

**TELEDYNE LABTECH**  
Everywhere you look™

## RF/Microwave PCB Manufacturing Capability

Offering RF & Microwave Value-Added  
Services for Demanding Applications



# RF/Microwave PCB Manufacturing Capability

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## Introduction



Teledyne Labtech is one of the world's leading manufacturers of complex, demanding RF/Microwave PCB printed circuit boards with an established pedigree, which spans more than 40 years. Providing specialist solutions for Military and challenging Commercial markets, Teledyne Labtech offers a wide range

of complementary RF/Microwave PCB capabilities. Through comprehensive technical support, our ability to meet prototype-to-volume production requirements, along with state-of-the-art testing facilities, means we've set new standards in the development, manufacturing and testing of RF/Microwave PCB's for demanding and critical applications.

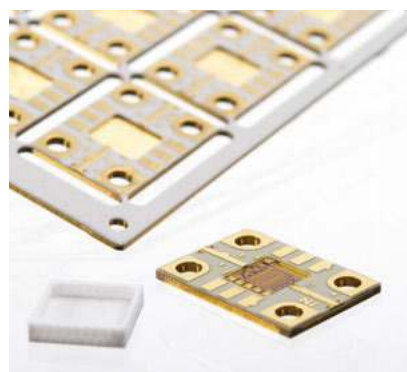
- Dedicated RF/Microwave PCB manufacturer
- Wire bondable surface finishes
- Embedded component capability
- Bonded Wave guide structures & components
- Large format capability
- Laser drilling, profiling and ablation to sub-layers
- Heavy metal machining capability
- Assembly and microwave testing to 40 GHz

### Metal-Backed RF/Microwave PCB's

- Pre-bonded laminates
- Post bonding of finished RF/Microwave PCB's to discrete carriers
- Conductive and non-conductive adhesives
- Plated thru hole capability to metal backing
- Aluminium, brass & copper
- Copper-invar-copper, copper moly copper and other exotic metal backings

### Precision Single Sided and Double Sided RF/Microwave PCB's

- Thin dielectrics
- MMIC Packages
- High tolerance capability



### Multilayer RF/Microwave PCB's

- PTFE, LCP and mixed Dielectric constructions including flexible substrates
- Blind, buried and sequential vias
- Metal core and metal backed structures
- Coins and copper filled vias for thermal management
- Ohmega Ply & Ticer Foil – planar resistor technology
- Embedded components
- Vacuum Press and Autoclave bonding capability
- Fusion bonding for PTFE and LCP substrates



## Materials

Teledyne Labtech has extensive experience using the full range of RF/Microwave PCB materials. These materials can be combined with multi-functional epoxy or high temperature laminates to construct multi-layer structures. Teledyne Labtech has full capability to process metal backed laminates and where these are not available from the supplier can be constructed in-house.

### Microwave Materials used Typical Dk's

- |                                 |       |
|---------------------------------|-------|
| • Random glass                  | 2.33  |
| • LCP                           | 2.90  |
| • Thermoset                     | 3.50  |
| • Woven glass & ceramic fillers | 6.00  |
| • PTFE with ceramic fillers     | 10.20 |



### Data Submittal

Email: [labtechsales@teledyne.com](mailto:labtechsales@teledyne.com)  
 Note, Zip files will need to be posted onto Teledyne Liquid files  
 FTP: <http://transfereast.teledyne.com>

### Data Formats

- RF/Microwave PCB design
- ODB++
  - Extended Gerber (RS-274x)
  - Autocad DWG/DXF

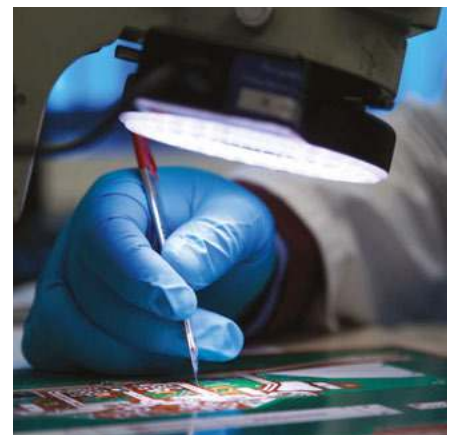
### Mechanical Design

- STP files
- Autocad DWG/DXF

## Board Dimensions

Maximum standard panel	457mm x 610mm	18" x 24"
Large format capability	254mm x 1800mm	10" x 70"
Bonded Antenna structures	Up to 500mm x 1800mm	20" x 70"
Minimum laminate thickness	0.025mm	0.001"
Maximum Board thickness	8mm	0.315"

Board thickness above 8mm can be manufactured although certain processes are not compatible with boards above this thickness.





## Circuit Feature Capability

### Imaging

#### Base foil thickness

	1/4oz 9 micron	1/2oz 18 micron	1oz 35 micron	2oz 70 micron
Minimum Track	50 $\mu$ m* 0.002"	75 $\mu$ m 0.003"	125 $\mu$ m 0.005"	150 $\mu$ m 0.006"
Minimum Gap	50 $\mu$ m* 0.002"	75 $\mu$ m 0.003"	125 $\mu$ m 0.005"	150 $\mu$ m 0.006"
Etch Tolerance Print & Etch	+/- 10 $\mu$ m 0.0004"	+/- 10 $\mu$ m 0.0004"	+/- 25 $\mu$ m 0.001"	+/- 40 $\mu$ m 0.0016"

\* Print & etch only, minimum 65 $\mu$ m 0.0025" for pattern plate process.

Values quoted are best possible without major yield impact.

Wherever possible tolerances should be relaxed and minimum features should only be used where necessary, not globally.

#### Pad - Drilled Hole Registration

Standard	+/- 50 $\mu$ m	+/- 0.002"
Technical	+/- 25 $\mu$ m	+/- 0.001"

#### Minimum Designed Annular Ring to Avoid Drill Breakout (Outer Layers)

Standard	100 $\mu$ m	0.004"
Technical	50 $\mu$ m	0.002"

Where required it is possible to plate hole barrels only to avoid pad build up on surface. This is not possible on holes below 0.30mm (0.012") drilled diameter.

#### Image Registration Side-Side

Standard	+/- 45 $\mu$ m	+/- 0.0018"
Technical	+/- 25 $\mu$ m	+/- 0.001"

PTFE laminates can stretch or shrink during the process cycle.

# Laser Capability

## Positional Accuracy

Feature – feature	+/-25µm	+/-0.001"
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## Laser Via

### Thru

Standard	200µm	0.008"
Technical	50µm	0.002"

### Blind

Standard	200µm	0.008"
Technical	100µm	0.004"

Maximum 1:1 aspect ratio on blind hole processing.

## Hole – Hole Spacing

Minimum	50µm	0.002"
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## Profiling

Internal radii	10µm	0.0004"
Dimensional Tolerance	+/-25µm	+/-0.001"
Alignment to circuit image	+/-25µm	+/-0.001"

## Ablation

### Dimensional Tolerance

X & Y Axis	+/-25µm	+/-0.001"
Z Axis	+/-10µm	+/-0.0004"

Laser ablation can be controlled to ablate material and thus expose buried circuit features, the minimum base copper on these should be 18 micron 1/2oz.

# Mechanical Drilling

## Maximum Aspect Ratio

(Board Thickness : Hole Diameter)

Standard	10:1
Technical	11:1
Metal Backed	10:1
Blind Holes	1:1

Aspect ratios in excess of the above could cause plating deposition issues. Note, limitations on drill sizes may impact the above ratios

## Minimum Drill Diameter

### Softboard & Multilayer

Standard	0.20mm	0.008"
Technical	0.10mm	0.004"

### Metal Backed

Standard	0.50mm	0.020"
Technical	0.30mm	0.012"

## Hole – Hole Spacing

Minimum	0.20mm	0.008"
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## Z Axis Control

Standard	+/-0.050mm	+/-0.002"
Technical	+/-0.025mm	+/-0.001"

## Hole Size Tolerance

### Plated

Standard	+/-0.10mm	+/-0.004"
Technical	+/-0.05mm	+/-0.002"

### Non-plated

Standard	+/-0.05mm	+/-0.002"
Technical	+/-0.02mm	+/-0.0008"



# Mechanical Machining

## Profile Feature Tolerance

Standard	$\pm 0.050\text{mm}$	$\pm 0.002''$
Technical	$\pm 0.030\text{mm}$	$\pm 0.0012''$

## Minimum Internal Radii

### Metal Backed

Standard	1.000mm	0.040"
Technical	0.500mm	0.020"

### Soft-board/Multilayer

Standard	0.500mm	0.020"
Technical	0.200mm	0.008"

Where required by the use of tool overshoot in corners a pocket without radii in corners can be achieved. Note, minimum radii will be dependent upon material thickness

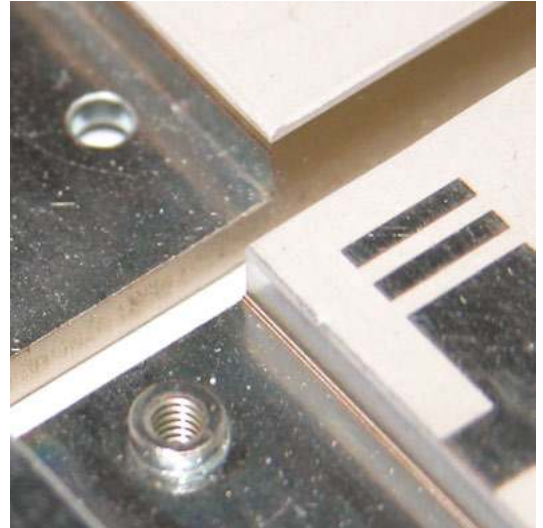
## Alignment to Circuit Image

Standard	$\pm 0.050\text{mm}$	$\pm 0.002''$
Technical	$\pm 0.025\text{mm}$	$\pm 0.001''$

## "Z" Axis Depth Control

Standard	$\pm 0.05\text{mm}$	$\pm 0.002''$
Technical	$\pm 0.025\text{mm}$	$\pm 0.001''$

Critical waveguide features designed on thin dielectrics can be formed using a combination of mechanical and chemical processing techniques.



# Solder Mask etc.

## Solder Mask

Type:	Peters SD2467SG DG
Thickness:	20 – 70µm/0.0008" – 0.0028"
Colour:	Green (Red or blue also available)
Hardness:	6 H

## Circuit Feature – Mask Clearance on Design

Standard	0.050mm	0.002"
Technical	0.025mm	0.001"

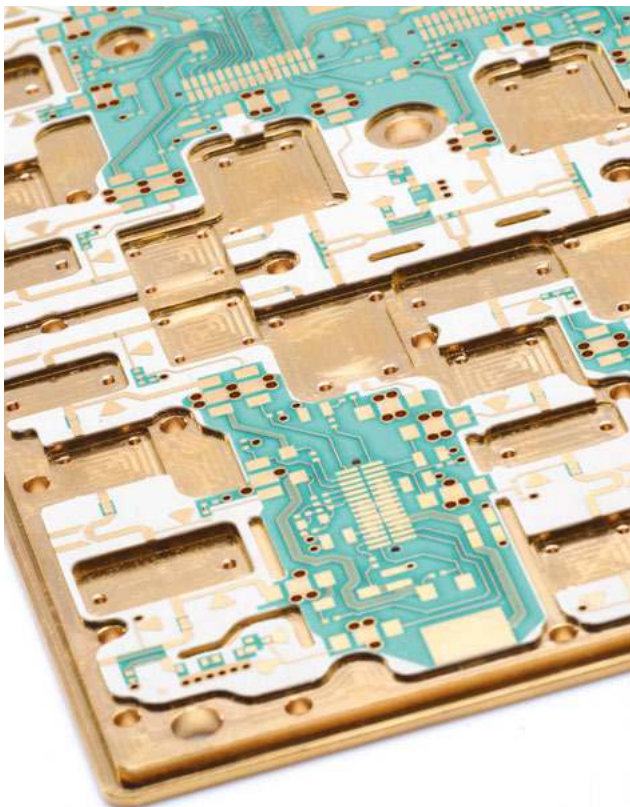
## Minimum Solder Mask Web (Isolation)

Standard	0.150mm	0.006"
Technical	0.100mm	0.004"

## Solder Resist Dams (Line Thickness)

Standard	0.200mm	0.008"
Technical	0.100mm	0.004"

Due to the nature of some PTFE laminates it is not possible to achieve fine solder-mask features when positioned over bare laminate.



## Notation

Type:	Peters SD2513UV
Thickness:	10 – 20µm/0.0004" – 0.0008"
Colour:	White, yellow & black (Others also available)
Hardness:	4 H

## Minimum Character Size

Standard	1.500mm	0.060"
Technical	1.000mm	0.040"

## Minimum Line Thickness

Standard	0.254mm	0.010"
Technical	0.150mm	0.006"

## Peelable Solder Masks (Temporary)

Type:	Elektra EM55
Minimum Thickness:	0.200mm 0.008"
Colour:	Green/Red

Type:	Peters DD 2954
Minimum Thickness:	0.300mm 0.012"
Colour:	Blue

# Surface Finishes

## Profile Feature Tolerance

Tin/Lead (60/40 ratio) (As plated or brushed)	Min thickness 2.00um
Bright Acid Tin	Min thickness 2.00um
Tin (as plated or brushed)	Min thickness 2.00um
Immersion Tin	0.10um
Electroless Tin	0.50 – 1.5 um
Electroless Nickel/Immersion Gold	Ni 3.50 – 8.00um Au 0.05 – 0.15um
Electroless Nickel/Immersion Gold (Higher build Gold for wire bonding)	Ni 3.50 – 8.00um Au 0.10 – 0.20um
Electroless Nickel/Palladium/Gold (Universal plating for wire bonding)	Ni 3.00 – 6.00um Pd 0.05 – 0.30um Au >0.03um
Electrolytic pure soft Gold Plating (Suitable for wire bonding)	Au 0.50 – 5.00um
Optional Nickel under-layer	Ni 1.00 – 10.00um

Alternative finishes are available through our network of fully approved sub-contractors.

## Planar Resistor Technology

Ohmega-Ply clad laminates or foils

Ticer Foil

25, 50 & 100 ohm/square material

10% capability tolerance



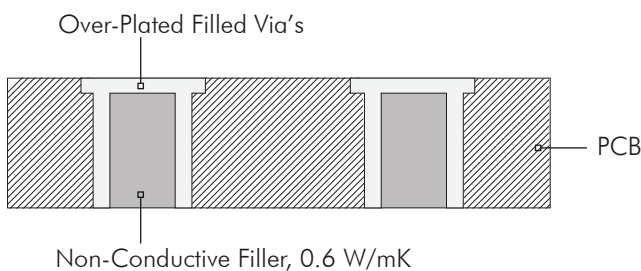


# Thermal Management in High Performance PCB

As new RF and microwave systems evolve, we are seeing a greater need for effective thermal management and significantly higher RF performance from Printed Circuit Boards (PCB's) and subsystems; at the same time these systems are required to decrease in mass and still offer greater functionality than ever before. Constraints like these are often most acute in applications where Size, Weight and Power (SWaP) are high priorities such as military and aerospace and typically include RF power amplifiers and phased array TxRx modules.

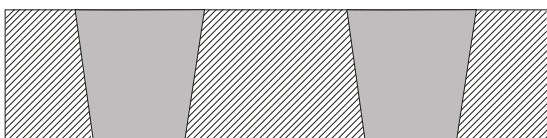
Teledyne Labtech has developed a number of techniques to manage the thermal dissipation of heat through the body of the PCB and into the core of the chassis or cold plate. Below are the design rules and features that Teledyne Labtech has to offer with thermal management.

## Over Plated Filled Via's

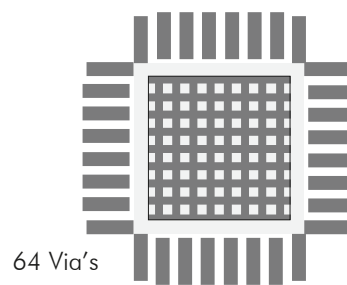


Minimum Hole Diameter	0.40mm	0.016"
Minimum Hole to Hole Spacing	0.20mm	0.008"
Minimum Hole to Pad Edge	0.20mm	0.008"

## Copper Filled Blind Via's



Maximum Hole Diameter	0.20mm	0.008"
Minimum Hole to Hole Spacing	0.20mm	0.008"
Maximum Hole Depth	0.20mm	0.008"
Minimum Hole to Pad Edge	0.20mm	0.008"



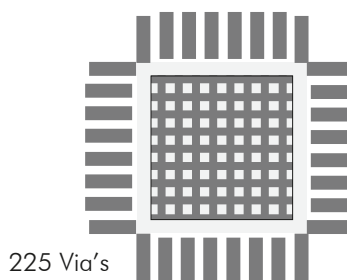
64 Via's



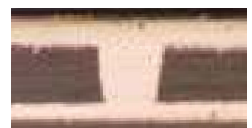
**Total Thermal Conductance**

**Typical 3.2 W/°C**

**Note:** The total thermal conductivity is subject to Cu plated thickness and filled via hole size. Please refer to Teledyne Labtech Whitepaper - **Thermal Management in High Performance PCB**. This is available via the Teledyne Labtech website.



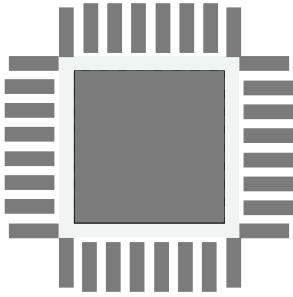
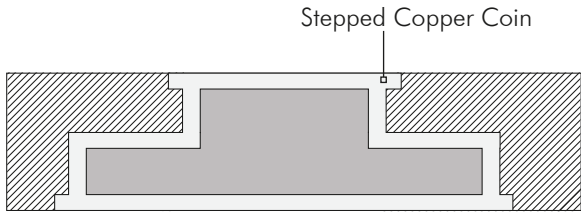
225 Via's



**Total Thermal Conductance**

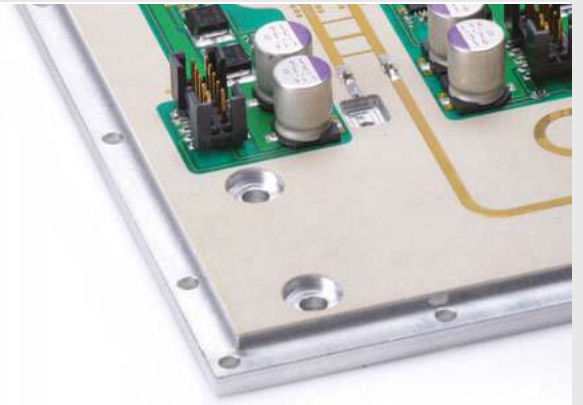
**Typical 14.1 W/°C**

## Copper Coin Technology



**Total Thermal Conductance**

**Typical 17.9 W/°C**



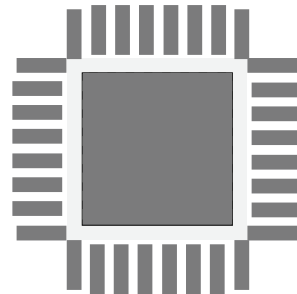
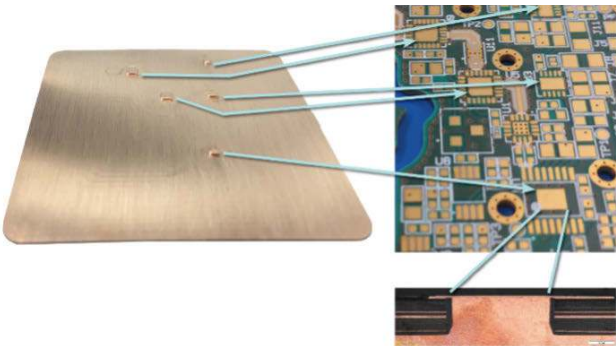
### Pillar

Minimum Width & Length	2.00mm	0.080"
Minimum Radius	0.50mm	0.020"
Minimum Height	0.50mm	0.020"
Minimum Annular Ring	0.30mm	0.012"

### Step

Minimum Width & Length	1.00mm	0.040"
	(Larger than pillar width & Length)	
Minimum Radius	0.50mm	0.020"
Minimum Height	0.50mm	0.020"
Minimum Annular Ring	0.30mm	0.012"

## Stepped Coin with Multiple Pillars



**Total Thermal Conductance**

**Typical 17.9 W/°C**

### Pillar

Minimum Width & Length	1.20mm	0.047"
Minimum Radius	0.50mm	0.020"
Minimum Height	0.50mm	0.020"
Minimum Annular Ring	0.30mm	0.012"

### Step

Minimum Width & Length	5.00mm	0.040"
	(Larger than pillar width & Length)	
Minimum Radius	0.50mm	0.020"
Minimum Height	0.50mm	0.020"
Minimum Annular Ring	0.30mm	0.012"

# Assembly & Testing

Teledyne Labtech has extensive assembly and RF/microwave testing facilities, which ensures we can provide a complete turnkey microwave assembly solution.

From bare board manufacture through to component assembly, test and conformal coating, Teledyne Labtech offers a unique “one-stop” manufacturing solution.

**Assembly of connectors, resistors, SMT components and bare die placement**

**Full RF Test capability, including:**

- S parameters up to 40 GHz
- Return loss
- VSWR
- Vector and phase measurement

**Conformal coating**



# Quality & Environment

Teledyne Labtech prides itself on being able to offer the highest quality RF/microwave PCBs available; our goal is to reliably produce specification compliant products for our customers by designing and building quality into all aspects of our business.

From space applications to mission critical electronics, Teledyne Labtech is your trusted partner. Our extensive chemical laboratory coupled with our in-house testing and measurement capabilities ensure that the highest possible standards are achieved and maintained.

Fully accredited to ISO 9001 & ISO 14001

Full micro-section preparation and analysis

Daily chemical analysis and SPC controls

Member of ADS SC21

Fully integrated quality management system



ISO 14001  
(2015)



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