LPKF Laser & Electronics

General ProtoMat and ProtoLaser Substrate Capabilities Guide






	ProtoMat E44	ProtoMat S64/S104		ProtoLaser H4	ProtoLaser S4	ProtoLaser U4	ProtoLaser R4
	40,000 rpm spindle	**60k and 100k rpm spindle motors**		**1064nm NIR fiber + mechanical drill and cut**	**532nm Green nanosecond**	**355nm UV nanosecond**	**515nm Green picosecond**
FR4 Details:							
FR4 ½ oz Cu	4 mil traces/6 mil spacing	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination	2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal
FR4 1oz Cu	6 mil trace/space	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	4 mil traces/23µm spacing; Hatch & Delamination	~3 mil traces/20µm spacing; Hatch & Delamination or Ablation removal	~2 mil traces/15µm spacing; Ablation removal only*
FR4 2oz Cu +	Not recommended	6 mil trace/space at 2oz 10 mil traces if above 2oz; dependent on End mill tooling used		Not recommended	~4 mil traces/50µm spacing ***LPKF Hatch & Delamination only at 2oz**	~3 mil trace/40µm space at 2oz. Cu ***Ablation removal only**	~3 mil trace/40µm space at 2oz Cu ***Ablation removal only**
FR4 Pocket Engraving	Not recommended; *limited with End Mill tools	Pocket depths of up to 8mm with 2.5D automated cut depth control		Not recommended	Not recommended	Bare material pocketing and remove material to next Cu layer; ~40µm wide recommended +Blind/buried vias	Bare material pocketing and remove material to next Cu layer; 30µm wide recommended +Blind/buried vias
FR4 Drilling/Cutting	6 mil drills Cut up to 3mm	6 mil drills Cut up to 3mm		Mechanical drill & cut up to 2mm thickness down to 6 mil drills	~75µm diameter + Drill & Cut up to 2mm thick	~50µm diameter + Drill & Cut up to ~2mm	~25µm diameter + Drill & Cut up to ~2mm

	ProtoMat E44	ProtoMat S64/S104		ProtoLaser H4	ProtoLaser S4	ProtoLaser U4	ProtoLaser R4
RF/MW Substrates:							
PTFE Woven up to 1oz (e.g. Taconic TLY-5, TLX)	4 mil traces/6 mil spacing	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination*	~2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal*	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal*
PTFE with ceramic or random glass fill up to 1oz (e.g. Rogers 5870™, 5880™, 6002™, 6010™)	4 mil traces/6 mil spacing; **~20 mil thickness or greater recommended for double sided. S104 recommended.**	4 mil traces/4 mil spacing; ***5 mil (0.125mm) thickness or greater for single sided. ~10 mil for double sided due to soft substrates and design dependent**		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination*	~2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal*	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal*
Hydrocarbon w/ Ceramic fill up to 1oz (e.g. Rogers 4003™, 4350B™, 4730™)	4 mil traces/6 mil spacing	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination*	~2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal*	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal*
Ceramic w/ Thermoset Resin up to 1oz (e.g. Rogers TMM®)	4 mil traces/6 mil spacing	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination*	~2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal*	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal*
PPE and PPO Blend Resin Substrate (e.g. Panasonic Megtron 6)	4 mil traces/6 mil spacing	4 mil traces/4 mil spacing		4 mil traces/50µm spacing; Hatch & Delamination	3 mil traces/23µm spacing; Hatch & Delamination*	~2 mil traces/20µm spacing; Hatch & Delamination or Ablation removal*	1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal*
Woven PTFE, Hydrocarbon or Ceramic filled Thermoset Resin **Pocket Engraving**	Not recommended	Pocket depth up to 8mm		Not recommended	Not recommended	Bare material pockets and remove material to next Cu layer +Blind/buried vias	Bare material pockets and remove material to next Cu layer +Blind/buried vias
Woven PTFE, Hydrocarbon or Ceramic filled Thermoset Resin **Drilling/Cutting**	6 mil diameter drills min Cut up to 1mm	6 mil diameter drills min Cut up to 2mm		Mechanical drill & cut up to 2mm thickness down to 6 mil drills	~75µm diameter + Drill & Cut up to 2mm thick	~50µm diameter + Drill & Cut up to ~2mm	~25µm diameter + Drill & Cut up to ~2mm

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Flex PCB Substrates:							
Flex DuPont™ Pyralux® TK, 12µm or 18µm (½ oz) Cu	Not recommended	Not recommended		4 mil traces/50µm spacing on Pyralux® TK single sided; Hatch & Delamination only	3 mil traces/2 mil spacing on Pyralux® TK double sided; 2 to 4 mil (50-100µm) material thickness double sided; Hatch & Delamination only	~2 mil traces/40µm spacing min. on Pyralux® TK double sided on 2 mil thick material; Hatch & Delamination only with TK	~1 mil traces/30µm spacing on Pyralux® TK; Hatch & Delamination processing only with TK.
Flex DuPont™ Pyralux® AP 8535R and 8565R; 18µm (½ oz) Cu	Not recommended	6 mil trace/space on Pyralux AP; single sided 5 mil thick substrate with End Mill tooling		Not recommended	Not recommended	~2 mil traces/20µm spacing; Hatch & Delamination possible but direct Ablation removal recommended on AP	~1 mil traces/15µm spacing; Hatch & Delamination possible but direct Ablation removal recommended on AP
Flex DuPont™ AG, AC, CG 18µm (½ oz) Cu	Not recommended	Not recommended		Not recommended	Not recommended	~2 mil traces/20µm spacing on Pyralux® AG and AC double sided on 2 mil thick material; Ablation removal needed	~1 mil traces/30µm spacing Hatch & Delamination or Thermal Cold ablation* Double sided 1 mil thick
Flex DuPont™ PET with ME614 Cu or Kapton with ~12µm Ag silver	Not recommended	Not recommended		Not recommended	Not recommended	~2 mil traces/40µm spacing; Ablation removal; 2 mil +recommended for double sided	30µm trace 30 µm spacing; Ablation removal; 2 mil +recommended for double sided
Datex Instruments Microclad™ Flex Poyimide	Not recommended	Not recommended		Not recommended	Not recommended	~3 mil traces/40µm spacing; Hatch & Delamination on 25µm (1 mil) thickness and greater for single sided. 2 mil thick material or greater recommended for double sided	~1 mil traces/30µm spacing; Hatch & Delamination or Ablation removal on 25µm (1 mil) thickness and greater for single sided. 2 mil thick material or greater recommended for double sided
PET 1 mil thick w/ 9µm Al	Not recommended	Not recommended		~3 mil traces/50µm spacing; Ablation removal only	Not recommended	Not Recommended	1 mil traces/15µm spacing; Hatch & Delamination or Thermal Cold ablation Double sided 1 mil thick
PET 1 mil thick w/ Cu; up to ~35µm	Not recommended	Not recommended		Not recommended	Not recommended	~2 mil traces/40µm spacing; Ablation removal only*	~1 mil traces/30µm spacing; Ablation removal only*
Stretchable Flex with Ag, Cu paste (e.g. DuPont™ Intexar™)	Not recommended	Not recommended		Not recommended	Not recommended	~3 mil traces/40µm spacing; Ablation removal only*	~1 mil traces/30µm spacing; Ablation removal only*
Pure CuFlon® PTFE	Not recommended	Not recommended		Not recommended	Not recommended	~3 mil traces/40µm spacing; Hatch & Delamination or Ablation removal* (Drilling or Cutting not possible with U4/355nm)	~1 mil traces/15µm spacing; Hatch & Delamination or Ablation removal* (Drilling and Cutting possible with R4 picosecond laser.
Flex Polyimide (Kapton®/Pyralux® AP) **Pocket Engraving**	Not recommended	Not recommended		Not recommended	Not recommended	Bare material pockets and remove material to next Cu layer +Blind/buried vias	Bare material pockets and remove material to next Cu layer +Blind/buried vias
Flex Polyimide (Kapton®/Pyralux® AP) **Drilling/Cutting**	6 mil drill dia. Cut up to 10 mil	6 mil drill dia. Cut up to 10 mil		Mechanical drill & cut up to 2mm thickness down to 6 mil drills	Drill & Cut 0.050mm (2 mil) holes in Kapton®/Pyralux® AP	Drill & Cut 0.035mm (~1.5mil) holes in Kapton®/Pyralux® AP	Drill & Cut 0.025mm (1 mil) holes in Kapton®/Pyralux® AP Kapton/Pyralux® AP, TK, AC, CG

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Fired/Unfired Ceramics trace/space:							
Fired ceramics Alumina (Al2O3) thin film	Not recommended	Not recommended		~3 mil traces/50µm spacing; Ablation removal only	~2 mil traces/23µm spacing; Ablation removal only	~1 mil traces/20µm spacing; Ablation removal only	~1 mil traces/15µm spacing; Ablation removal only
Fired ceramics Alumina (Al2O3) thick film	Not recommended	Not recommended		Not recommended	~2 mil traces/23µm spacing; Ablation removal only	~2 mil traces/20µm spacing; Ablation removal only	~1 mil traces/15µm spacing; Ablation removal only
Fired ceramics Alumina (Al2O3) DBC above 1oz	Not recommended	Not recommended		Not recommended	~3 mil traces/50µm spacing **Ablation removal only**	~3 mil traces/40µm spacing **Ablation removal only**	~2 mil traces/30µm spacing **Ablation removal only**
DuPont™ LTCC Green Tape™ unfired	Not recommended	Not recommended		Not recommended	~2 mil traces/23µm spacing **Ablation removal only**	~2 mil traces/20µm spacing **Ablation removal only**	~1 mil traces/40µm spacing **Ablation removal only**
DuPont™ LTCC Green Tape™ post-fired	Not recommended	Not recommended		3 mil traces/50µm spacing **Ablation removal only**	2 mil traces/23µm spacing **Ablation removal only**	2 mil traces/20µm spacing **Ablation removal only**	1 mil traces/40µm spacing **Ablation removal only**
Fired Ceramics, Al2O3, SiN, AlN Pocket Engraving	Not recommended	Not recommended		Not recommended	Not recommended	Bare material pocketing up to ~1mm depth	Bare material pocketing up to ~1mm depth
Fired Ceramics, Al2O3, SiN, AlN Drilling/Cutting	Not recommended	Not recommended		Al2O3 up to 0.5mm thick with laser drill and cutting *(U4 or R4 recommended)	Al2O3 or LTCC up to 1mm (slower than U4 or R4)	Al2O3 or LTCC up to ~2mm	Al2O3 or LTCC up to ~2mm
Cutting of Metals/Alloys:							
Cu, Ni, brass, Au, Ag Cutting	Not recommended	Up to 8mm max thickness		Not recommended; higher heat transfer reduces edge quality	Up to ~0.5 mm	Up to ~0.75 mm *clean edge quality	Up to ~0.75 mm *pristine edge quality
Cu, Ni, brass, Au, Ag Pocket Engraving	Not recommended	8mm max pocket depth		Not recommended	Not recommended	Pocket depth up to ~0.5mm *low heat effect and high level of control per laser pass	Pocket depth up to ~0.5mm *pristine quality and high level of control for cut depth per pass

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Glass Direct Laser Processing:							
Borofloat™ 33 and Mepax™ glass from SCHOTT (surface metal removal trace/space)	Not recommended	Not recommended		Not recommended	Surface metal etching of Cu, Au, Ag, ITO, TCO, ~25µm traces	Surface metal etch Cu, Au, Ag, ITO, TCO, HRC, LRC, etc. with traces down to ~15m	Surface metal etch Cu, Au, Ag, ITO, TCO, HRC, LRC, etc. with traces down to ~10µm
Borofloat™ 33 and Mepax™ glass from SCHOTT Drilling and Cutting	Not recommended	Not recommended		Not recommended	Not recommended	Not recommended	Up to ~1mm thickness; smaller holes below 10 mil (0.25mm) requires drilling from both sides)
Borofloat™ 33 and Mepax™ glass from SCHOTT Controlled Laser Channel Engraving	Not recommended	Not recommended		Not recommended	Not recommended	Not recommended	Max depth of ~0.75mm
Fused Silica drilling/cutting	Not recommended	Not recommended		Not recommended	Not recommended	Not recommended	Up to ~1mm thickness; smaller holes below 10 mil (0.25mm requires drilling from both sides)
Additional Applications:							
Stainless Steel/hard alloys **Drill & Cutting**	Not recommended	Not recommended		Not recommended	Up to ~0.25 mm (10 mil) *clean edge quality	Up to ~0.25 mm (10 mil) *higher edge quality	Up to ~0.25 mm (10 mil) *prisitne edge quality
Pure CuFlon® PTFE **Cut or Engrave**	Not recommended	Not recommended		Not recommended	Not recommended	Not recommended	Up to 1.5mm cutting Pocket engraving pristine quality & controllable depth

***Trace/Space limitations are subject to material/metal peel strength, substrate thickness, type & the laser settings applied by the operator. We recommend a substrate thickness of at least 5 mils for single sided mechancial milling and 10 mil thickness for double sided designs for rigid materials. Thinner materials can be processed on the ProtoLaser models and may be possible with the ProtoMat models if only isolation milling is needed on one side.**

The latest LPKF ProtoLaser models continue to provide advanced development capabilities for PCB prototyping, RF/MW/mmW applications and MEMS research. Controlled depth engraving and laser micromachining with the ProtoLaser U4 and ProtoLaser R4 models enable a vast range of research applications.

With the rapid laser etching speeds, on-demand production is possible on a wide range of applications. The LPKF CircuitPro software is included with each machine allowing for design import and machine operations in one platform. The operator can also adjust laser travel speed, pulse frequency, power and repetitions to dial in and save new "laser tools" within the software.

This document was created as a general guideline to help detail the differences between each LPKF ProtoLaser and capabilites on a variety of PCB substrates; specifications are subject to updating as new and additional materials are processed.

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We look forward to earning your business and if there are any questions, please do not hesitate to call.

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