REDCUBE

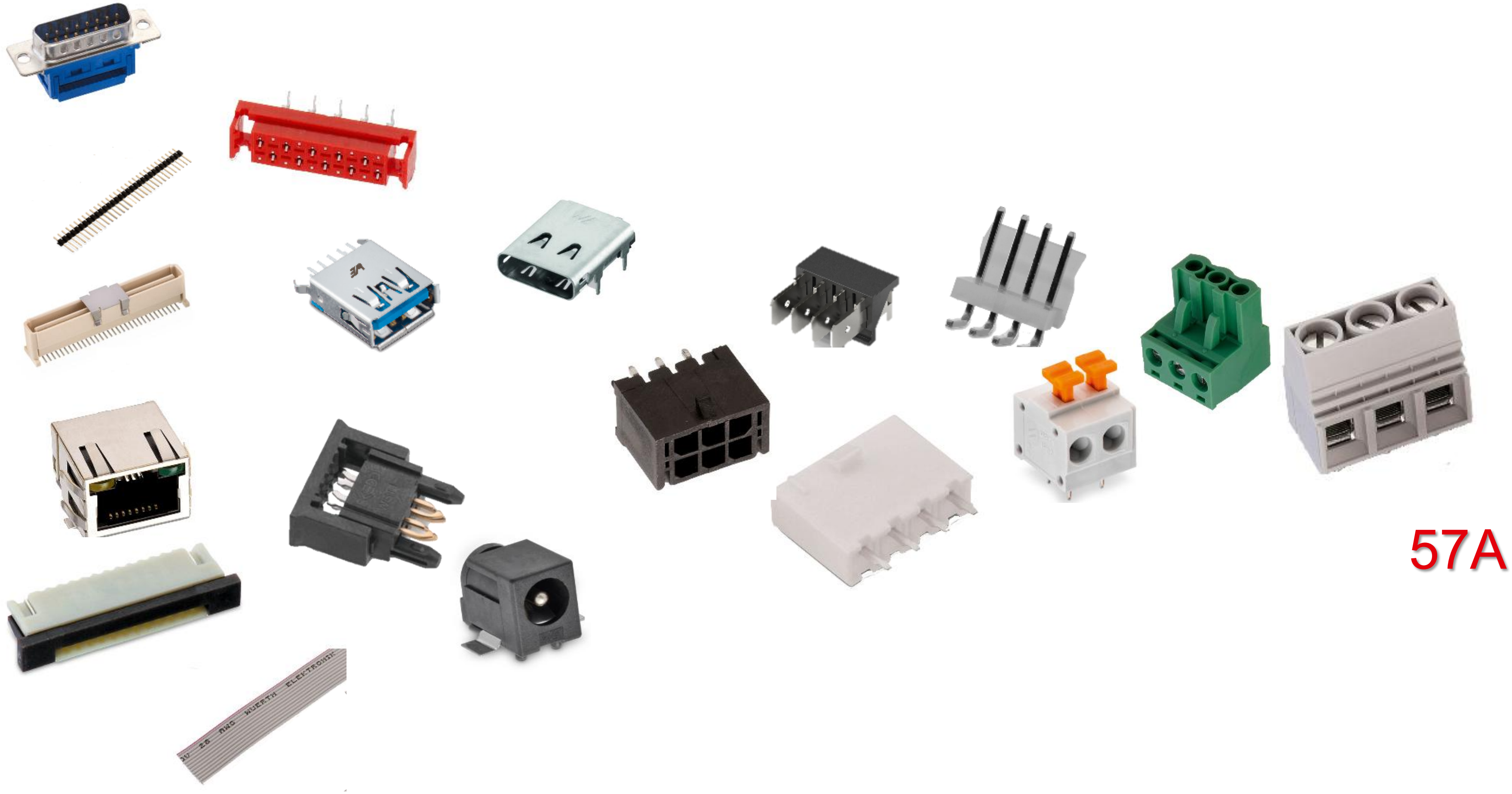
Philipp Grünberger
Field Application Engineer

PUBLIC

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

REDCUBE

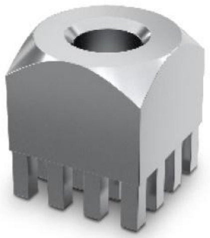
Vom Datensignal zum Leistungssteckverbinder



57A < ?

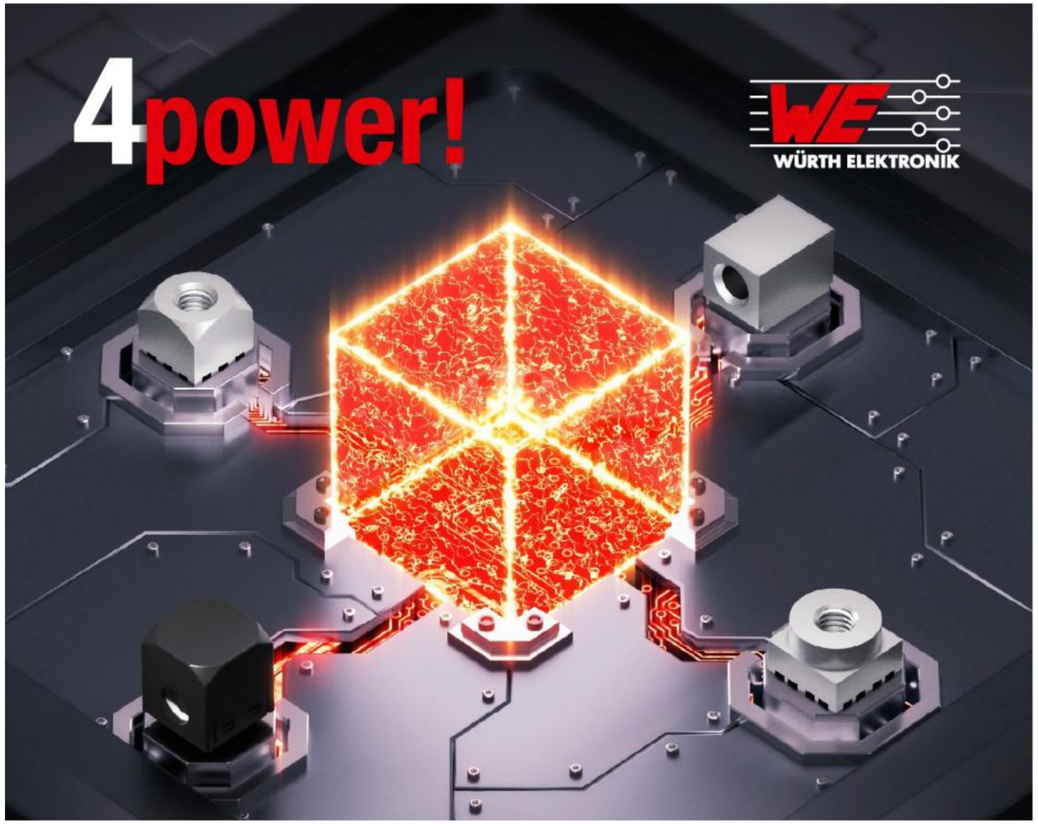
REDCUBE

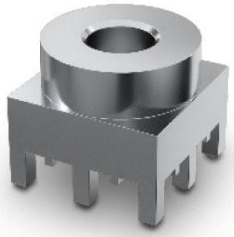
Übersicht



REDCUBE PRESS-FIT

REDCUBE PLUG



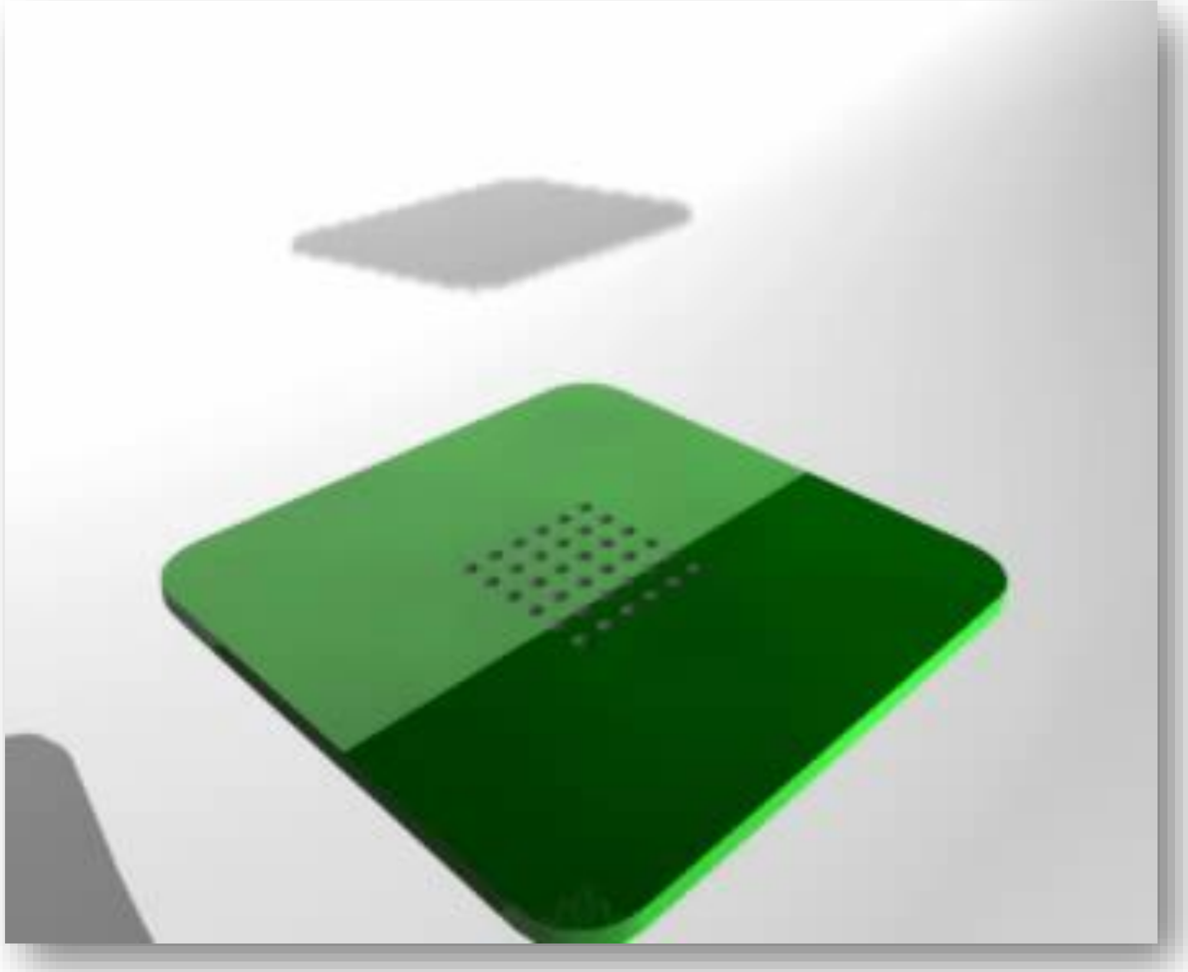


REDCUBE THR

REDCUBE SMD

EINPRESSTECHNIK

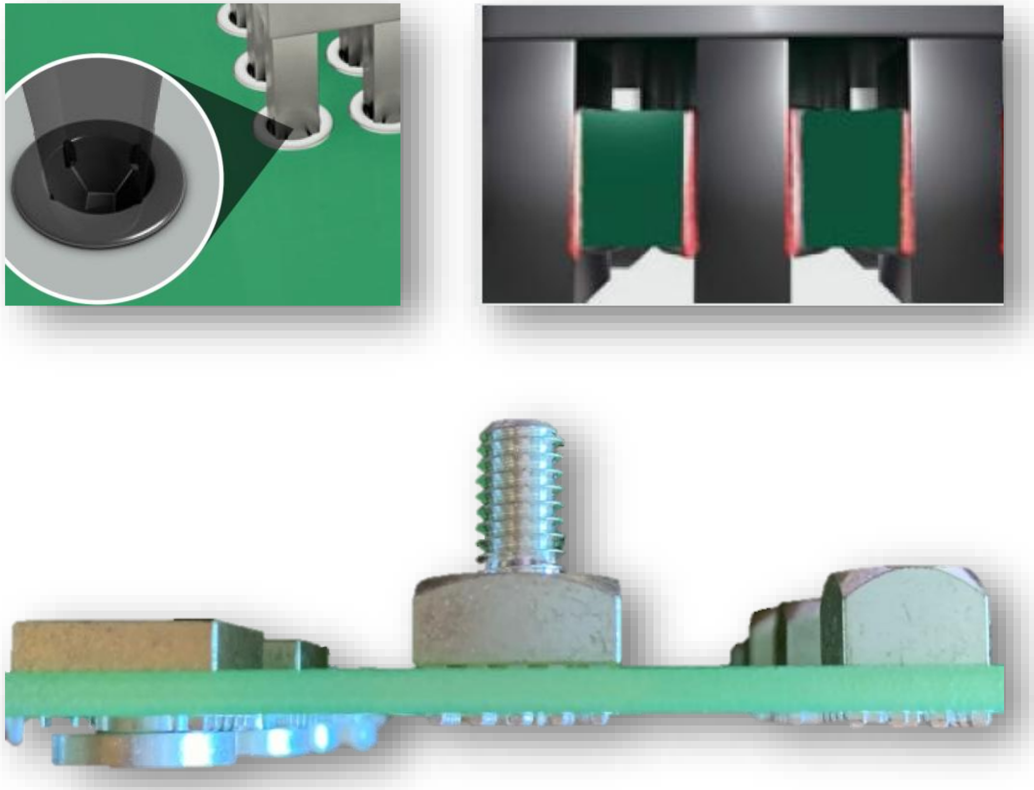
wie funktioniert das?



EINPRESSTECHNIK

wie funktioniert das?

- Lötfrei
- Kaltverschweißt
- Gasdicht
- Starke mechanische Verbindung
- Leistungsstarke elektrische Verbindung



AGENDA

- **Redcube:**
  - Spezifikation und Tests
- **Einpresstechnik**
  - wie funktionierts
  - Einpressen
  - PCB Design (Fausregel)
- **Lötbarkeit**
- **Applikationsbeispiele**

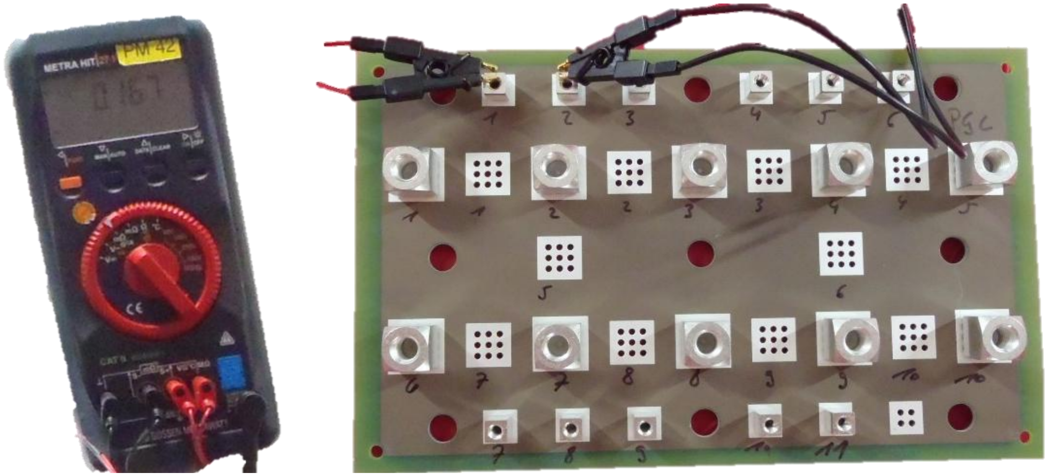
SPEZIFIKATION UND TESTS

REDCUBE

Elektrische Spezifikation

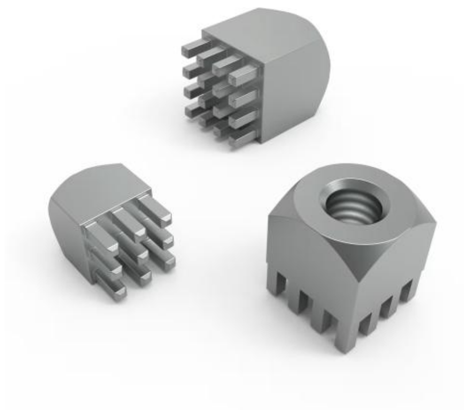
- Ein geringerer Übergangswiderstand erzeugt eine geringere Erwärmung am Bauteil.

Kontaktwiderstand IEC60512-2-1	
gelöteter Leistungssteckverbinder	Red cube
<20mΩ	**<200µΩ**

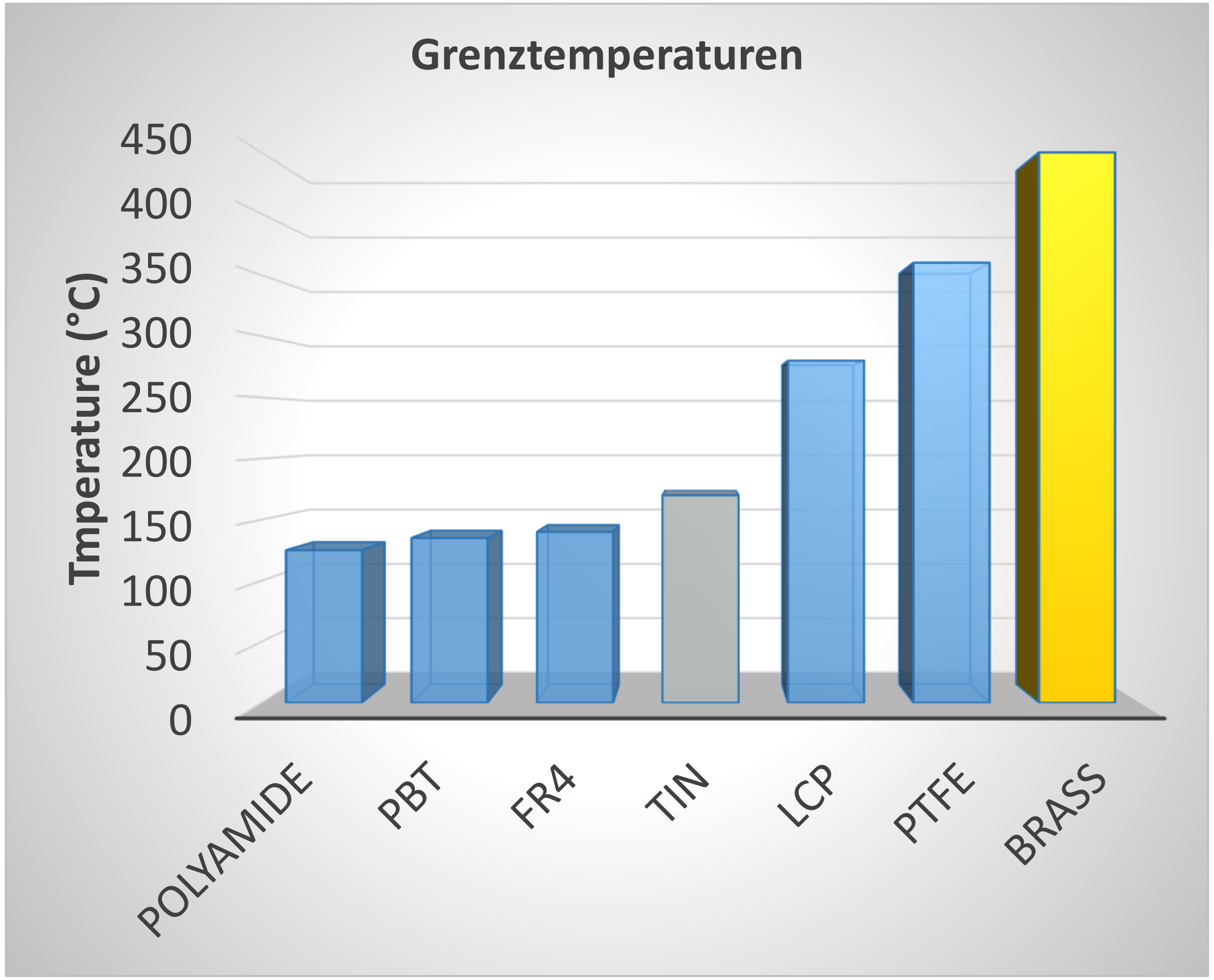


REDCUBE

Elektrische Spezifikation

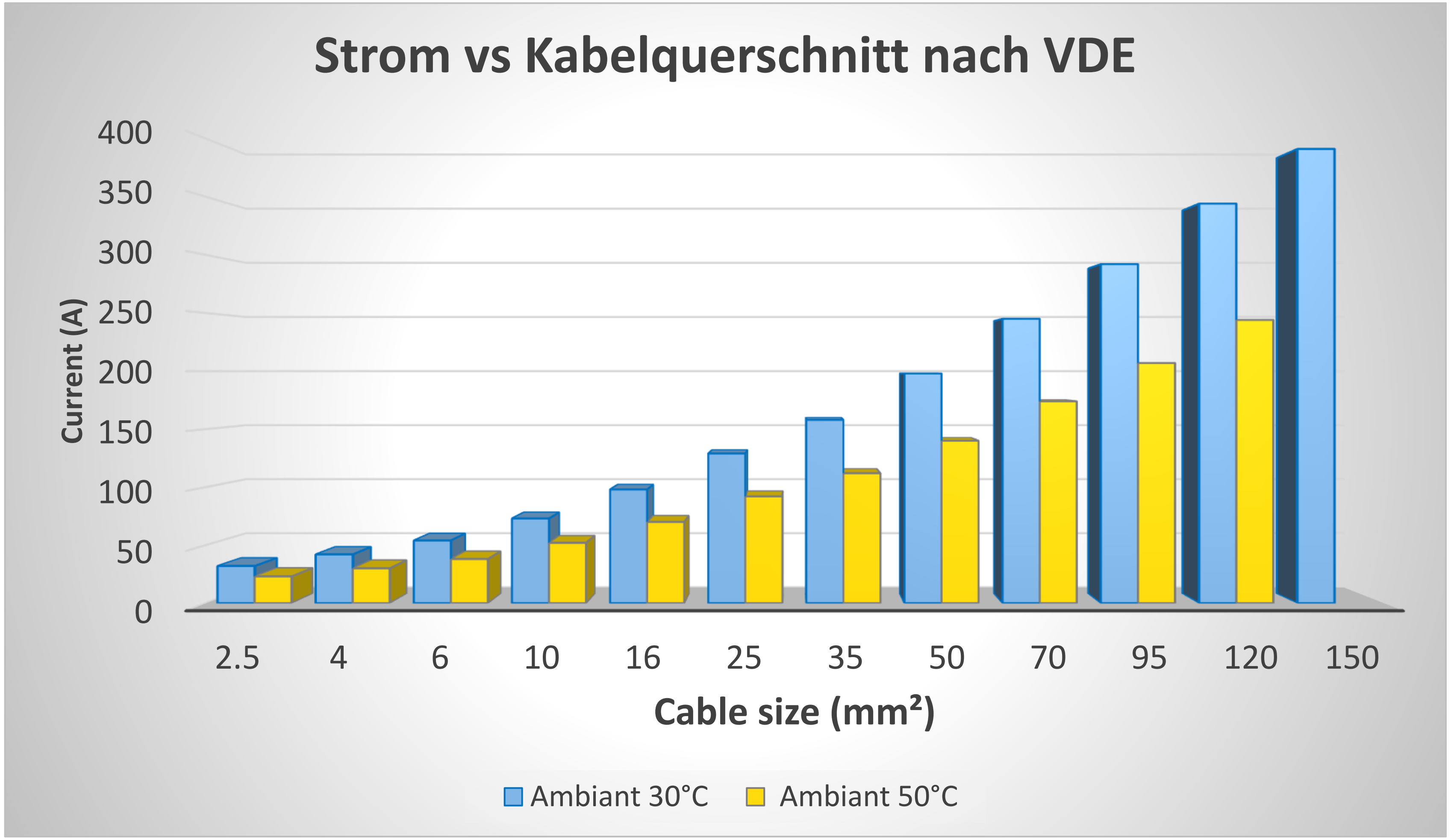


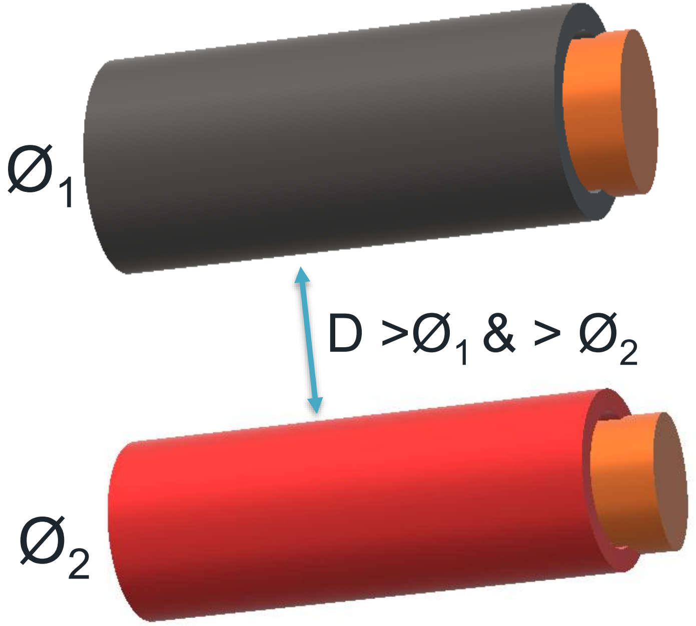
Temperaturanstiegstest IEC60512-2-5	
Leistungssteckverbinder ΔT	REDCUBE
IEC/VDE max 45K UL max 30K	**Max 150°C**



REDCUBE

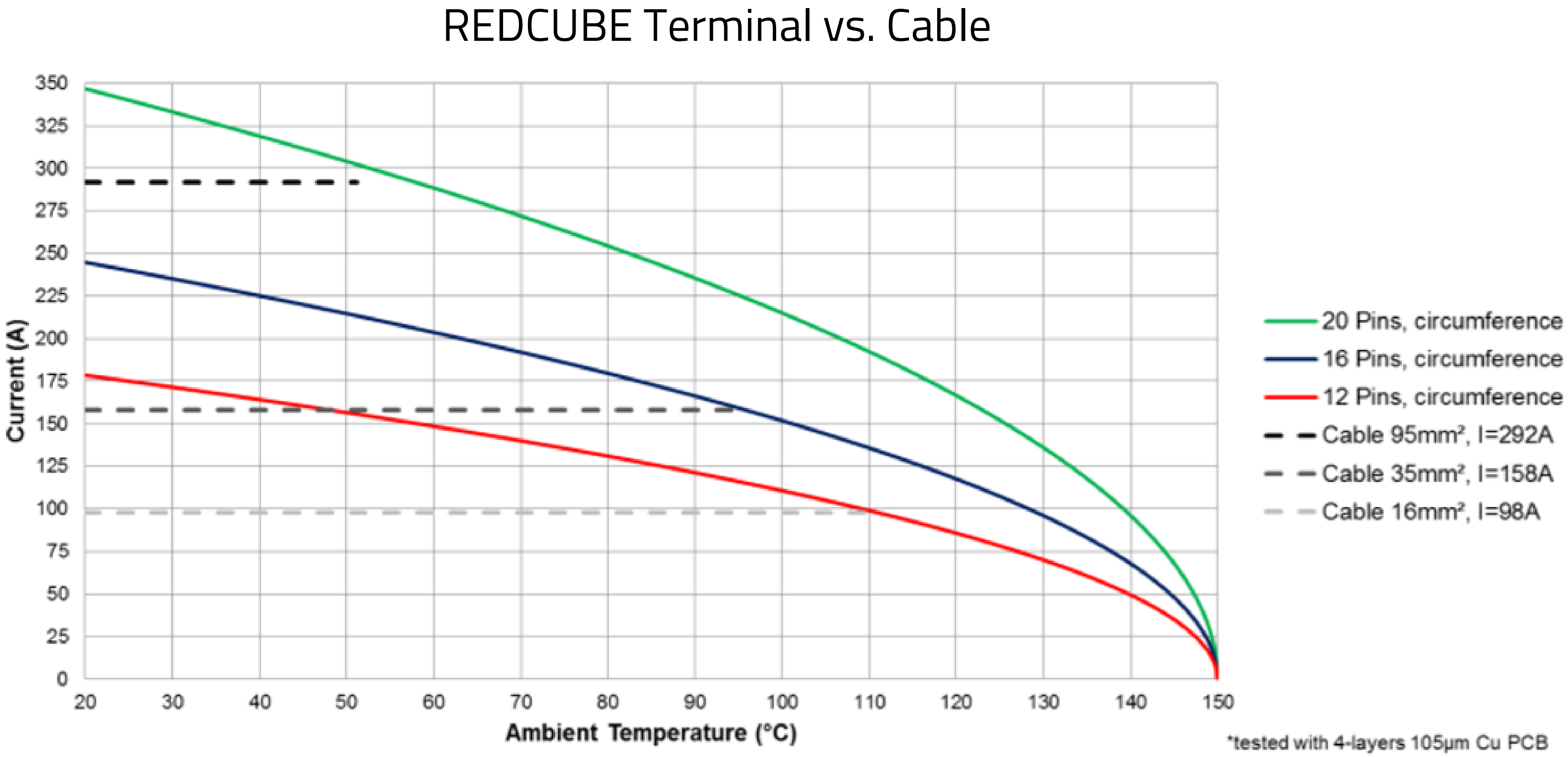
Elektrische Spezifikation





DERATIND KURVE

Elektrische Spezifikation

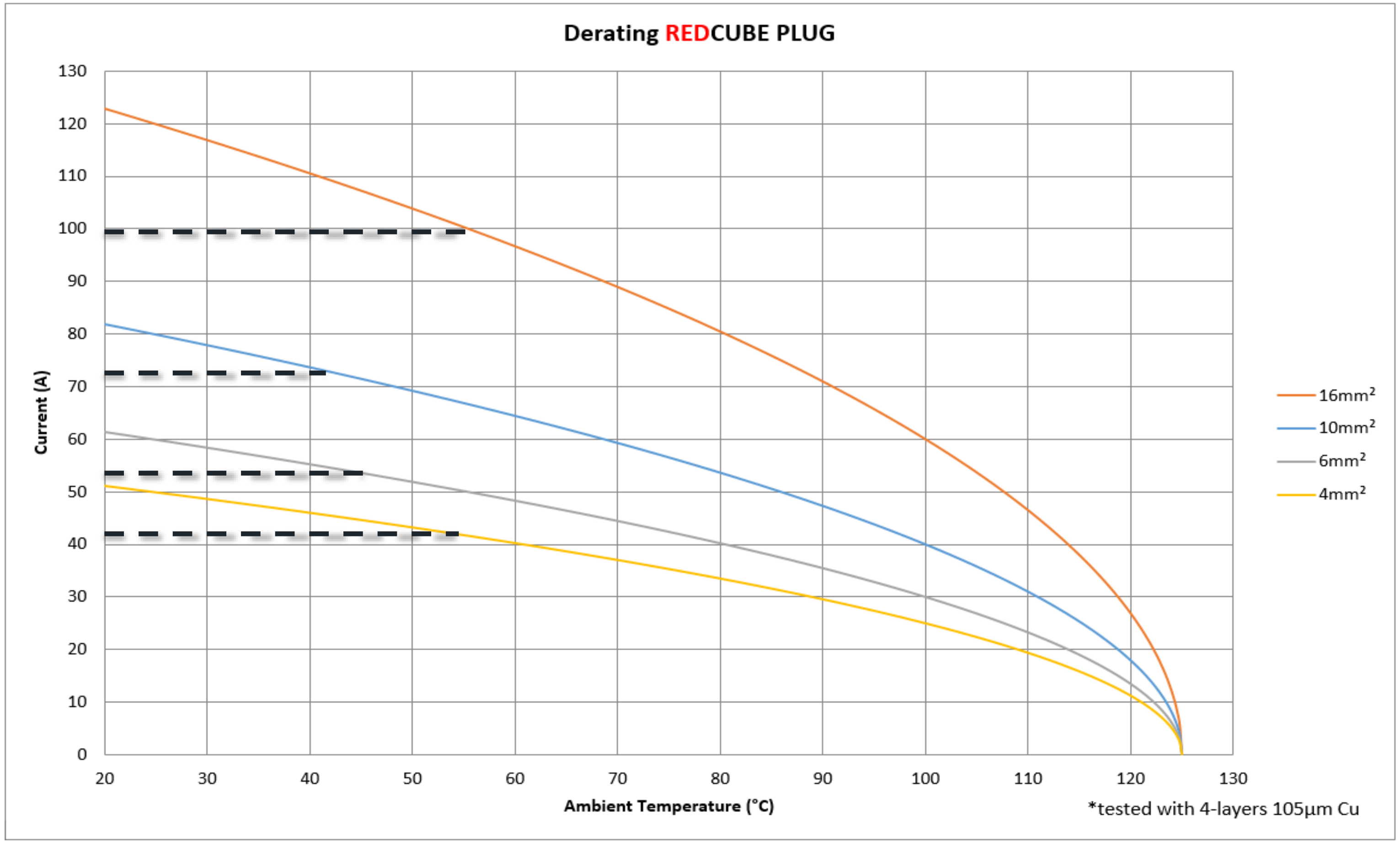


2 Rows

Circumference

Full

DERATING-KURVEN



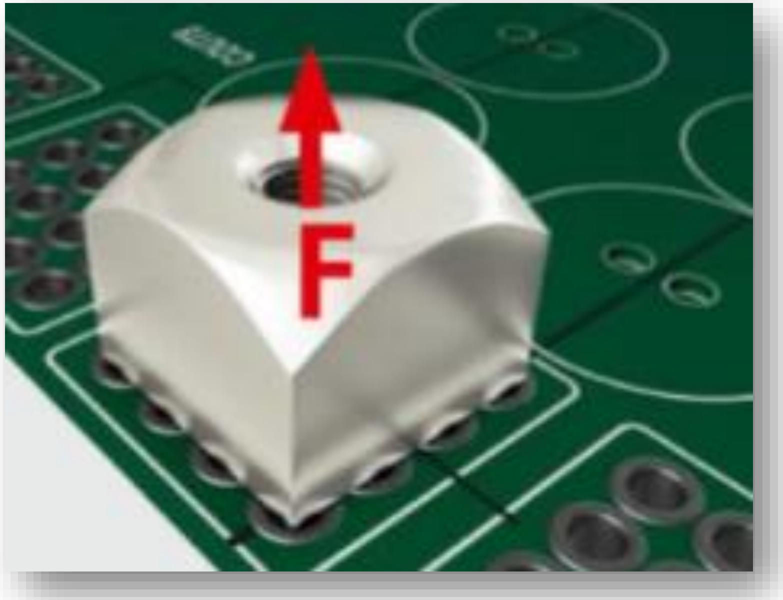
Bilder WE

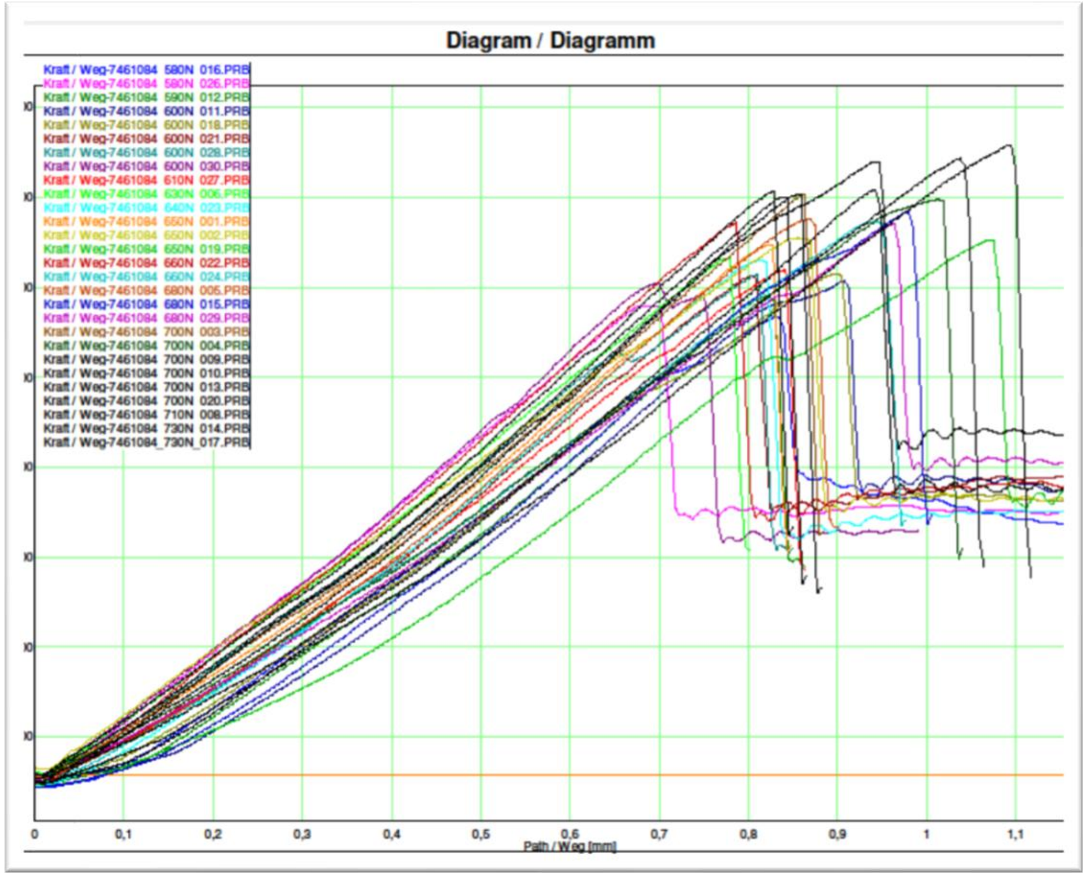
REDCUBE

Mechanische Spezifikation

Pull-out Test: PCB 1,6 mm

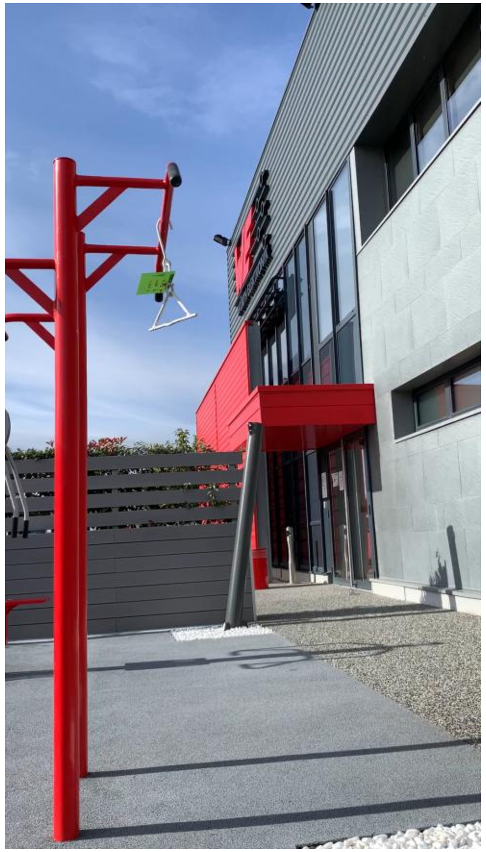
Extraction effort: 100 N/pin





REDCUBE

Mechanische Spezifikation: Pull-out test



WIE DIES ZERTIFIZIERT WIRD

Umwelttest

Thermal shock IEC60068-2-14		
Eigenschaften		Test
Üblich	REDCUBE	
-20°C	**-55°C**	R_c, pull force, torque
+65°C	**+150°C**	
96h	**1000h**	

Damp heat IEC60068-2-30		
Eigenschaften		**Test**
Üblich	**REDCUBE**	
+40°C	**+65°C**	R_c, pull force, torque
+95% moisture		
96h	**500h**	

All pictures WE

WIE DIES ZERTIFIZIERT WIRD

Umwelt

Salzsprühnebel IEC60068-2-52		
Eigenschaften		**Test**
Üblich	**REDCUBE**	
+40°C		R_c, pull force, visuell
5% NaCl		
48h	**72h**	

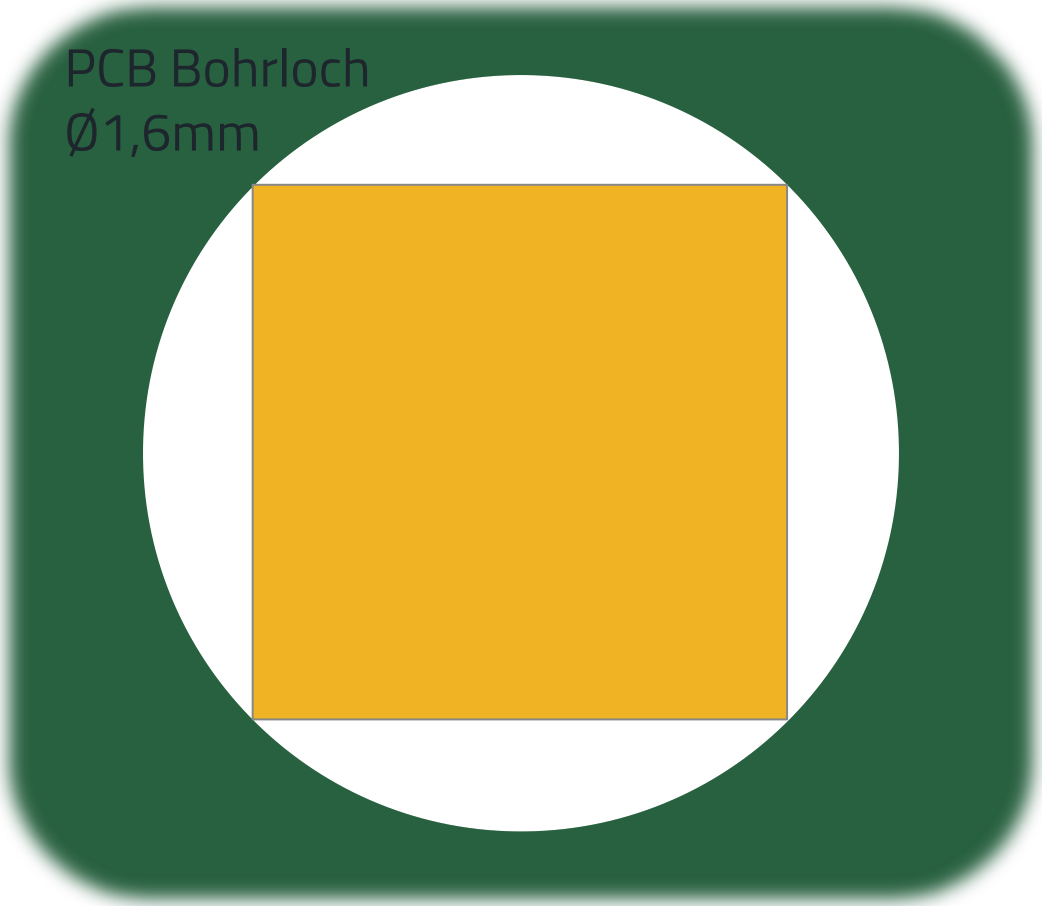
Vibrations test IEC60068-2-6		
Characteristics		**Test**
Übliche	**REDCUBE**	
10-55Hz	**10-1500Hz**	R_c, pull force
15min /axis	**20min /axis**	
3-10g	**15g**	

Alle Bilder WE

EINPRESSTECHNIK

PRESS-FIT

Schritt für Schritt: Das Bohrloch



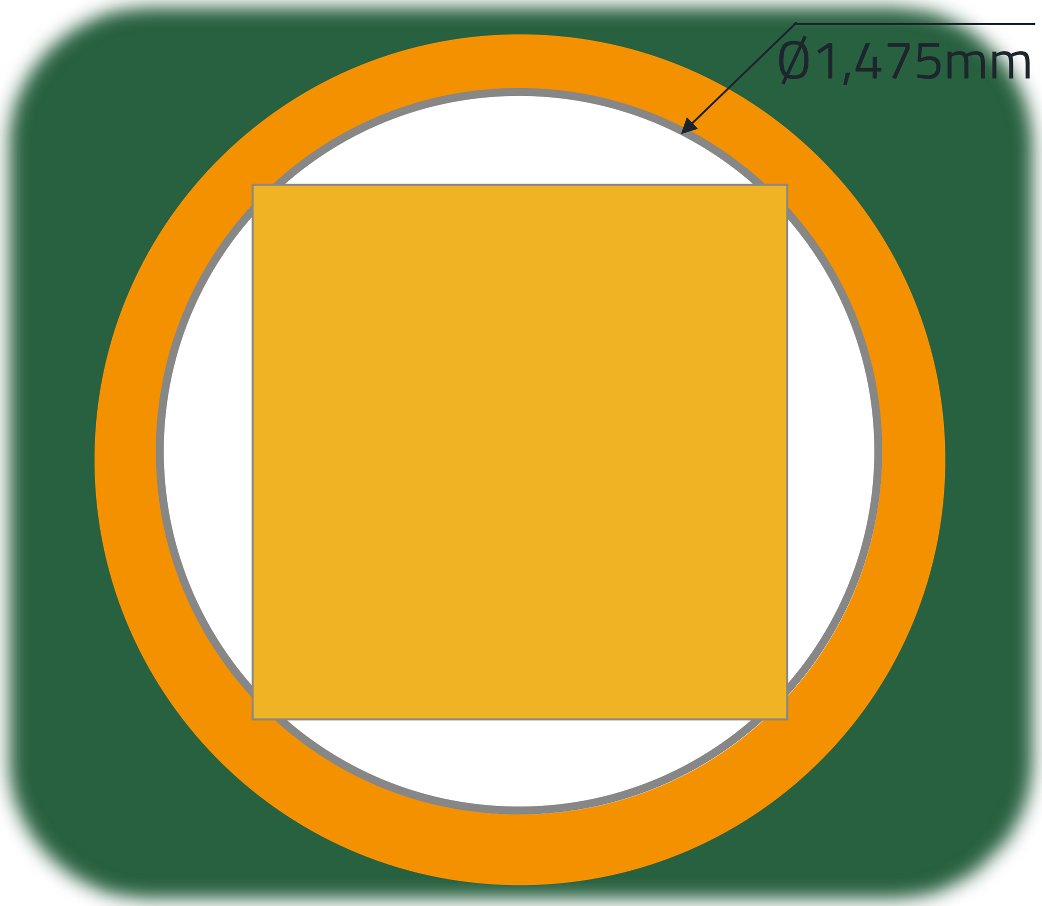
PCB Bohrloch
Ø1,6mm

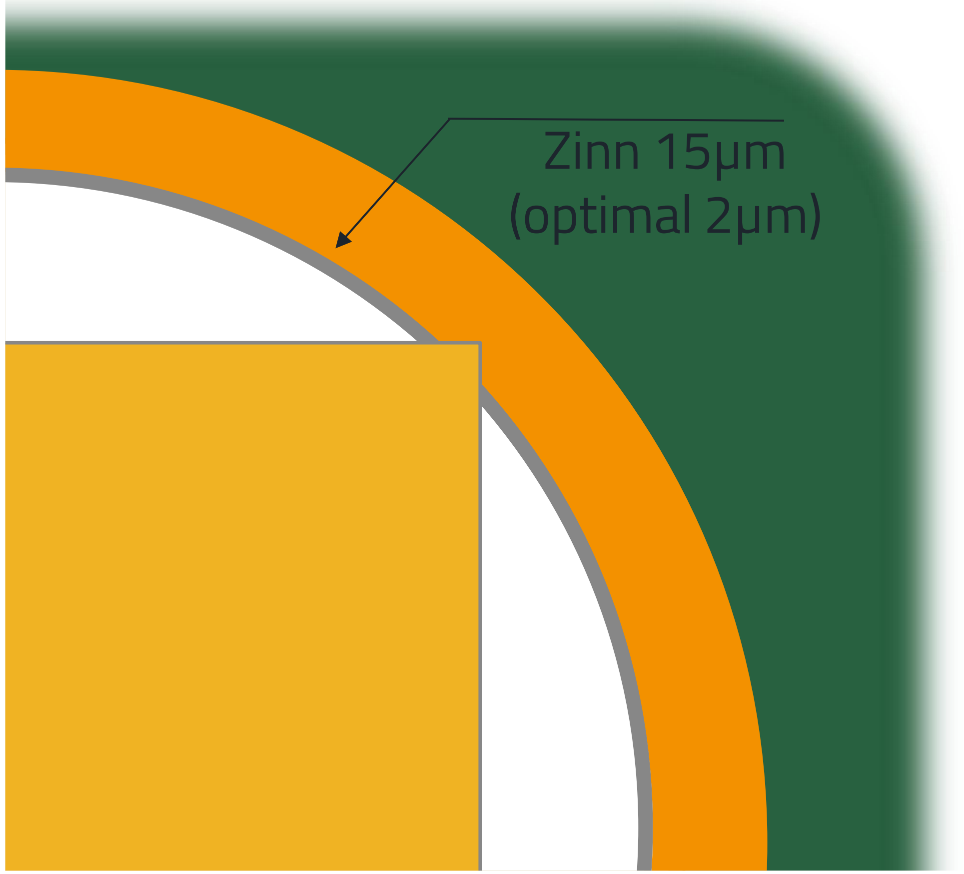
PRESS-FIT

Schritt für Schritt: Kupfer

PRESS-FIT

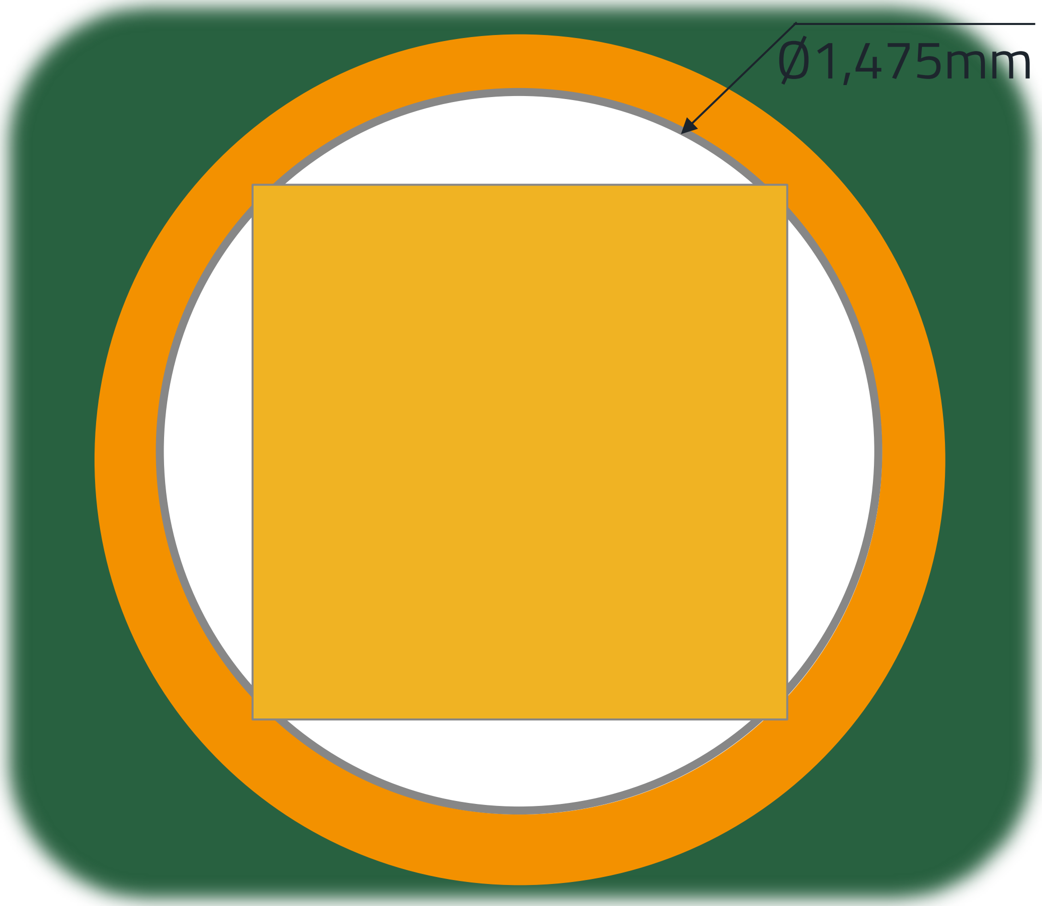
Schritt für Schritt: Zinn

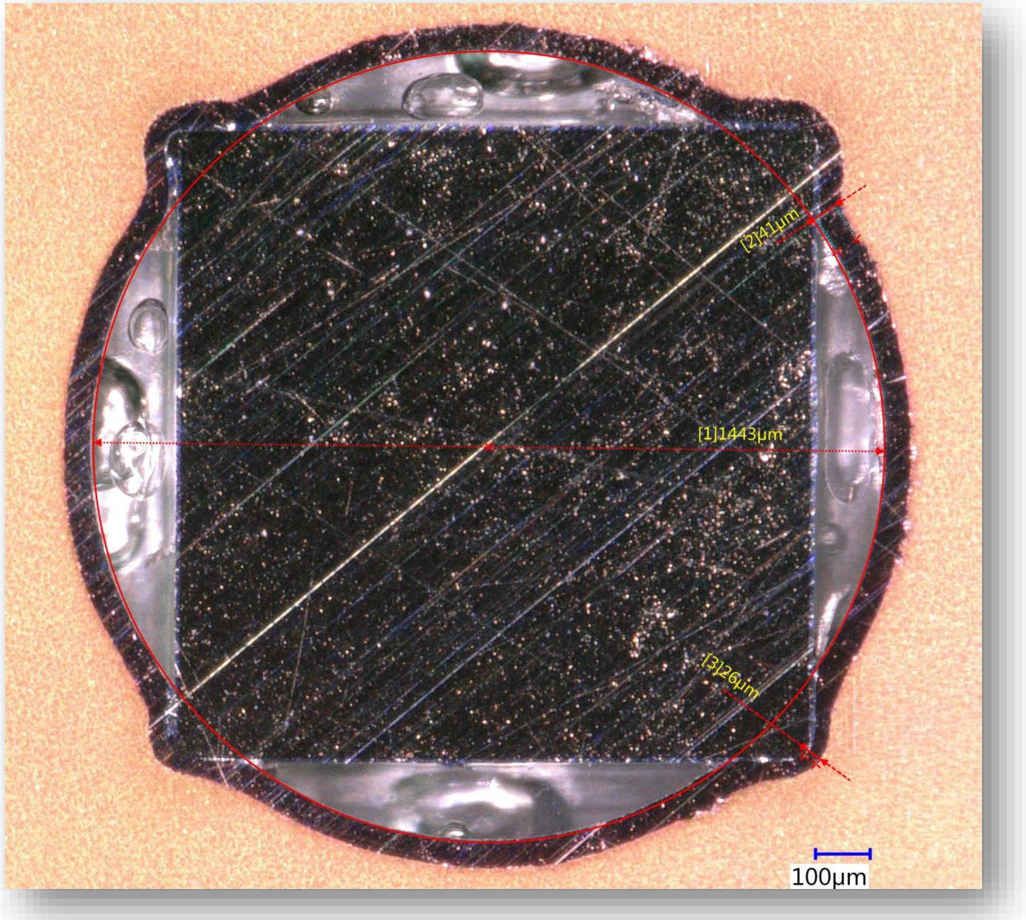




PRESS-FIT

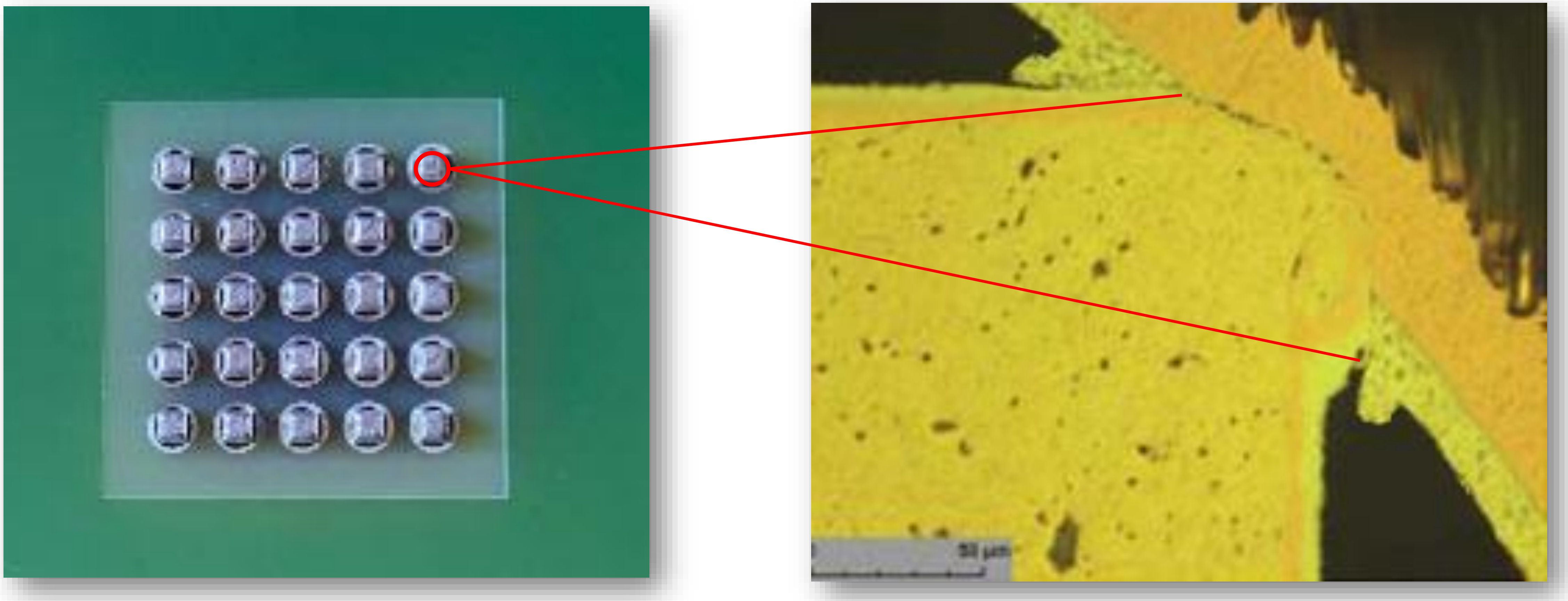
Schritt für Schritt: Ideal vs. Realität





PRESS-FIT

Schritt für Schritt: Kaltverschweißung



EINPRESSTECHNIK PROZESS

EINPRESSVORGANG

Benötigtes Material

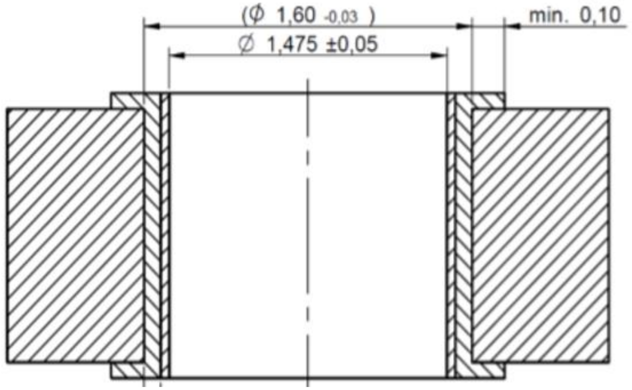
- Presse
- Stempel
- Leiterplatte
- Unterlage
- Basisplatte

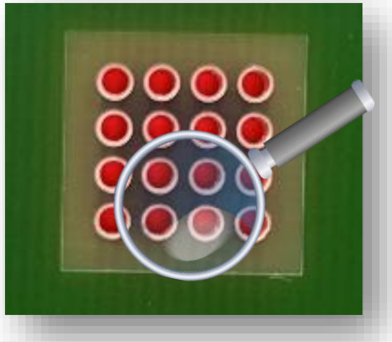
EINPRESSVORGANG

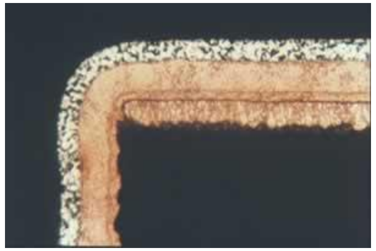
Leiterplatte

chemical tin

ENIG (NiAu)





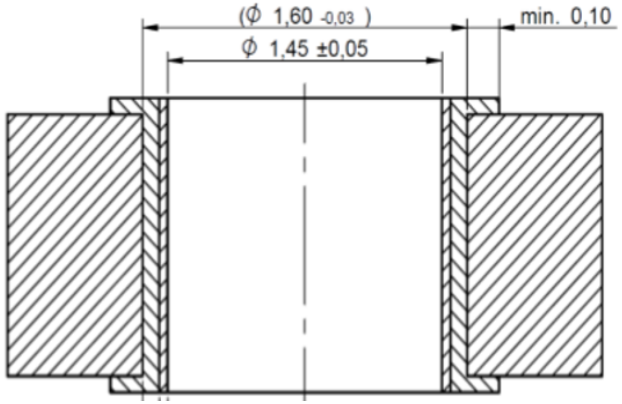


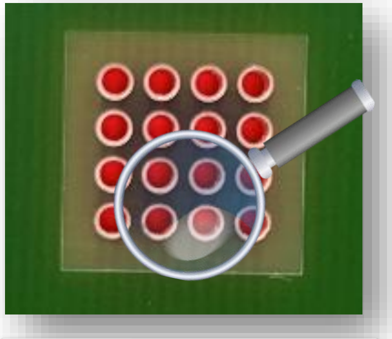
- 25 – 60 µm Kupfer – optimal 30 – 40 µm
- max. 15 µm Zinn – optimal 2 µm

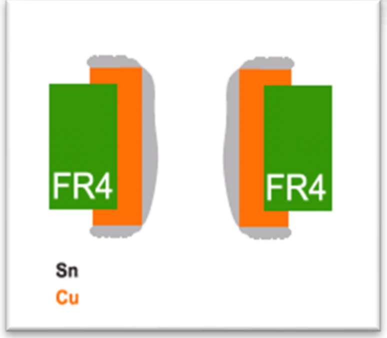
EINPRESSVORGANG

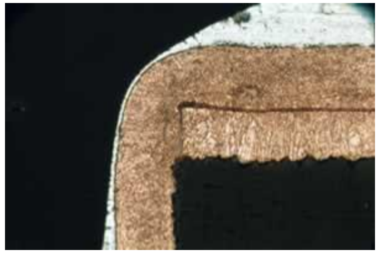
Leiterplatte

HAL – Hot Air Levelling





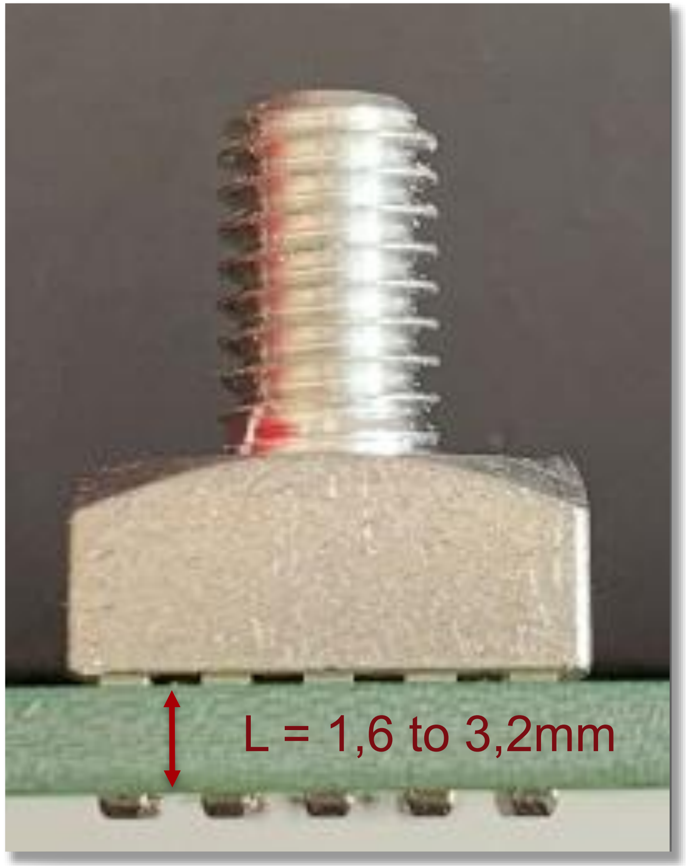


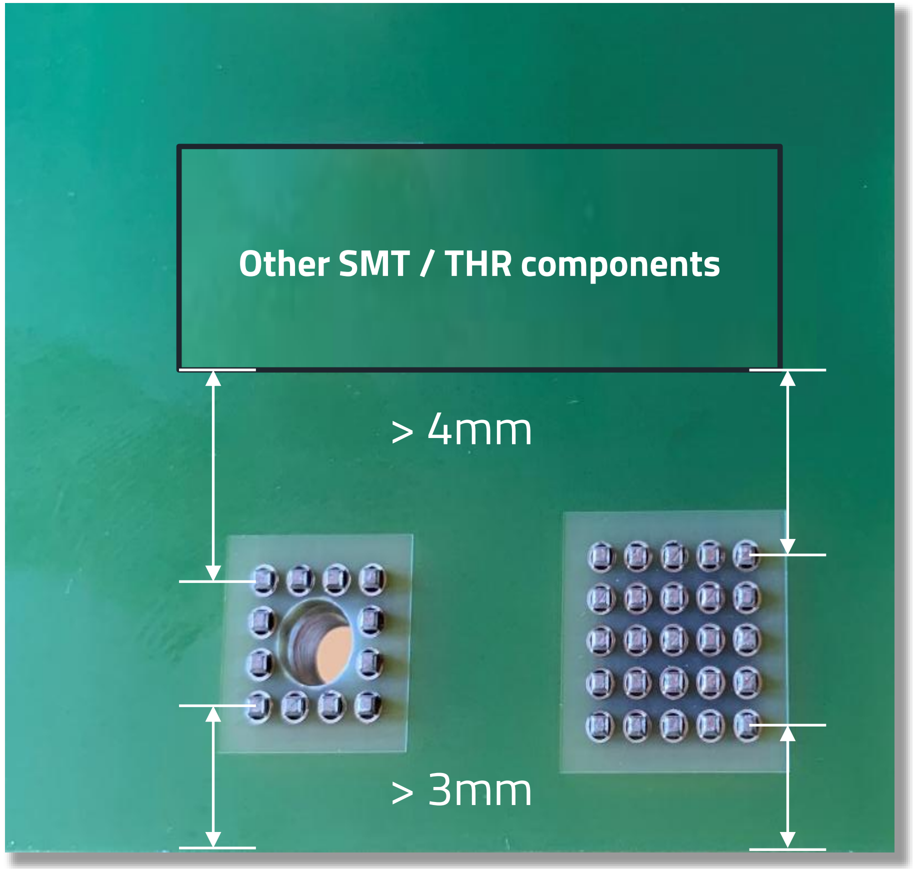


- 25 – 60 µm Kupfer – optimal 30 – 40 µm
- max. 15 µm Zinn – optimal 2 µm

EINPRESSVORGANG

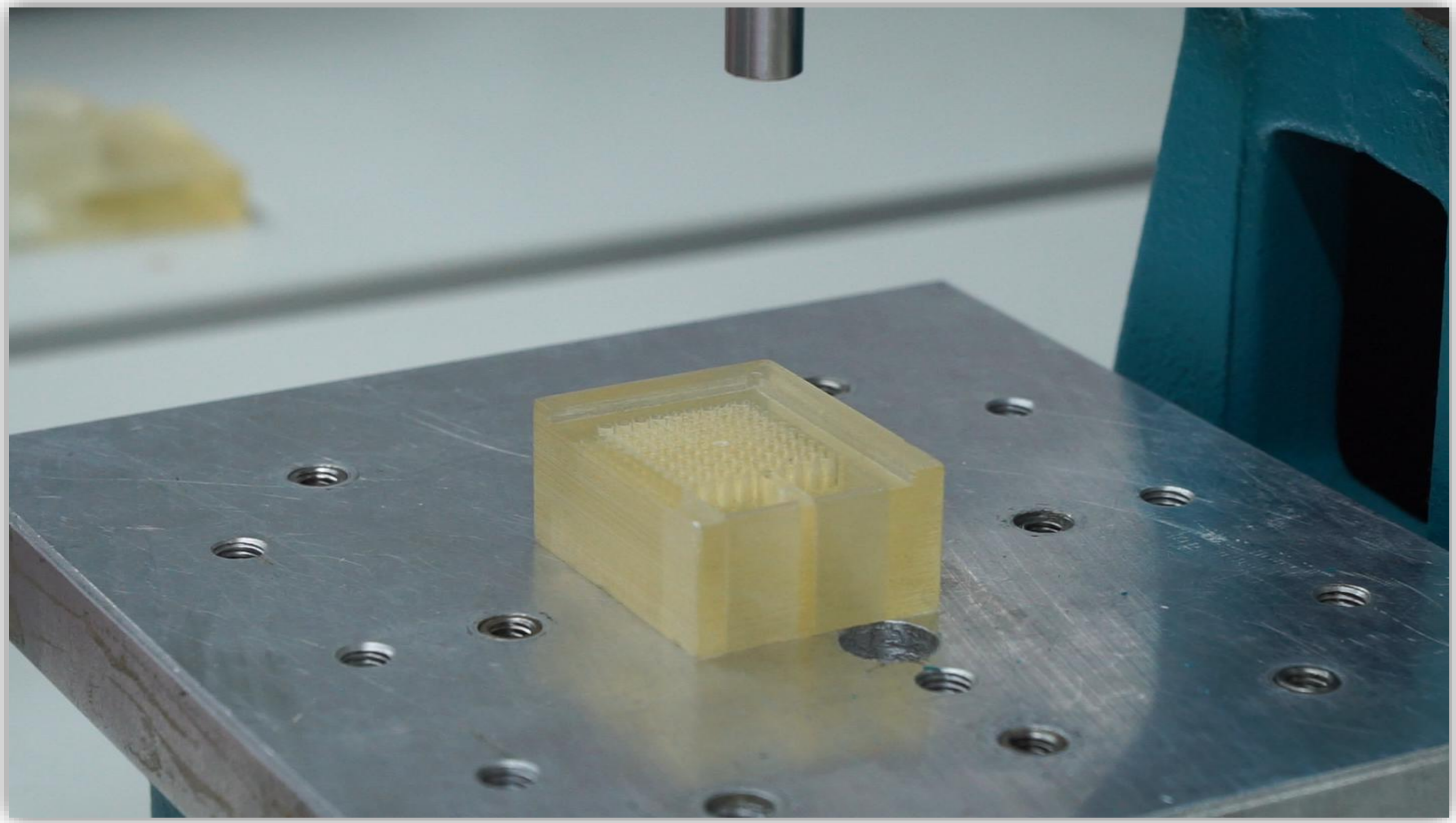
Leiterplatten Empfehlungen

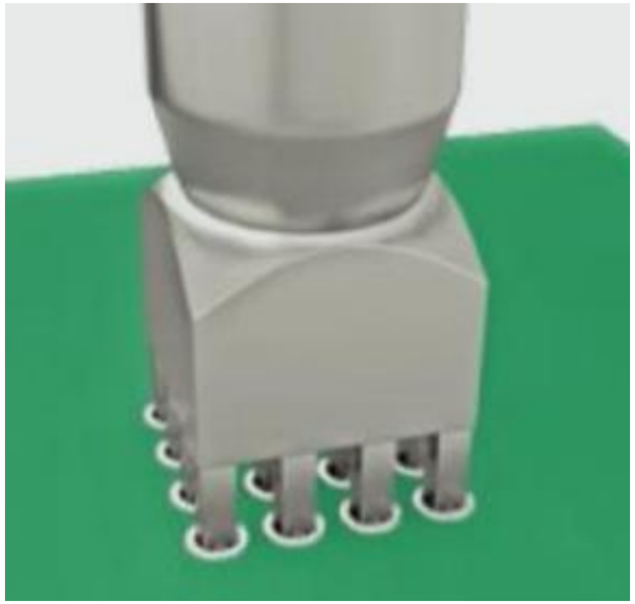




EINPRESSVORGANG

Einpressbeispiel

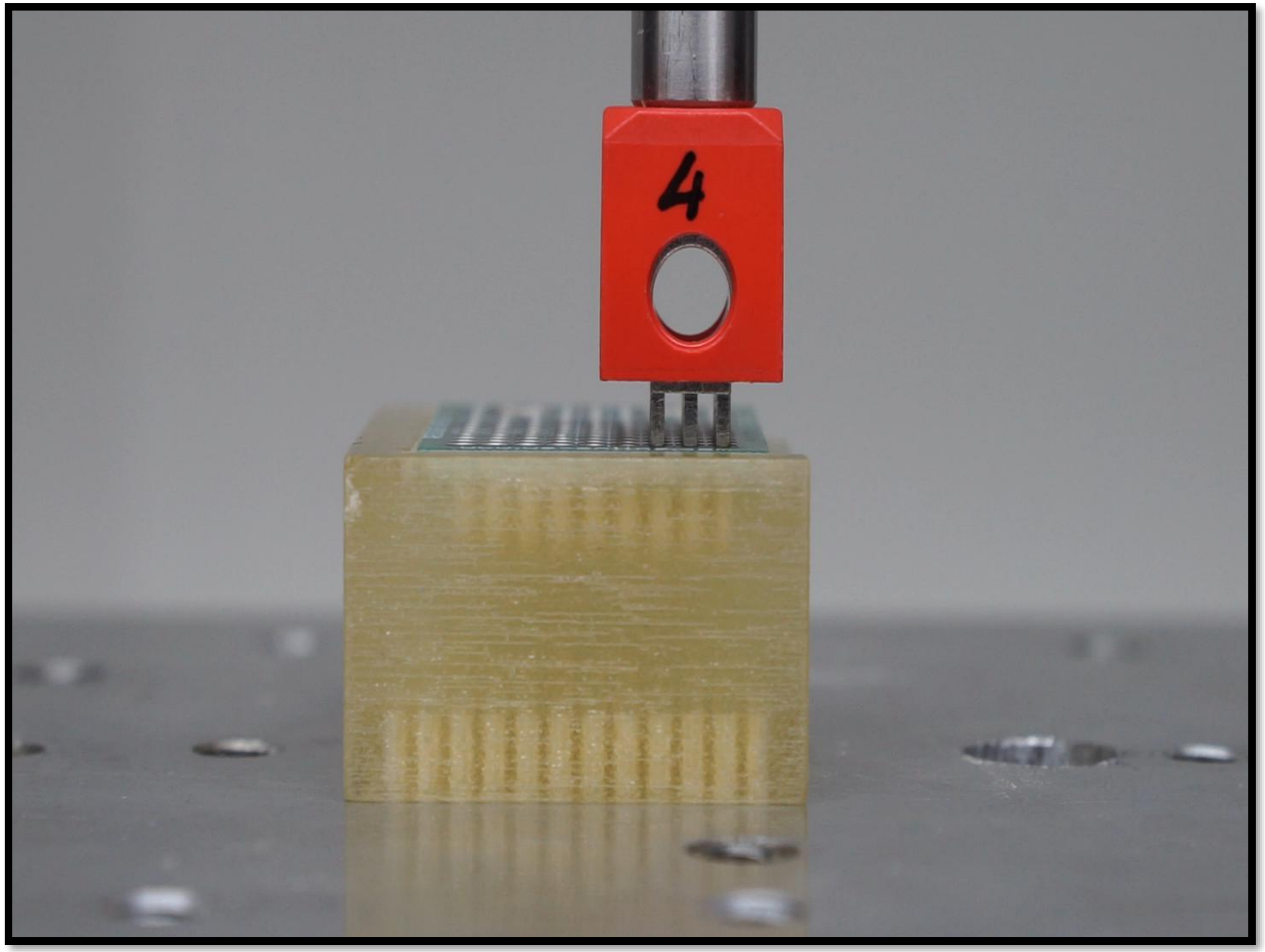




EINPRESSVORGANG

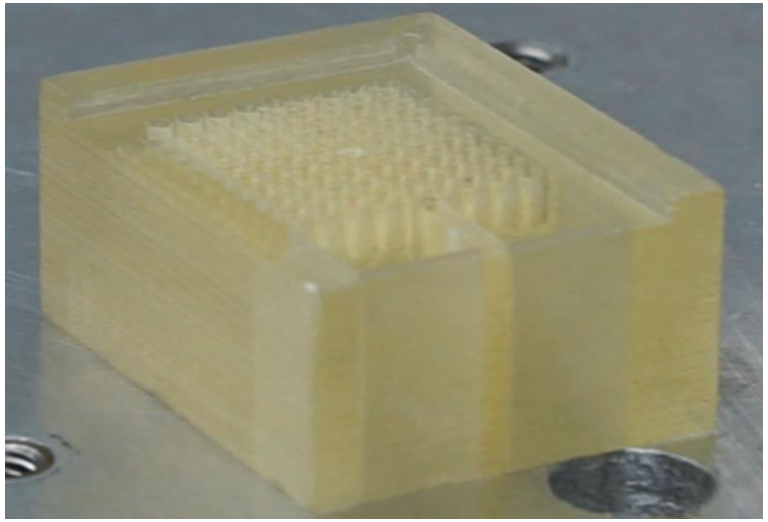
Einpressbeispiel

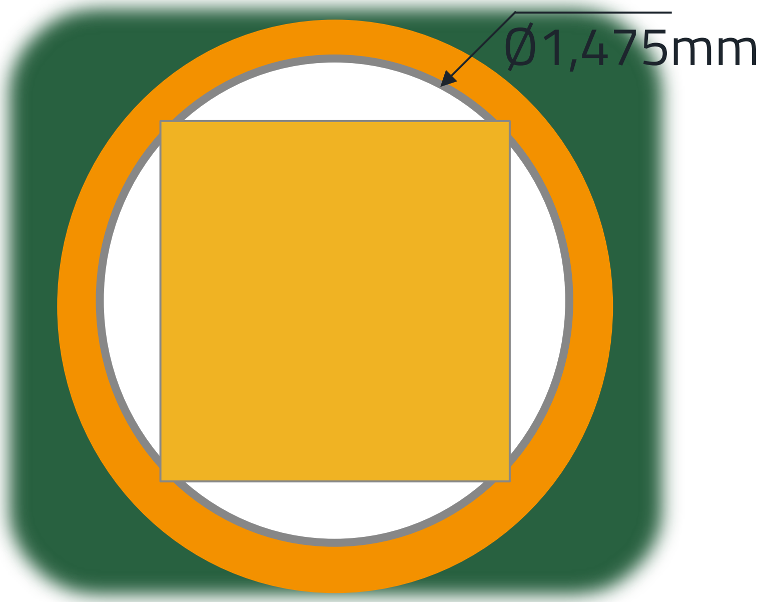
All pictures WE

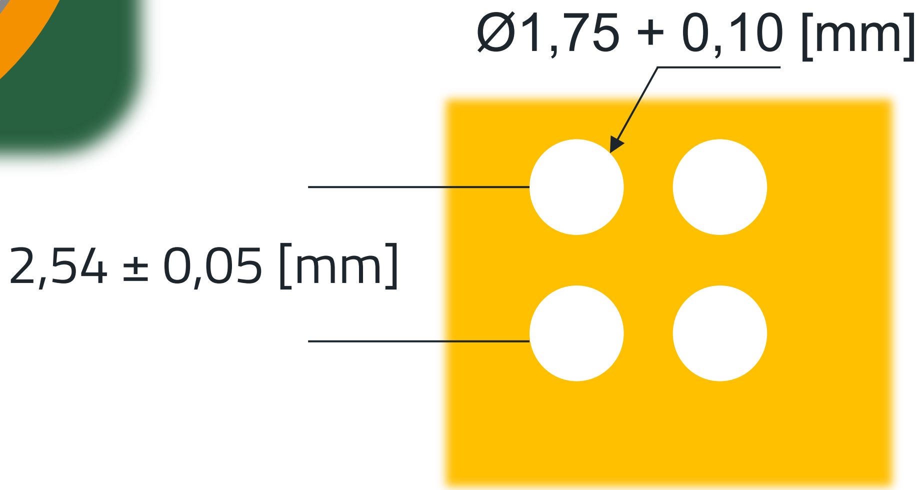


EINPRESSVORGANG

Unterlage: 3D gedruckte Unterlage







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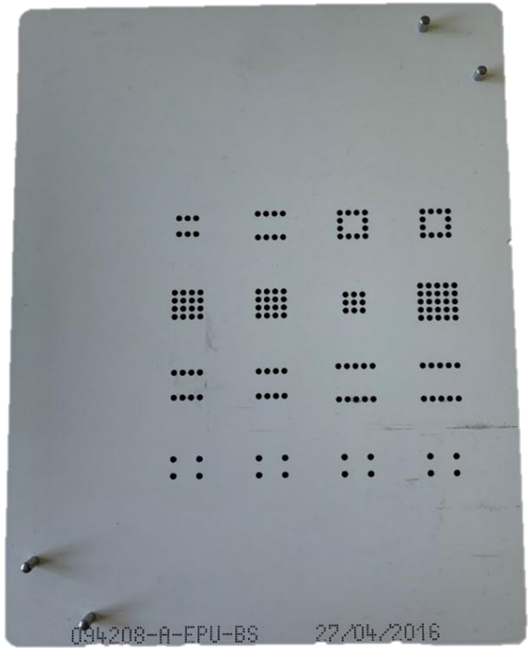

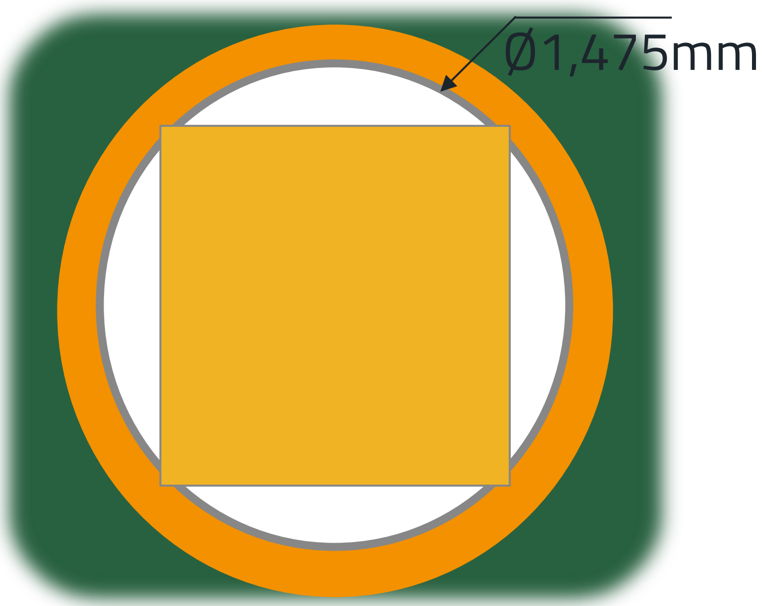

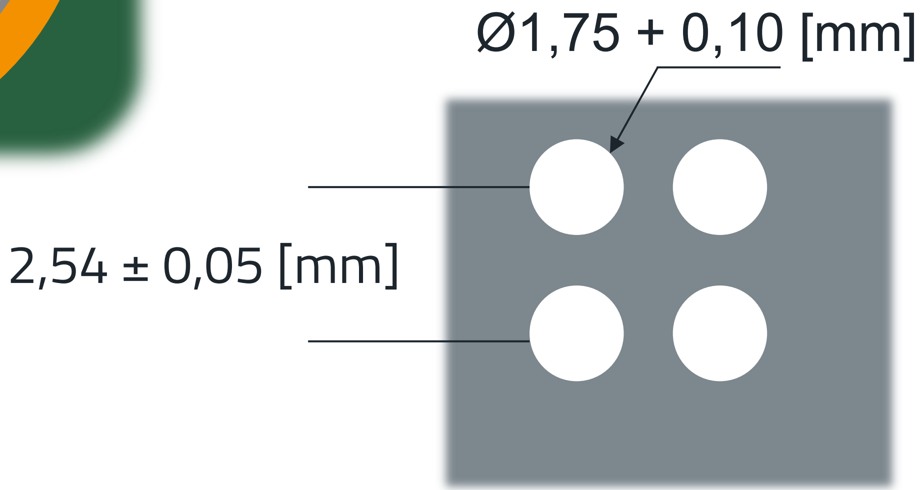

EINPRESSVORGANG

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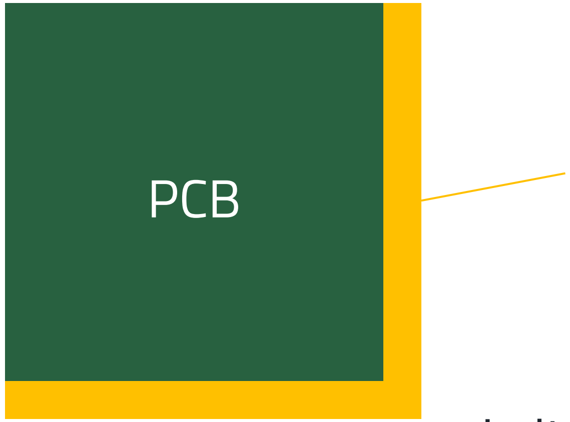
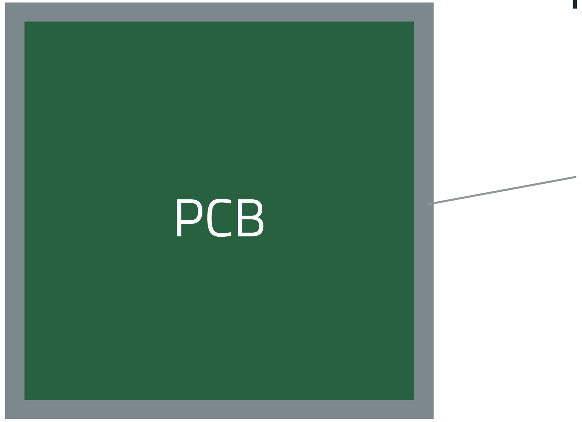
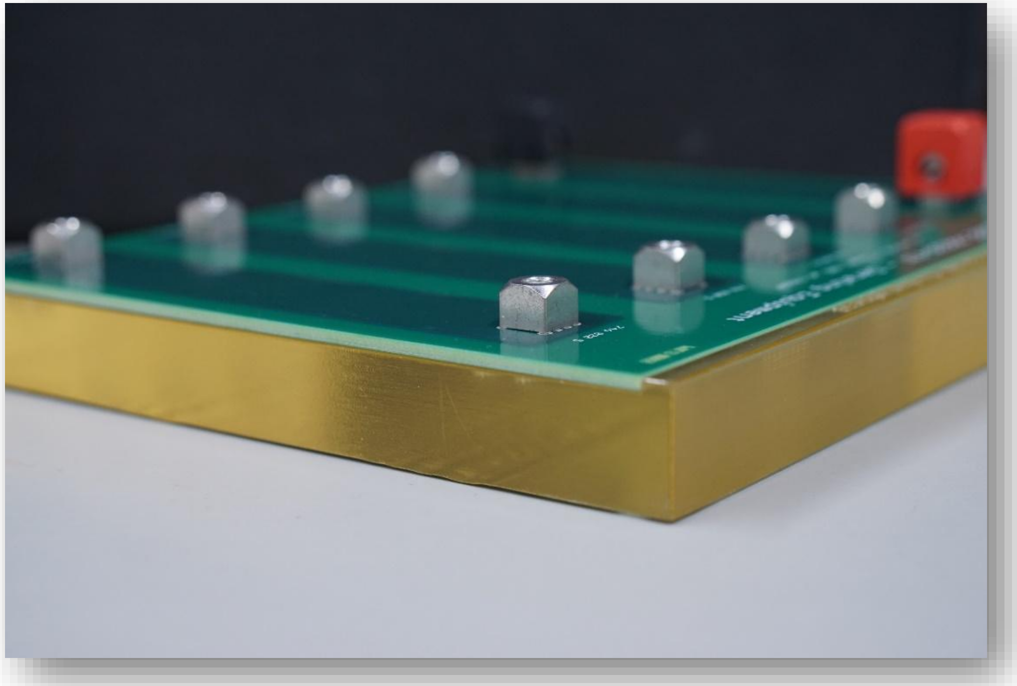


3D gedruckte Unterlage

Leiterplatten Arretierung mit Rahmen oder Stiften

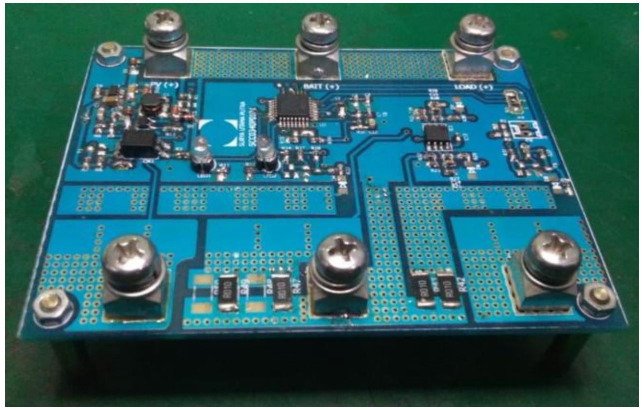


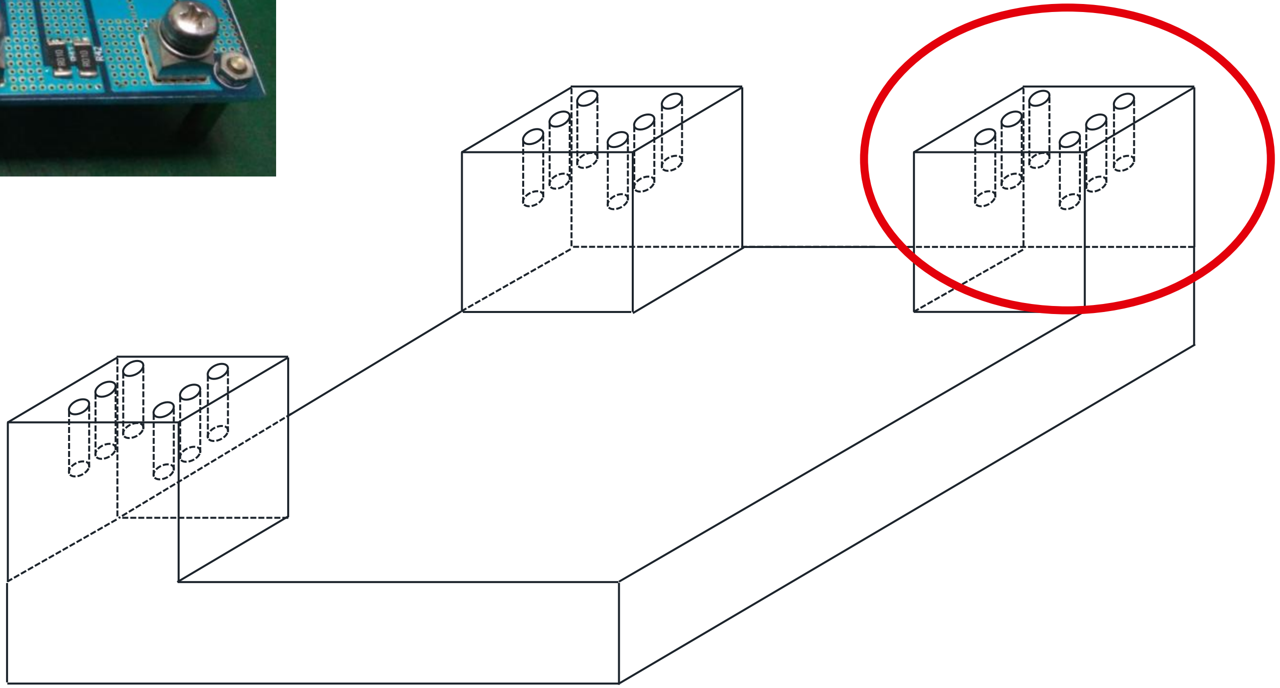
Metall Unterlage

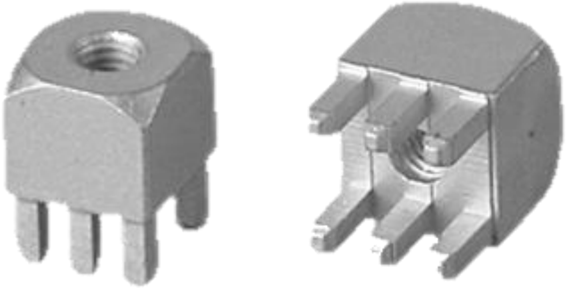


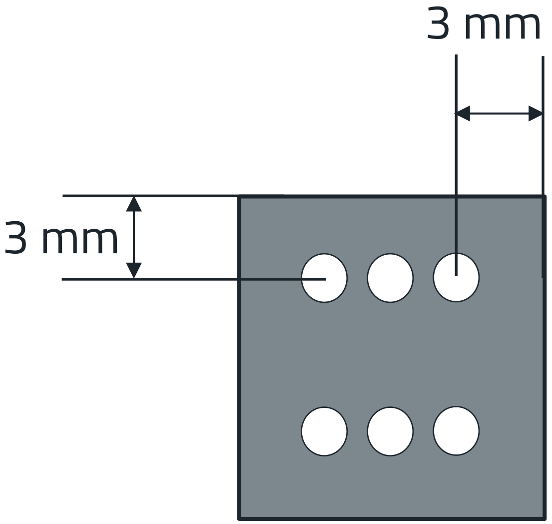
EINPRESSVORGANG

Kundenbeispiel







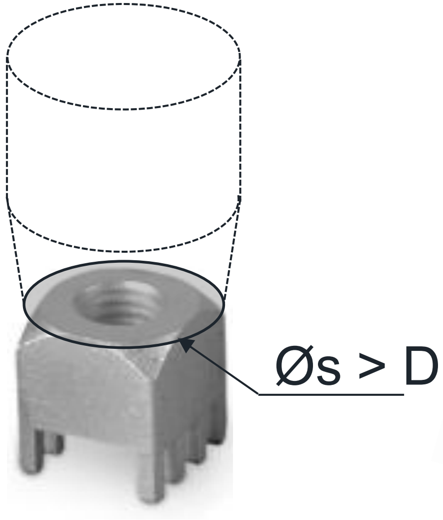


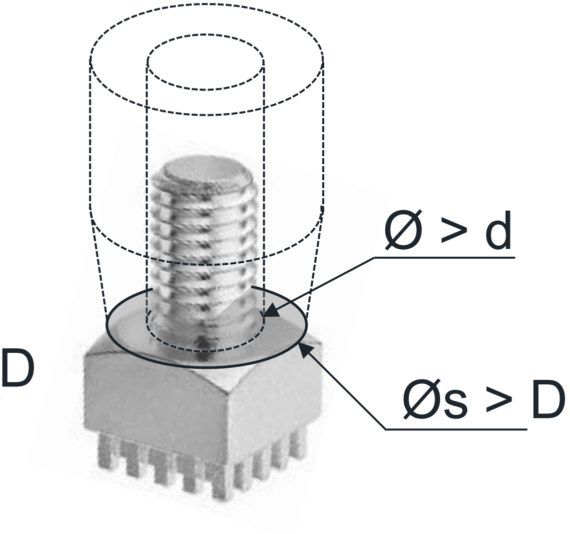
EINPRESSVORGANG

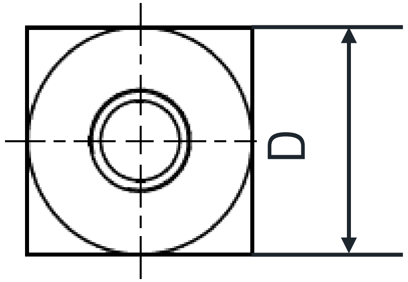
Unterlage: 3D gedruckte Unterlage

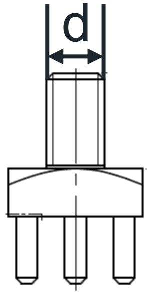
EINPRESSVORGANG

Stempel



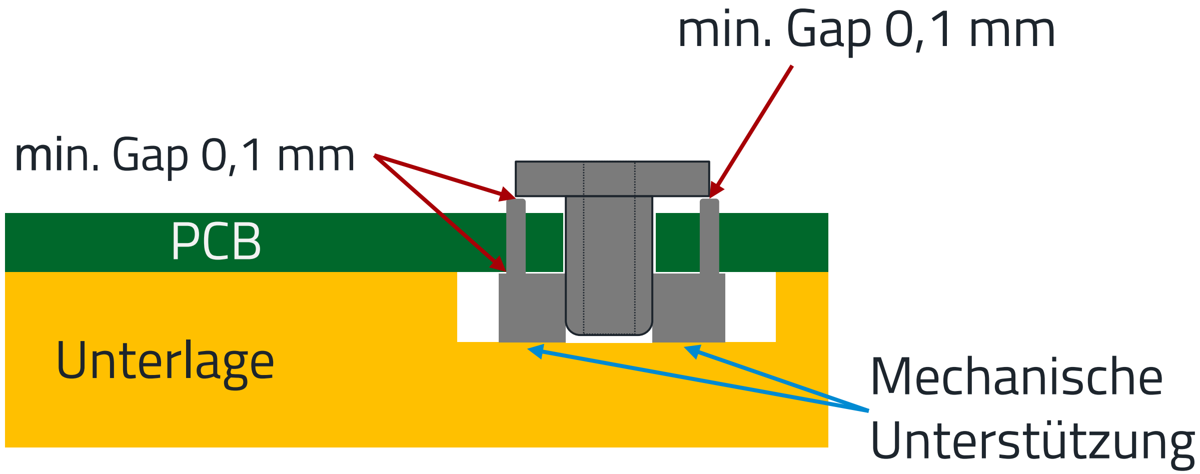


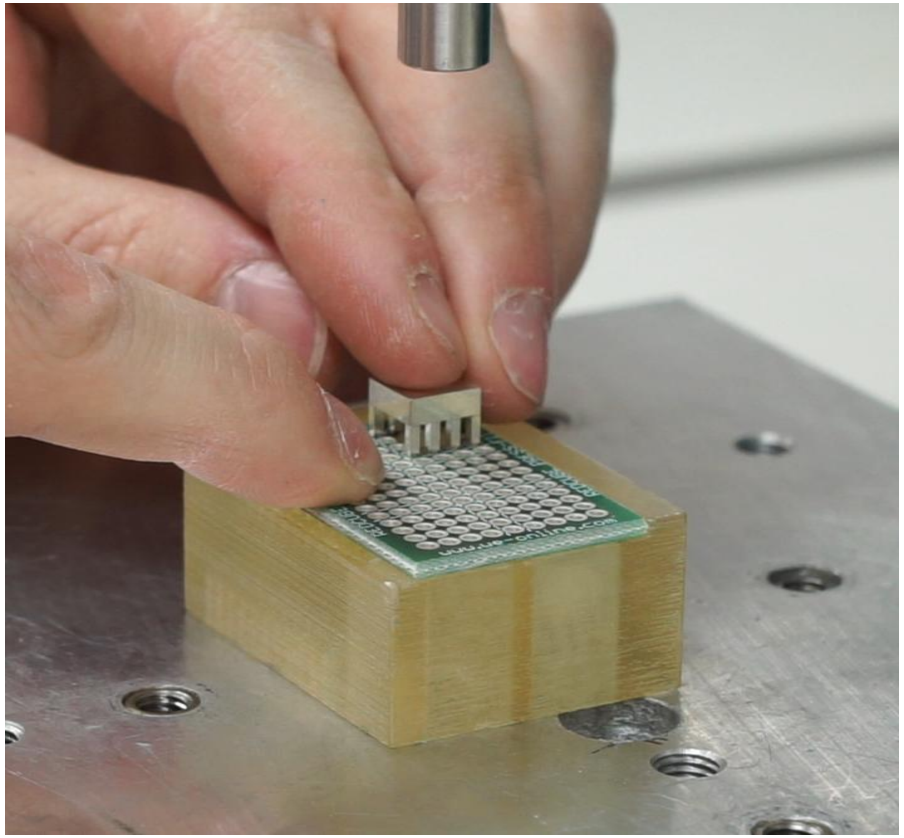




EINPRESSVORGANG

Einpressen von zweiteiligen Elementen





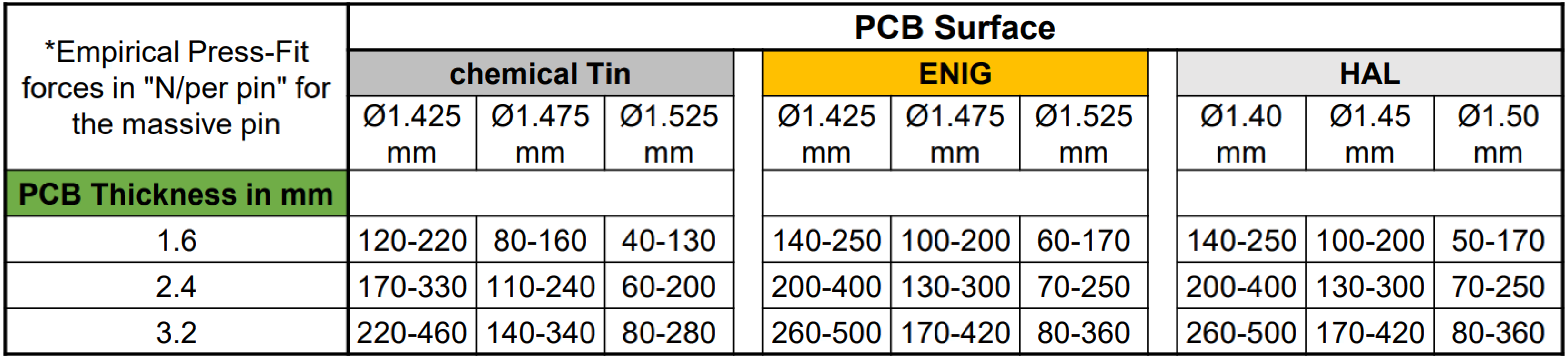
WERKZEUG

Pressen und Zubehör

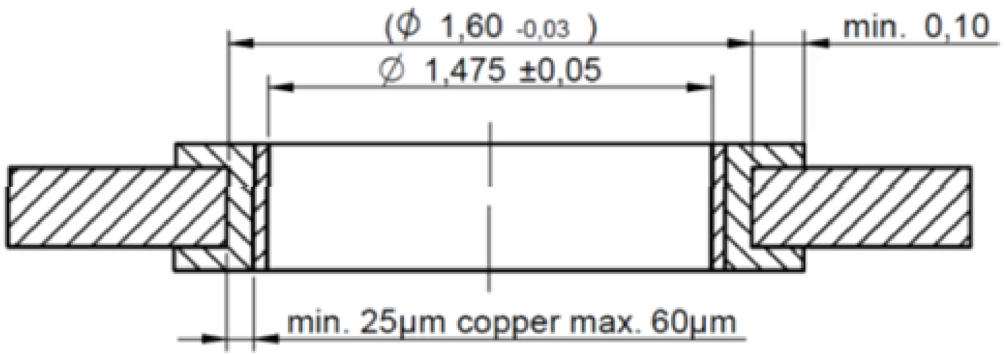
- Schmidt Presses
- Gechter GmbH

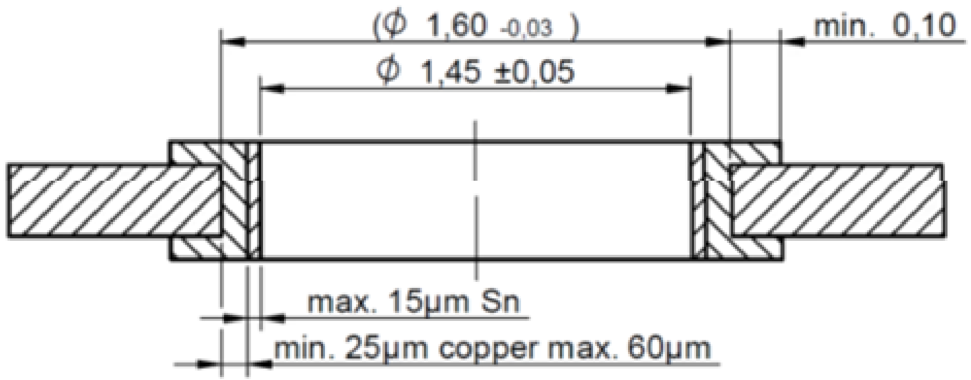
EINPRESSKRÄFTE

Chemische und HAL Oberflächen



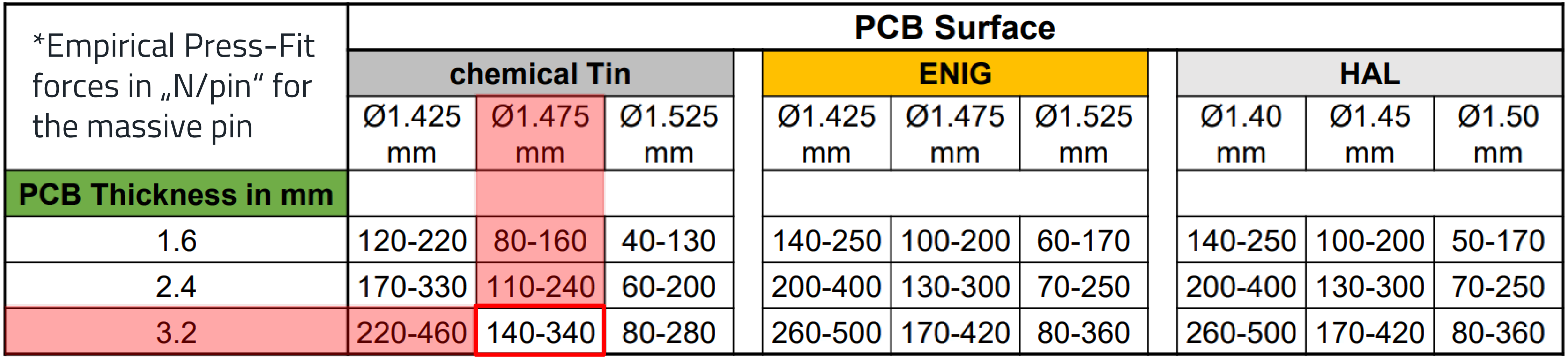
*Empirical Press-Fit forces in "N/per pin" for the massive pin	PCB Surface								
	chemical Tin			**ENIG**			**HAL**		
	Ø1.425 mm	Ø1.475 mm	Ø1.525 mm	Ø1.425 mm	Ø1.475 mm	Ø1.525 mm	Ø1.40 mm	Ø1.45 mm	Ø1.50 mm
PCB Thickness in mm									
1.6	120-220	80-160	40-130	140-250	100-200	60-170	140-250	100-200	50-170
2.4	170-330	110-240	60-200	200-400	130-300	70-250	200-400	130-300	70-250
3.2	220-460	140-340	80-280	260-500	170-420	80-360	260-500	170-420	80-360





EINPRESSKRÄFTE

Chemische und HAL Oberflächen



*Empirical Press-Fit forces in „N/pin“ for the massive pin	PCB Surface								
	chemical Tin			ENIG			HAL		
	Ø1.425 mm	Ø1.475 mm	Ø1.525 mm	Ø1.425 mm	Ø1.475 mm	Ø1.525 mm	Ø1.40 mm	Ø1.45 mm	Ø1.50 mm
PCB Thickness in mm									
1.6	120-220	80-160	40-130	140-250	100-200	60-170	140-250	100-200	50-170
2.4	170-330	110-240	60-200	200-400	130-300	70-250	200-400	130-300	70-250
3.2	220-460	140-340	80-280	260-500	170-420	80-360	260-500	170-420	80-360

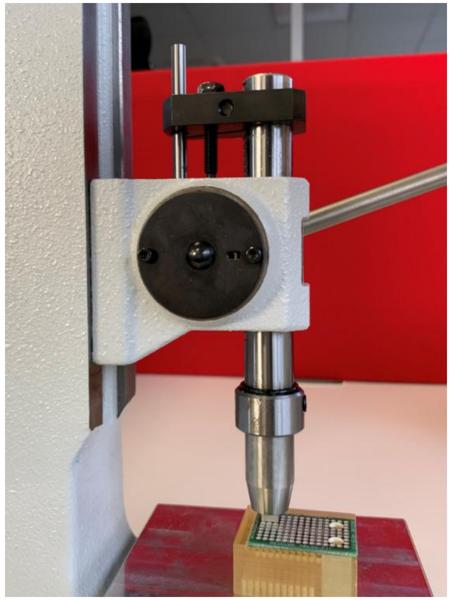
redcube12 pins - PCB chemical tin thickness 3,2 mm

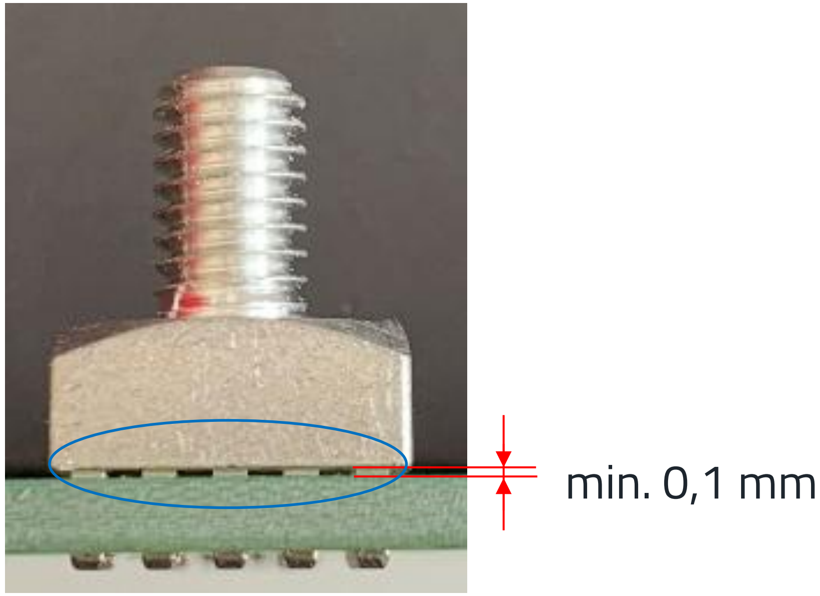
→ 1,7 kN < press effort < 4 kN

Press dimensioning > max effort +20 % security => pressforce ∼ 5 kN

EINPRESSVORGANG

Einstellungen und Optische Kontrolle





- Endanschlag einstellen
- Einpressgeschwindigkeit≈ 100 – 250 mm/min
- Einpressvorgang in einem Schritt durchführen

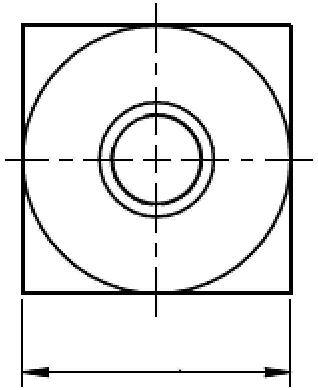
- Luftspalt zwischen REDCUBE and Leiterplatte
- Pinanfasung ist unter der Leiterplatte sichtbar.

PCB DESIGN

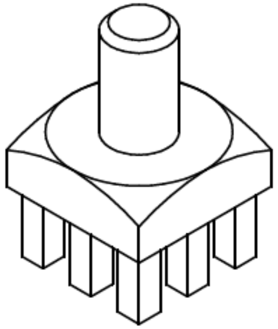
PCB DESIGN

Faustformel

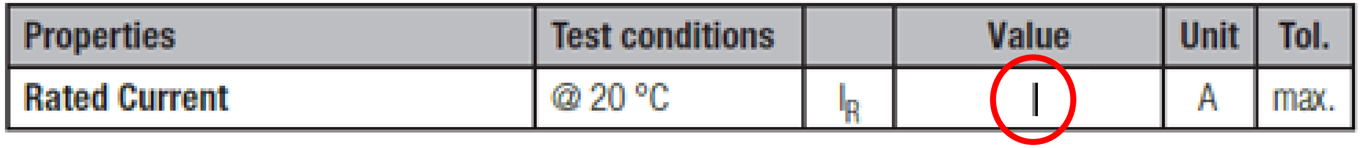
$$\text{Breite} \approx x[mm]\cdot 3$$



$$x\ mm$$



$$\text{Dicke} \approx \frac{I}{0,3}\,[\mu m]$$

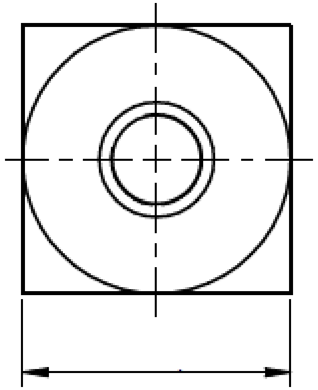


Properties	Test conditions		Value	Unit	Tol.
Rated Current	@ 20 °C	I_R	I	A	max.

PCB DESIGN

Faustregel- Beispiel

$\text{Breite} \approx 21\ mm$

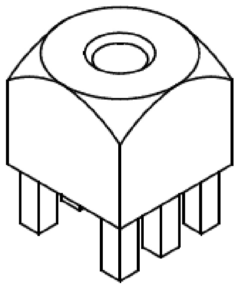


$\mathbf{7.0}\ mm$

$\text{Dicke} \approx \frac{I}{0,3}\ \mu m \approx 330\ \mu m$

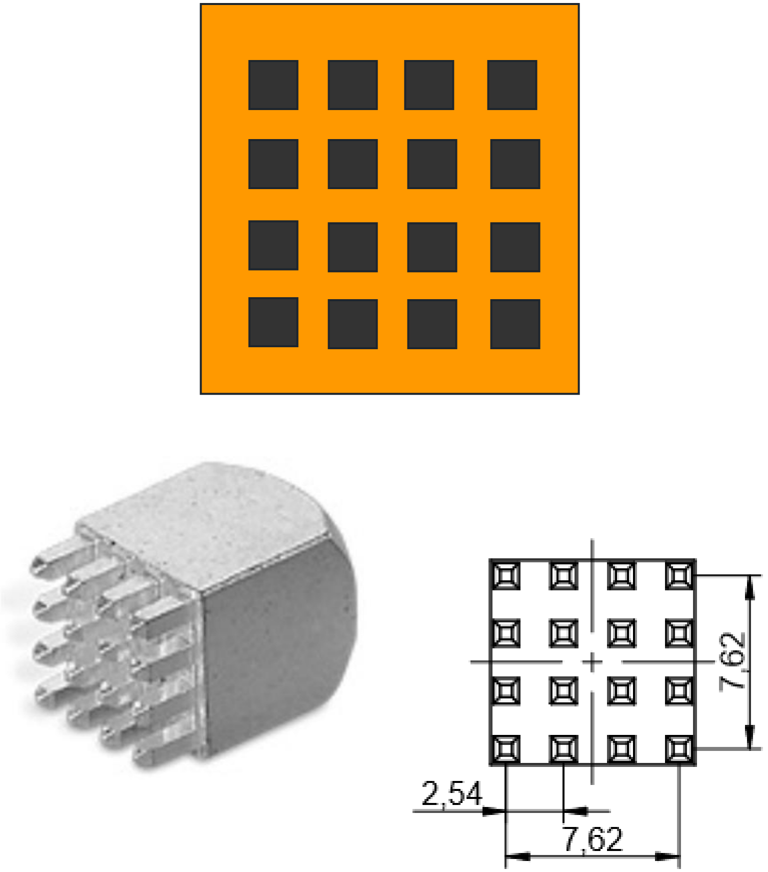
6 Lagen mit 70 µm
oder
4 Lagen mit 105 µm

Properties	Test conditions		Value	Unit	Tol.
Rated Current	@ 20 °C	I_R	100	A	max.

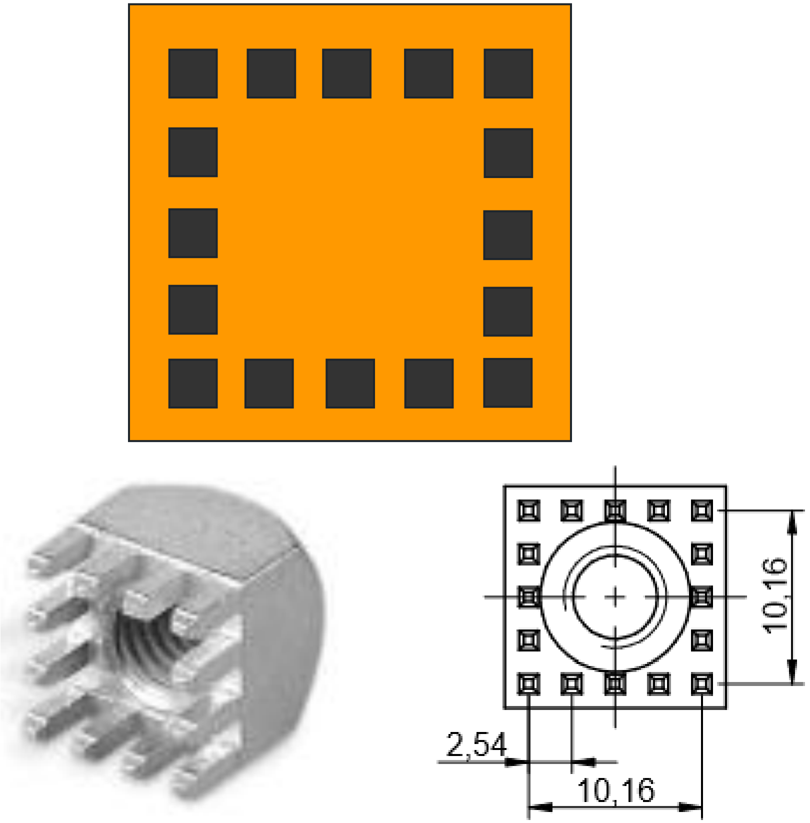


PCB DESIGN

Temperaturanstiegstest



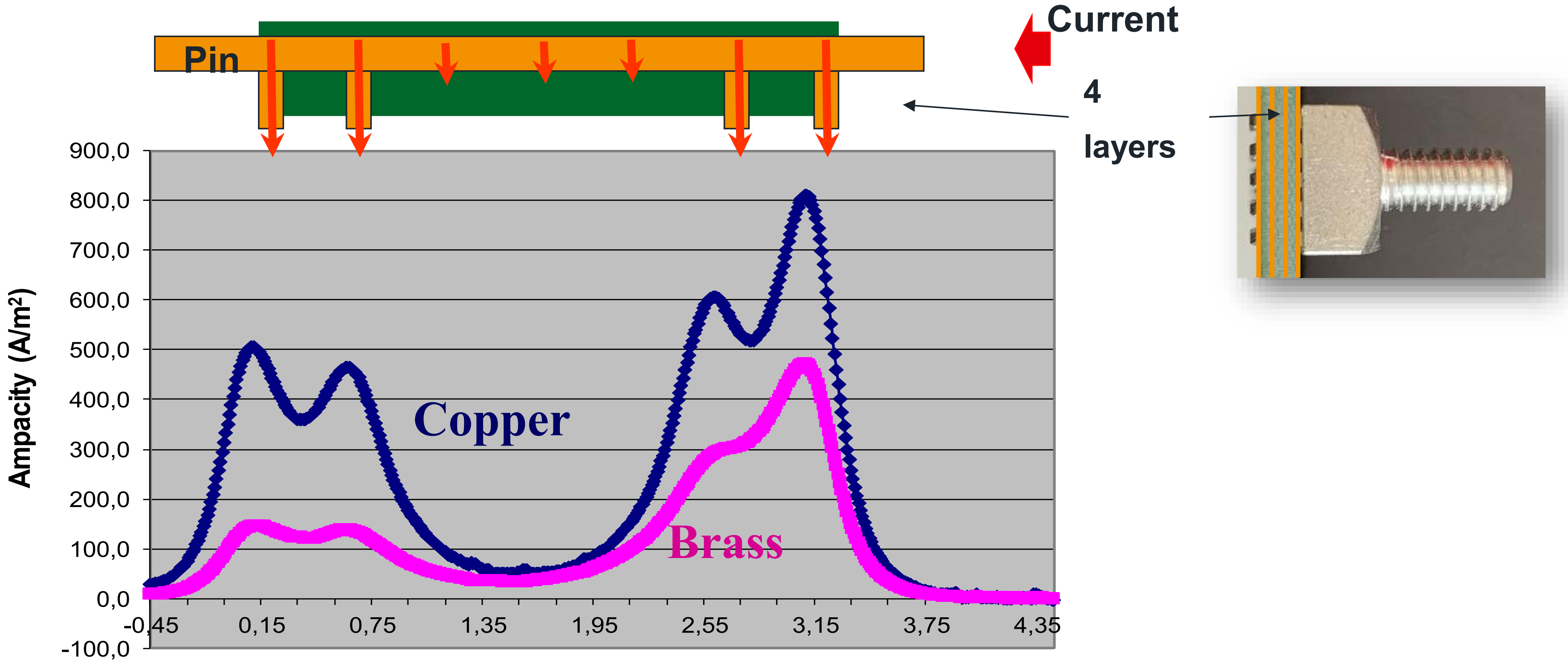
Imax = 180 A



Imax = 240 A

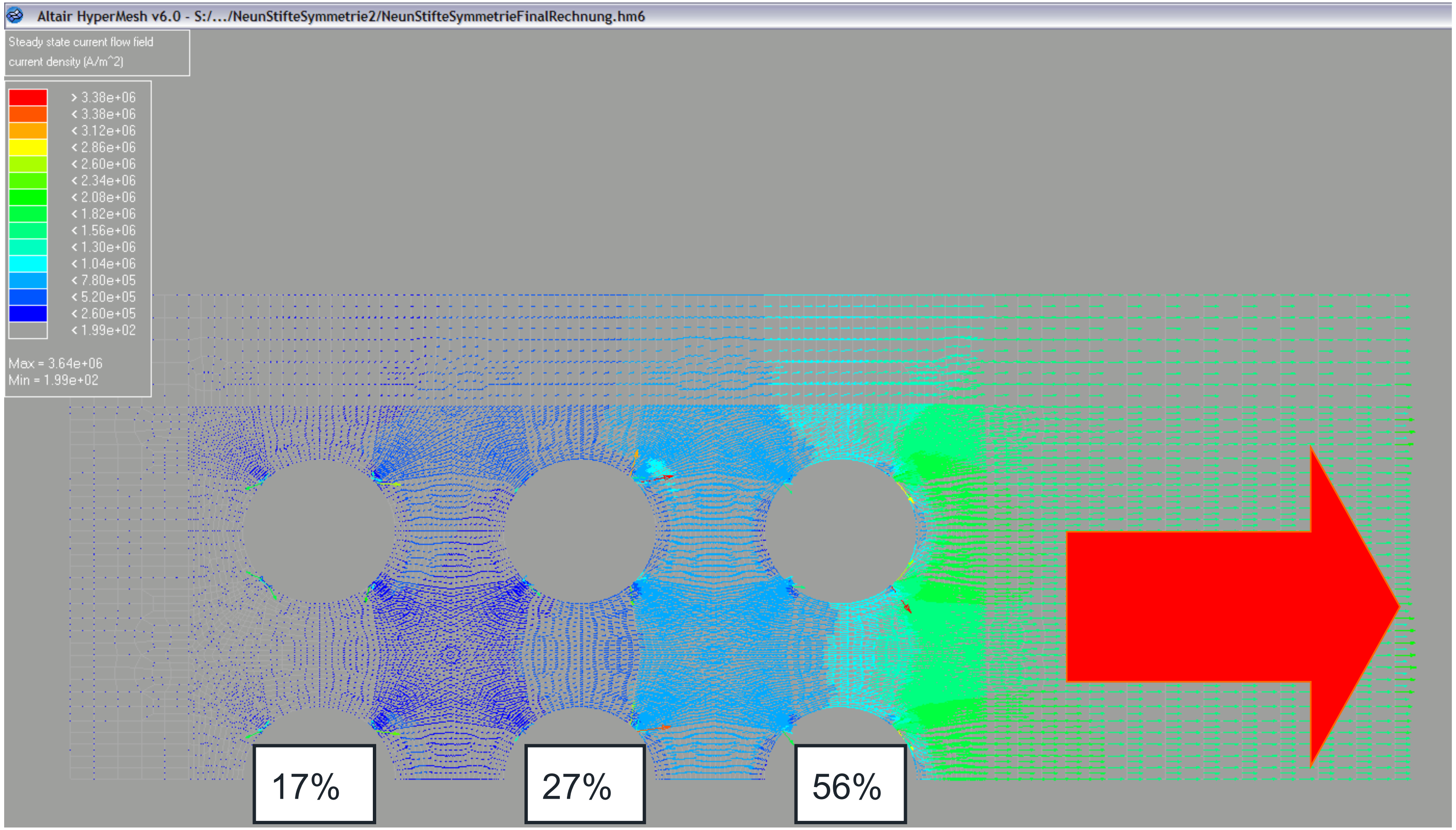
PCB DESIGN

Temperaturanstiegstest



PCB DESIGN

Stromdichte J=I/A



Altair HyperMesh v6.0 - S:/.../NeunStifteSymmetrie2/NeunStifteSymmetrieFinalRechnung.hm6

Steady state current flow field
current density (A/m^2)

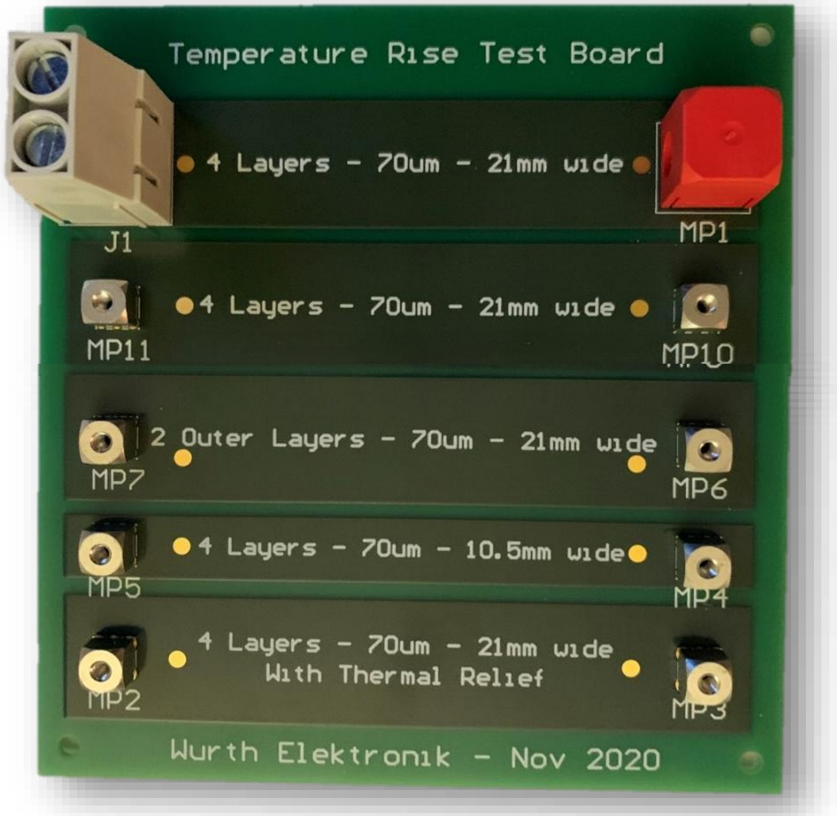
🟥 > 3.38e+06
🟧 < 3.38e+06
🟧 < 3.12e+06
🟨 < 2.86e+06
🟩 < 2.60e+06
🟩 < 2.34e+06
🟩 < 2.08e+06
🟩 < 1.82e+06
🟩 < 1.56e+06
🟦 < 1.30e+06
🟦 < 1.04e+06
🟦 < 7.80e+05
🟦 < 5.20e+05
🟦 < 2.60e+05
⬜ < 1.99e+02

Max = 3.64e+06
Min = 1.99e+02

PCB DESIGN

Temperaturanstiegstest

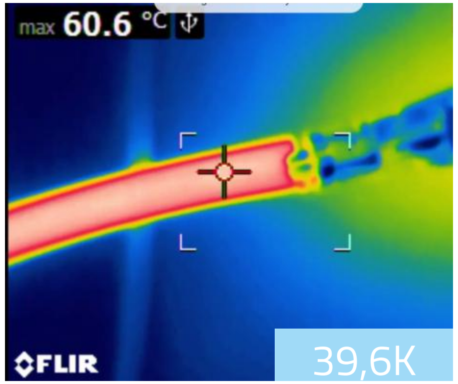
- Ziel:
  - Optimale Wärmeverteilung
  - Design Verifikation
  - Anzahl Layers, Einfluss auf die Temperatur?

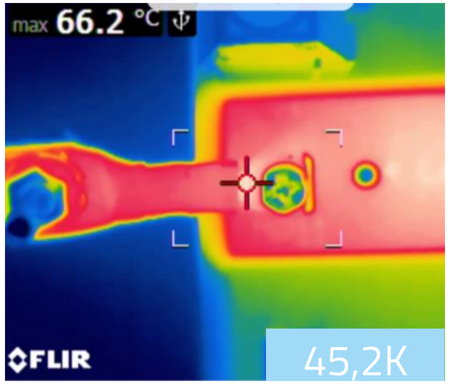


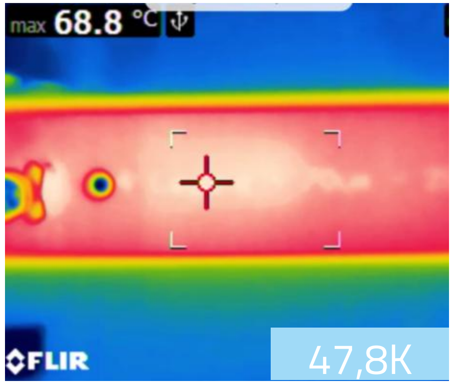
PCB DESIGN

Temperaturanstiegstest, Strom 100A

- PCB Design:
  - 4 Lagern
  - Kupfer 70 µm
  - Breite 21 mm
  - Umgebungstemperatur 21 °C

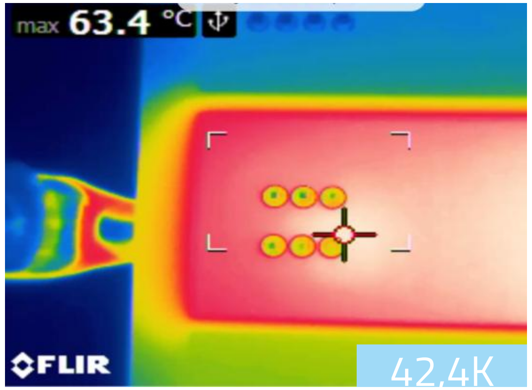






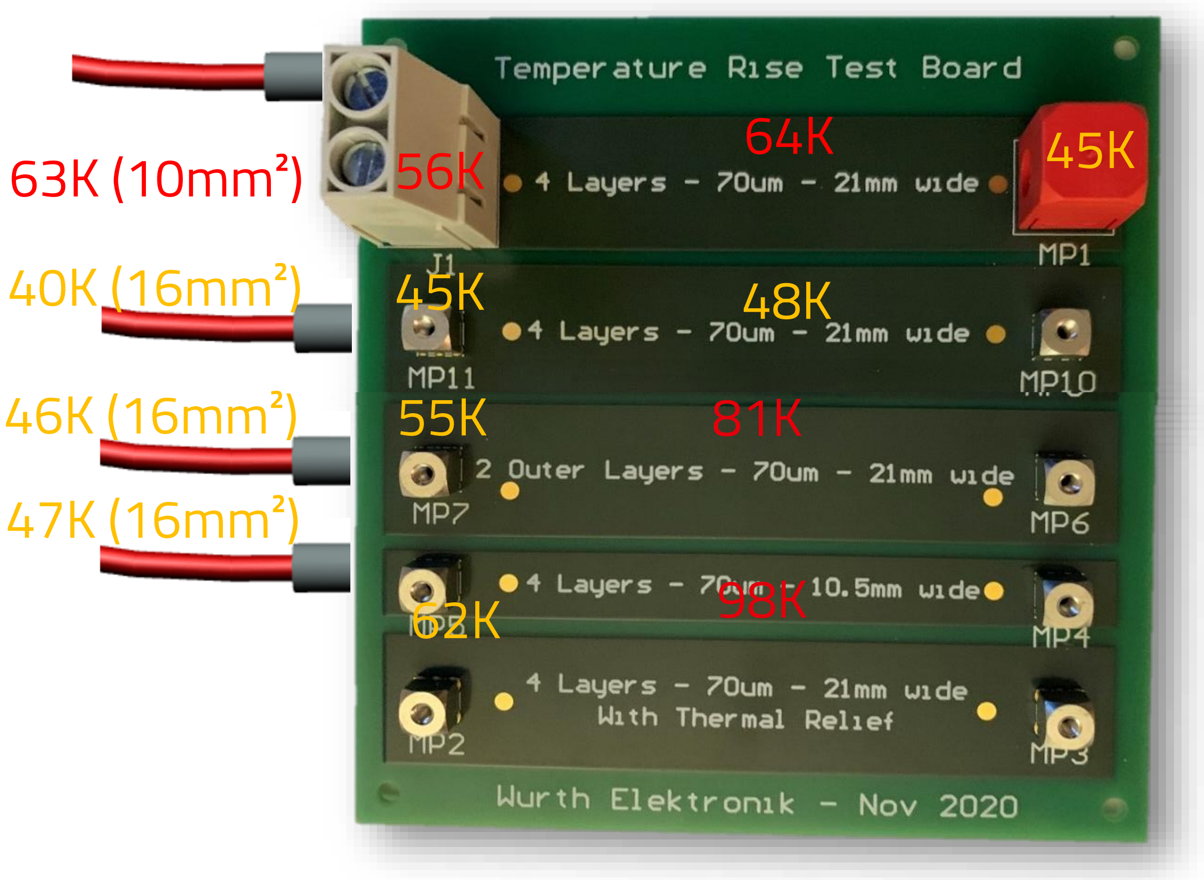
Das Design mit der Faustrgegel zeigt einen guten Temperaturausgleich im gesamten system.

Pressfit Verbindung erhöht nicht ΔT



PCB DESIGN

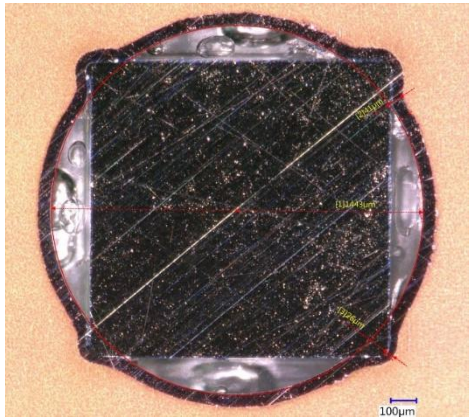
Temperaturanstiegstest, Strom 100A

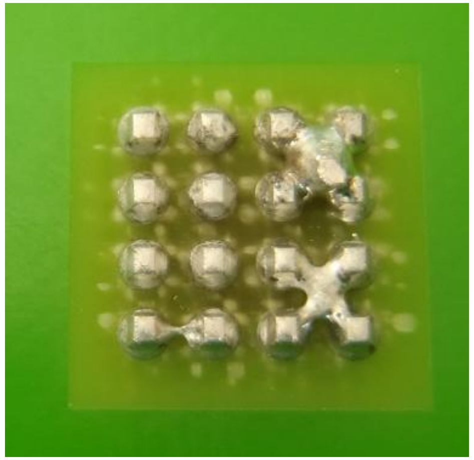


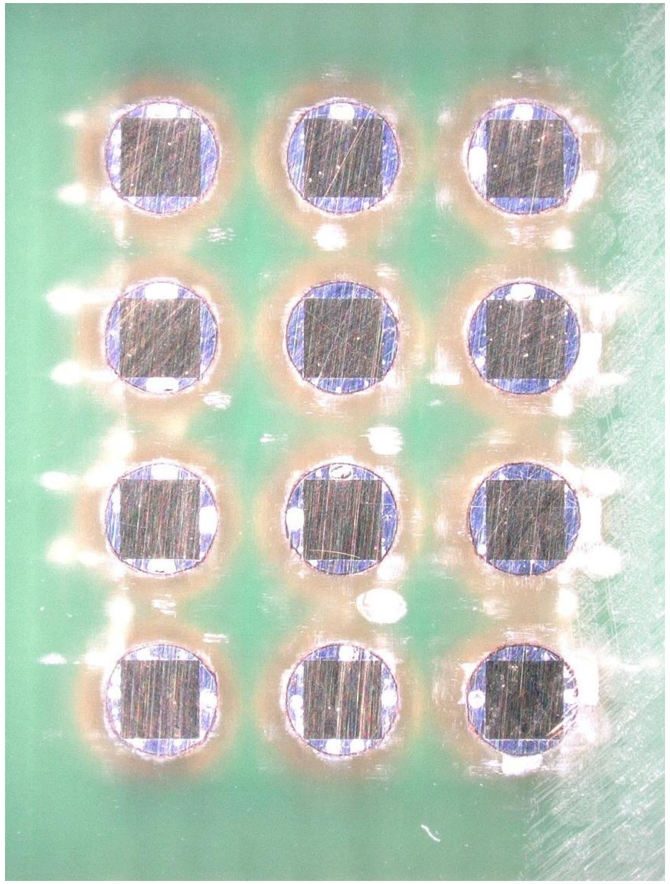
LÖTBARKEIT

LÖTBARKEIT

Pressfit

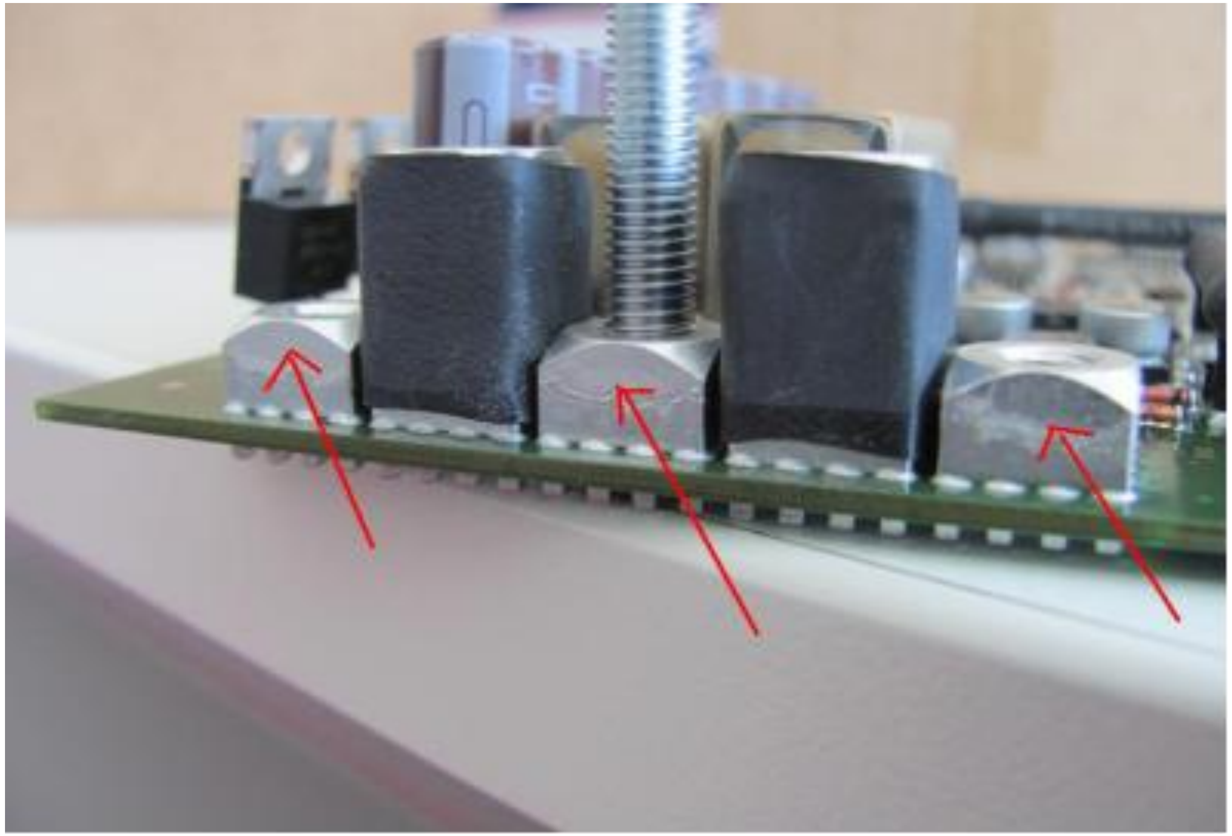


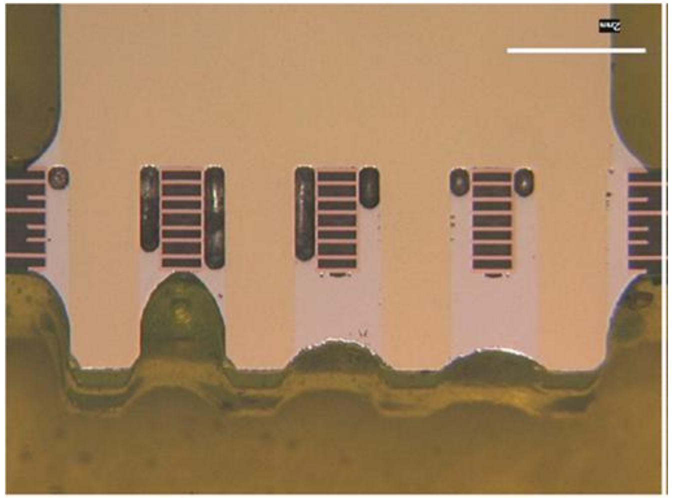




LÖTBARKEIT

Pressfit

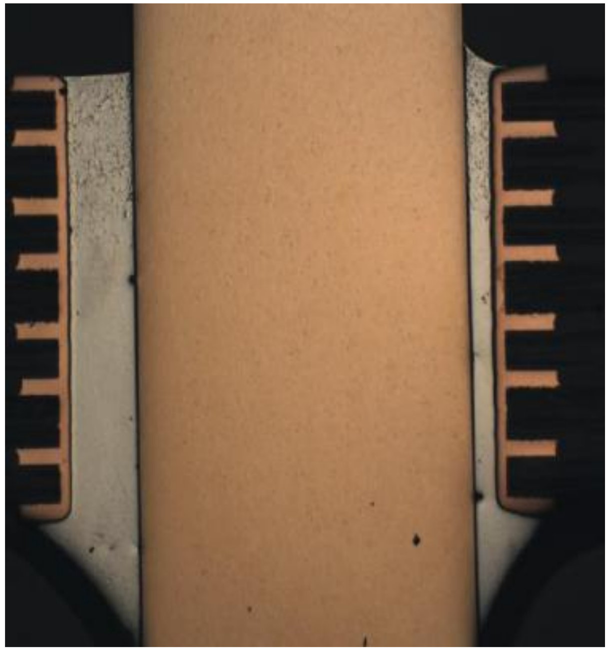


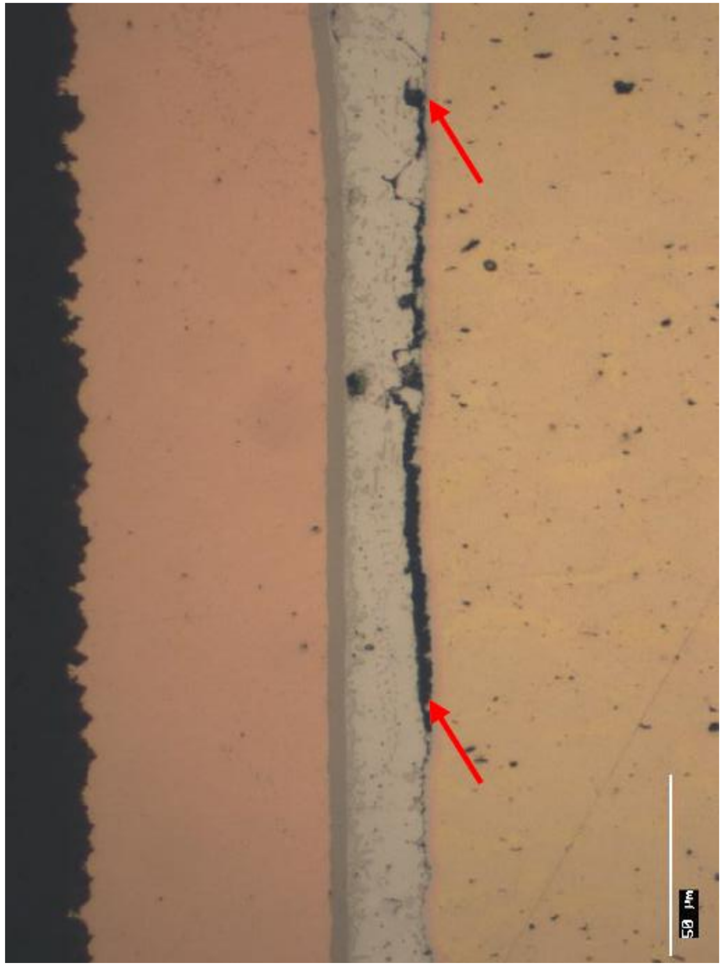


LÖTBARKEIT

Pressfit: Warum Löten nicht sinnvoll ist

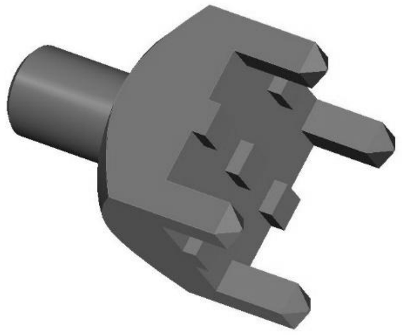
- Ausdehnungskoeffizient α
  - Kupfer: $16,5 \times 10^{-6} \times K^{-1} = 0,0165$ mm / m * K
  - Messing: $18,4 \times 10^{-6} \times K^{-1} = 0,0184$ mm / m * K
  - Zinn: $26,7 \times 10^{-6} \times K^{-1} = 0,0267$ mm / m * K

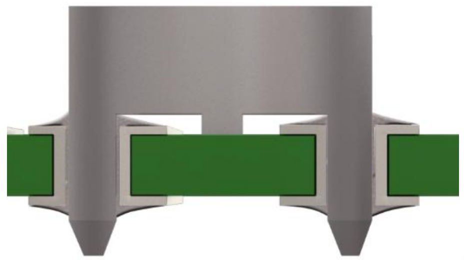


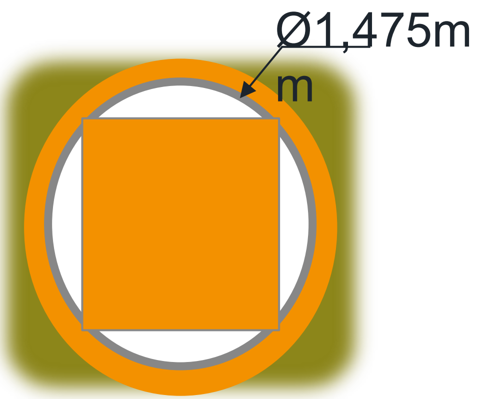


REDCUBE

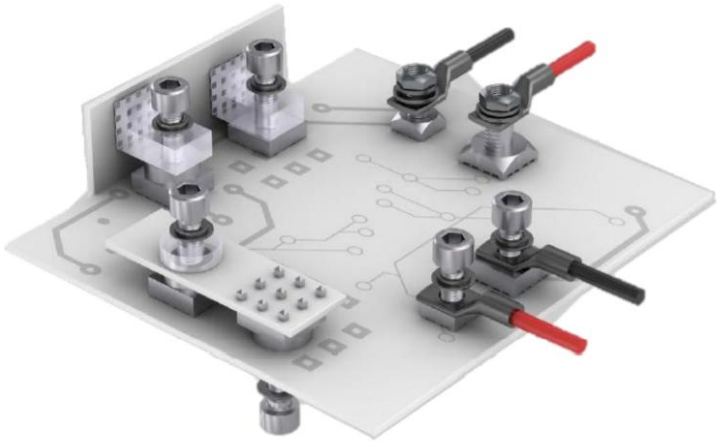
THR

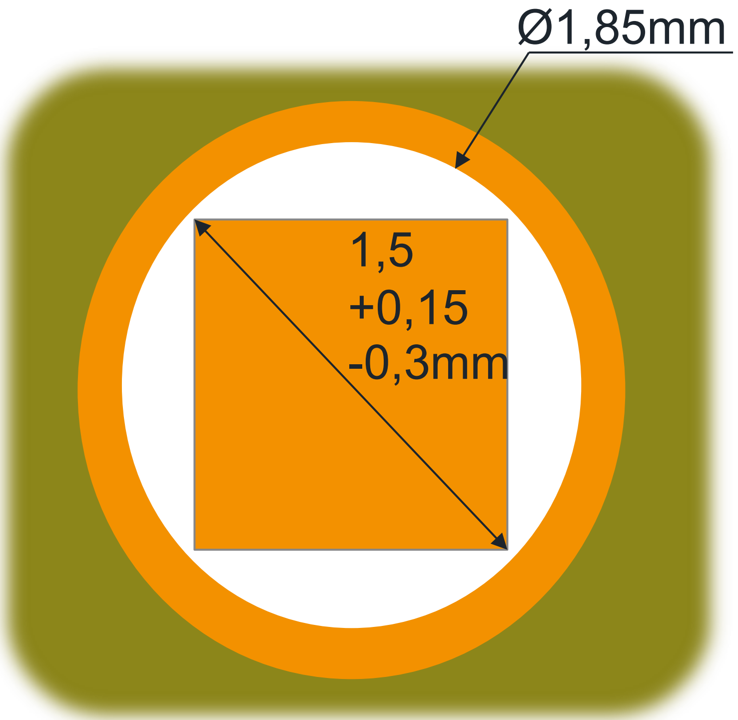






Press-fit

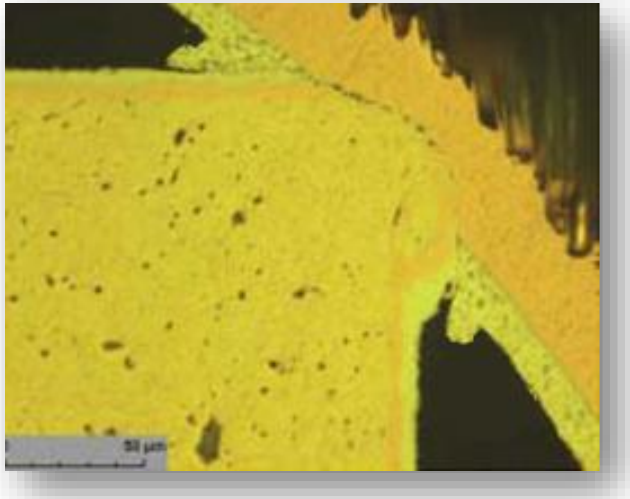




REDCUBE

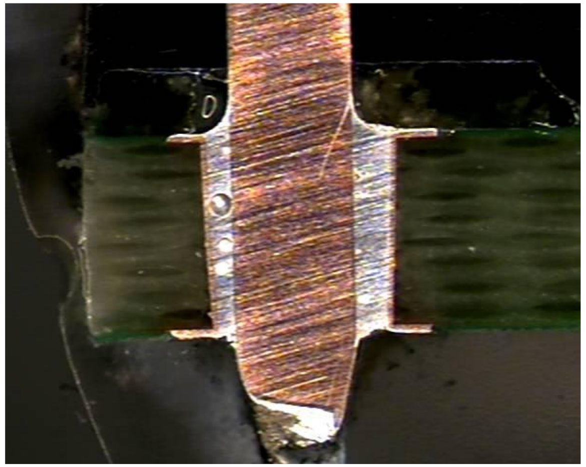
THR

- Press-Fit



Up to 350A

- THR

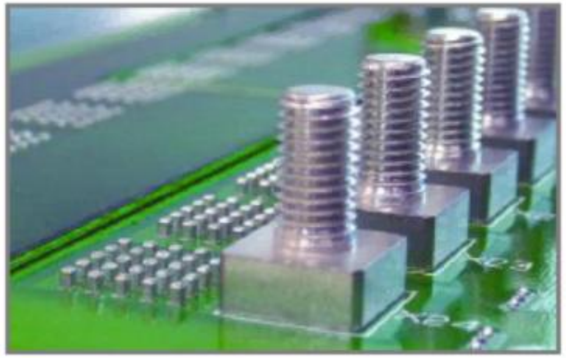


Up to 85A

APPLIKATIONEN

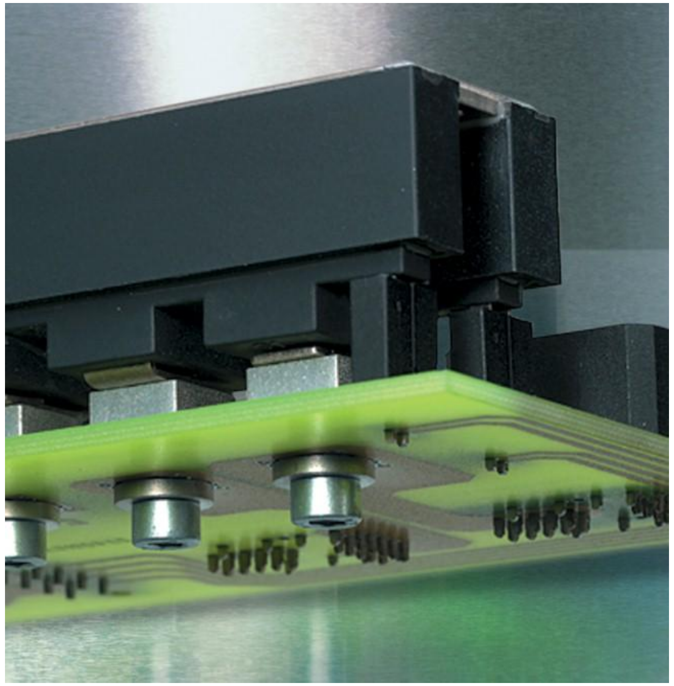
APPLIKATIONEN

Beispiel

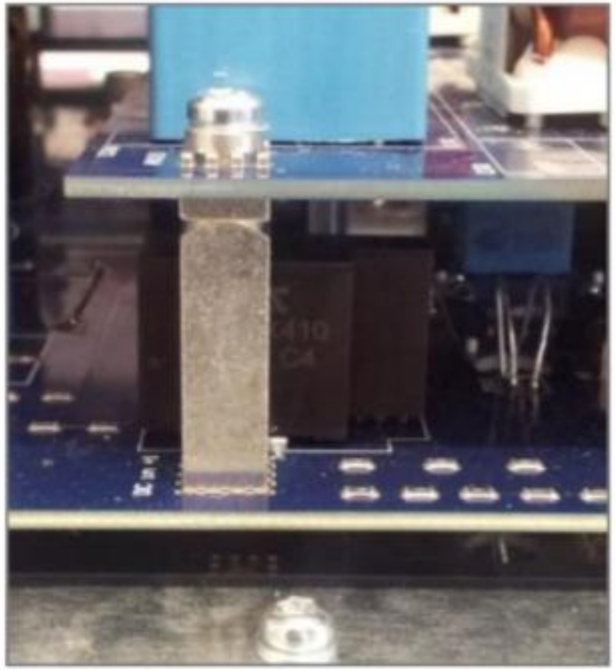


Double sides mounting

Laminated fuse



IGBT connection



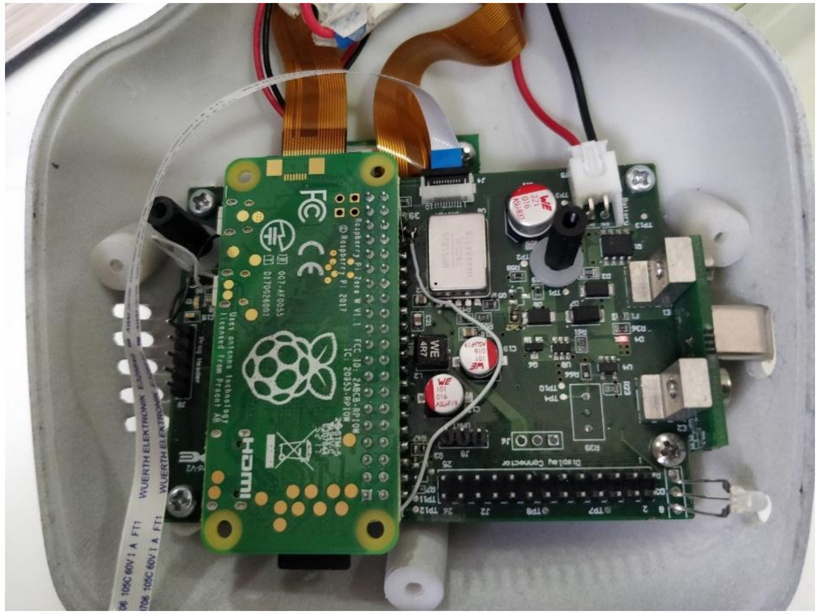
High current board to board

APPLIKATIONEN

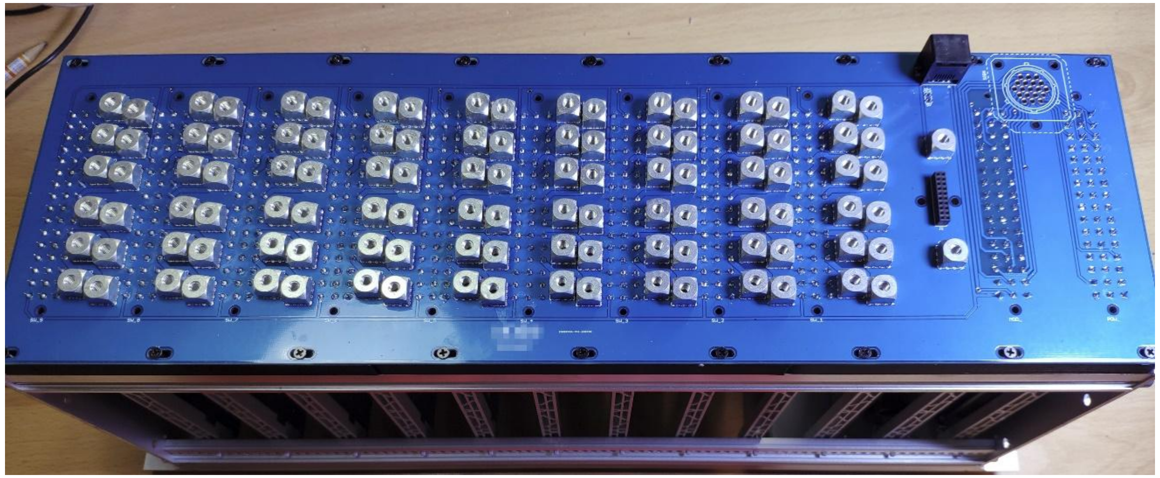
Beispiel

APPLIKATIONEN

Beispiel



Bilder WE



Bilder Polar

POLAR

Senkrechte Board-to-Board-Verbindung

High-Power-Backplane

APPLIKATIONEN

Beispiel

All pictures WE