scheme

(For substrates with Integrated Resistors, Plated Via or Edge Plating).

Design guidelines - Nickel barrier mask design

Blue area represents opaque area of mask. Transparent area defines borders of Nickel barrier (Note: Nickel barrier pad is 15 μm bigger in both axis than the underlying conductor).
Design guidelines - Nickel barrier metallisation scheme

(Note: Nickel barrier pad can be applied to both NiCr/Au and NiCr/Cu/Au metallisation schemes).

Design guidelines - laser welding modules

The maximum module size that can be accommodated is L300 mm W300 mm H250 mm.

For aluminium packages, the typical lid thickness is 0.8 mm, locally reduced to 0.5 mm for stake welding.

Fillet weld

This method allows the lid to sit on top of the box, covering the cavity by at least twice the thickness of the lid all round and allowing at least 1 mm spacing between box lid and outer profile of the box to enable the weld to flow to the edge of the package.

The preferred aluminium alloys are: lids 4047A, housings 6082.

We also have some experience in welding Kovar, stainless steel and copper.
Hybrid weld
With this configuration the lid partially sits in a recess in the housing, typically 0.3 mm for a 0.8 mm thick lid. The corners may need to have radii (or housings relieved to accommodate square corners), but tolerances are not critical; gaps up to 0.5 mm will be covered by the weld fillet. Larger gaps will result in a normal fillet type weld.

Stake weld
This method allows the lid to cover the entire box and no close tolerances are required. However, it is recommended that the contact area of the lid and the package face should not be less than 2 mm.

 Butt weld
This method allows for the lid to sit in a machined recess flush with the surface of the box. The tolerance between lid profile and box recess must not exceed a maximum of 0.05 mm total clearance.

Butt weld illustrates the tolerances for this method, which are critical for ensuring a proper fit and sealing of the lid to the box.

Stake weld illustrates the contact area recommended for this method, ensuring a secure seal.

Design guidelines – CO2 laser profiling
- Aspect ratio no greater than 2:1.
- Maximum size 250 mm x 250 mm.
- Thicknesses from 0.125 mm to 10 mm dependent upon material.
- Positional accuracy ± 25 μm.

Machinable materials include:
Alumina, alumina nitride, sapphire, RT Duroid, quartz, silicon, Kovar, Ablefilm, titanium, steel & metal matrix composites.
Bonding and assembly

Pin bonding
Pin length to be maximum 2x pin diameter to alleviate resonance whilst bonding.

Where cropped to length, pins to be lapped flat and square.

Gold plating to be 3-5 μm soft gold.

Plinth bonding
Where ground bonding to plinths is required, sufficient space to allow bonding wedge access, without encroachment onto area of resin bleed from the epoxy, or the back of wedge fouling the aperture.

Gold plating to be 3-5 μm soft gold.

Diode bonding
Pin diode bond pads to be minimum 50 μm diameter.

Where diodes are required to be stitch bonded, loops will be a minimum 0.7 mm long to allow the back of the wedge access without fouling the diode.

Auto bonding
Alignment markers (fiducials) to be patterned onto substrate to allow for alignment. Ideally these should be defined corners or cross marker

Components to be rotated such that the bond orientation will not short or cause potential damage to active area of device.

Wedge bonding
For fine wire bonding the receiving bond pad dimensions should be a minimum of 3 x the wire diameter.

The bond pad should have 3 x the fine wire diameter clearance around its periphery.

For tape bonding:
Tapes <125 μm in width:
- The bond pad should be 2 x the tape width.
- The bond pad should have 2 x the tape width clearance around its periphery.
Tapes >125 μm in width:
- The bond pad can be of equal size to the tape width.
- The bond pad should have 250 μm clearance around its periphery.

A minimum access angle of 30 degrees is required when placing a bond as seen below.

Component attachment
Plinths designed to have minimum 25 μm clearance from all internal walls of substrate cut out.

Component face & Bonding face of plinths to have parallel and flatness tolerances of 20 μm. Surface finish is normally 0.8 μm.

Substrate to carrier assembly
CF3350 Film Adhesive preferred bonding medium for use as pre-forms.

Automated assembly
Component sizes - preferred minimum size of 0.4 mm x 0.4 mm.

MMIC’s - air bridges require specialised collet pick up tools.

Fiducials - Preferred method uses 4 off circular fiducials in alignment with each other in “x” and “y” at the extremities of each substrate.

Substrate size - maximum 200 mm x 200 mm.

Pockets and profiles - can be up to 25 mm deep, however this would need a diameter clearance of 25 mm around the tool holder.

Waffles - if more than 40 types of components per substrate are required, this would require populating with an additional program.

For general enquiries or to speak to our Engineering department contact:

Steve Pook
BAE Systems Mission Systems
Broad Oak, The Airport, Portsmouth
Hampshire PO3 5PQ, United Kingdom
Telephone +44 (0) 2392 22 6756
Mobile +44(0)780 1718848
email steve.pook@baesystems.com