
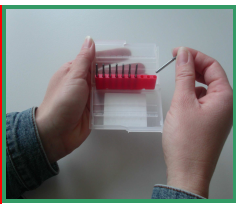


Impacts	Description	⇒ GCT's recommendation
Base material	Usually, the type of base material is pre-determined and can be influenced rarely. A good trade-off between quality and costs is achieved by optimal tool selection and by adjusting machining parameters to the required applications.	⇒ GCT parameter recommendation for different applications please visit our website www.gctool.com
Drilling	Straight type drills with different helix angles as well as undercut drills in some cases are used for machining of PCBs. Helix angles $\geq 38^\circ$ have a considerable advantage with regard to chip removal and better surface quality.	⇒ GCT products for different applications please visit our website www.gctool.com
Routing	Spiral- or diamond patterned routers are used for machining inner and outer contours of PCBs. Spiral cut routers have considerable advantages with regard to dimensional accuracy and better surface quality. For depth routing as well as for machining IMS and non-ferrous metals two flute end mill are required.	⇒ GCT products for different applications please visit our website www.gctool.com
Handling	The tool handling has a tremendous impact on the dimensional accuracy. The risk of damaging the cutting edges is very high. Therefore, the tools have to be put from the manufacturer's packaging into the tool cassette directly.	⇒ GCT recommend ordering routers with set rings from your supplier, if required. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p style="color: red;">wrong</p>  </div> <div style="text-align: center;"> <p style="color: green;">correct</p>  </div> </div>
Machine	The machines have to fulfil the quality demands. The regular maintenance of the machines according to manufacturer's specification is important for the process capability and the quality. Thus, the life cycles of spindles and collets as well as the tool life are positively influenced. The run-out of collets has to be checked regularly. PCBs are additionally fixed on the machine table by pressure feet. Smallest and sturdy pressure foot inserts are ideal for drilling, whereas brush inserts with short and strong plastic bristles are ideal for routing.	⇒ GCT recommend - run-out of drilling spindle: $\leq 10 \mu\text{m}$ - run-out of routing spindle: $\leq 25 \mu\text{m}$ - daily cleaning of collets at routing machines - routing spindle speed $\geq 80000 \text{ 1/min}$ - 1.00 - 2.00 mm distance between tip of the tool and pressure foot
Extraction	The extraction efficiency has a great influence on the quality and the tool life. Only if the suction output is measured at the pressure foot directly, the value is comparable. A central extraction unit is preferred.	⇒ GCT recommend $\geq 50 \text{ mbar}$ measured at pressure foot

Impacts	Description	⇒ GCT's recommendation
Parameter	Important factors are spindle speed, feed rate and return stroke. All criteria depend on the tool diameter and base material.	⇒ GCT parameter recommendation for different applications please visit our website www.gctool.com
Pre-drilling	Pre-drilling is recommended for standard geometry drills > shank-Ø. If you use GCT drills > shank-Ø, pre-drilling is mostly not necessary (depending on spindle). GCT drills with tapered diameter and thinned web reduce forces of Z-axis to < 50% compared to standard geometry drills. Pre-drilling at the beginning and end of the routing path increases the accuracy, cleanness and the tool life of routers. Infeed can be increased by factor 4 if you pre-drill.	⇒ GCT recommend - type 1534 if drill-Ø > shank-Ø - for drilling process: pre-drilling with 15 - 20 % of the drill-Ø, if necessary - for routing process: pre-drilling with drill-Ø = router-Ø
Routing direction	Surface quality, dimensional accuracy and router tool life are influenced by the routing direction.	⇒ GCT recommend routing outer contours anticlockwise and inner contours clockwise.
Working length / Stack height	Working length and stack height influence the productivity, the dimensional accuracy as well as the parameter. The unused flute length has to be considered for the chip removal and depth into the backup material. Working length = stack height + entry material + depth into the backup material.	⇒ GCT recommendation for working length and stack height please visit our website www.gctool.com
Tool life	The tool life is influenced by: - base material - tool - diameter - flute length - parameter - stack height - periphery of machinery - extraction - quality demands	⇒ GCT recommend - diamond coated drills: tool life increases by factor 20 - diamond coated routers: tool life increases by factor 12 - drilling and routing IMS and non-ferrous metals: feed rate increases by factor 3-4 compared to uncoated tools
Entry material / Backup material	Entry materials increase the drilling accuracy, reduce burr formation and protect PCBs in the machining process. The process capability for drill-Ø < 0.30 mm and very difficult applications is increased if entry materials with lubricant are used. Backup materials reduce burr formation and are mostly used on both sides.	⇒ GCT recommendation - hard and thin entry material without surface defects - coated backup material with hard and flat surface and minimal thickness tolerance
Tool deflection / Diameter compensation	There are always dimensional deviations between the top and bottom panel. They are influenced by the tool diameter, flute length, parameter, base material, entry material and stack height. When routing outer contours, the router will be pulled into the material, i.e. the bottom panel will become smaller than the top one. The diameter compensation is a mean for the correction of different impacts on the routing process. Router run-out, abrasion and influences on the system can be considered and corrected by means of the diameter compensation.	