

# AKAFLEX® PENCL HT: Copper laminates on a PEN-film backing for flexible printed circuits

## The AKAFLEX® PENCL HT programme

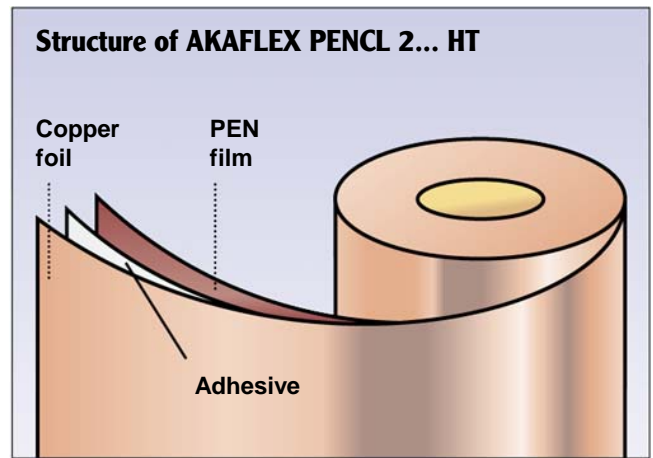
AKAFLEX PENCL HT is available from KREMPEL as

- ✓ two-layer laminates and
- ✓ three-layer laminates.

A polyethylene-naphthalate film (PEN) is used as the backing material for the copper. This is laminated on one or both sides with electrolytic (ED) copper foil. AKAFLEX PENCL HT is characterised by its lasting stability to high temperatures compared to PET-Laminates. PEN-film laminates of different dimensional stability (HT2 and HT3) or with special copper foils are available on request.

A modified epoxy system characterised by very good temperature stability has been developed for the HT product family. In combination with polyimide film, the bonding system used here reaches a temperature index per UL 796 of 150°C.

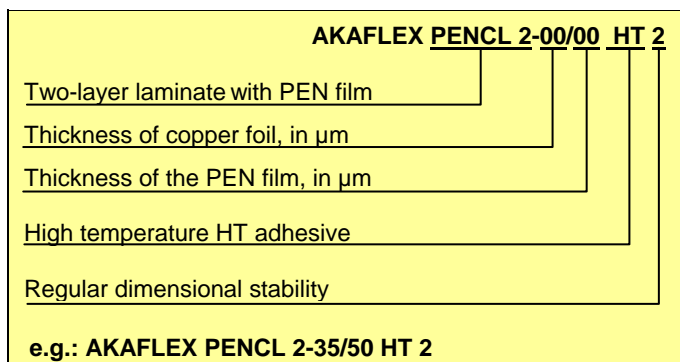
AKAFLEX PENCL HT is manufactured from PEN film and copper foil of differing thickness grades. The various types are identified in the product designation by letters and combinations of numbers.



### Standard types of AKAFLEX® PENCL HT

Standard-type designation	Thickness of copper foil	Thickness of PEN film
<b>Two-layer laminates</b>		
PENCL 2-17/50 HT 2	17 µm	50 µm
PENCL 2-35/50 HT 2	35 µm	50 µm
PENCL 2-35/75 HT 2 Regular dimensional stability (MD/TD ≤ 0.7%)	35 µm	75 µm
<b>... with PEN film of higher dimensional stability</b>		
PENCL 2-17/50 HT 3	17 µm	50 µm
PENCL 2-35/50 HT 3	35 µm	50 µm
PENCL 2-35/75 HT 3 High dimensional stability (MD/TD ≤ 0.3%)	35 µm	75 µm

### Designation for a two-layer laminate



**Other types  
on request**

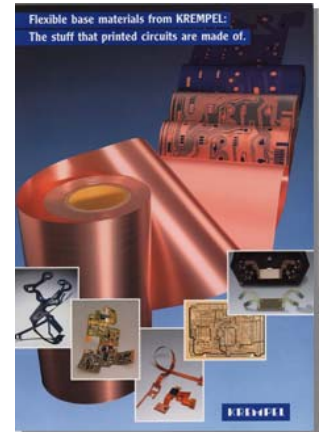
## Processing AKAFLEX® PENCL HT

AKAFLEX PENCL HT can be processed »reel to reel« by screen-printing or photolithography and the standard etching and cleaning techniques. The technical advantages in manufacturing are assured in this way.

A comprehensive range of **coverlays** for mechanical protection of the etched circuits is available from KREMPEL.

## Quality assurance

All AKAFLEX products are subject to the procedures of on-going quality control as defined in the Quality Assurance Handbook of August Krempel Soehne. This quality assurance system is certified as meeting the requirements of ISO 9001 and ISO/TS 16949. For AKAFLEX PENCL HT, testing is performed on the master reels according to the methods given in IPC-TM 650. The test results are evaluated in accordance with IPC-4204/23.



## Availability of AKAFLEX® PENCL HT

- ✓ **Standard reel width:**  
1350 mm, 1100 mm or 1000 mm;  
other widths on request
- ✓ **Standard reel length:**  
100 m;  
other lengths on request
- ✓ **Format:**  
As requested by the customer
- ✓ **Packaging:**  
Reels packed suspended in robust corrugated-cardboard cartons
- ✓ **Standard cores:**  
Inside diameter 76 mm
- ✓ **Certificate:**  
Test certificate according to EN 10 204 - 2.2.

## Technical data for AKAFLEX® PENCL 2-17/50 HT2 and HT3

### 17 µm copper foil / 50 µm PEN film

Laminate properties	Test method IPC-TM 650	IPC- 4204/23 May 2002	Typical values				Typical values			
			PENCL HT2				PENCL HT3			
Peel strength	2.4.9	≥ 0.35	0.9	N/mm	5.1	lb/in	0.9	N/mm	5.1	lb/in
Dimensional stability (after etching and 30 min. at 150°C/300°F)	2.2.4 Method C	≤ 0.3	≤ 0.7	%	≤ 0.7	%	≤ 0.3	%	≤ 0.3	%
Solder-bath stability (Reflow)	-	N/A	5 min at 250 °C		5 min at 480 °F		5 min at 250 °C		5 min at 480 °F	

Properties of the PEN film	Test method	Typical values			Typical values		
		HT2	HT3		HT2	HT3	
Dimensional stability MD/TD (30 min. at 150°C/300°F)	ASTM D1204	0.5	0.1	%	0.5	0.1	%
Tensile strength MD	ASTM D882	> 140		N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>		psi
TD	ASTM D882	> 140		N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>		psi
Failure strain MD	ASTM D882	> 50		%	> 50		%
TD	ASTM D882	> 50		%	> 50		%
Volume resistivity	ASTM D257	10 <sup>18</sup>		Ω · cm	10 <sup>18</sup>		Ω · cm
Surface resistivity	ASTM D257	10 <sup>17</sup>		Ω / □	10 <sup>17</sup>		Ω / □
Breakdown voltage	ASTM D149	> 220		kV/mm	> 5600		V/mil
Dielectric constant (ε <sub>r</sub> ) (23°C/73°F; 1kHz)	ASTM D150	2.9		--	2.9		--
Dielectric loss factor (tan δ) (23°C/73°F; 1kHz)	ASTM D150	0.005		--	0.005		--
Melting point	-	266		°C	510		°F
Glass transition temperature	DSC	120		°C	248		°F
Coefficient of linear thermal ex- pansion (between 30°C/86°F and 50°C/122°F)	ASTM D696	1.3 x 10 <sup>-5</sup>		1/K	1.3 x 10 <sup>-5</sup>		1/K
Max. service temperature	UL 746B	160		°C	320		°F
Max. water absorption Immersion, 24 h at 23°C/73°F)	ASTM D570	0.4		%	0.4		%

**3.3.3**

All values stated are to be seen as typical values. We reserve the right to introduce changes within the framework of further technical development. We do not accept any obligations or liabilities in respect of this information. Status: 11/2005  
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## Technical data for AKAFLEX® PENCL 2-35/50 HT2 and HT3

### 35 µm copper foil / 50 µm PEN film

Laminate properties	Test method IPC-TM 650	IPC-4204/23 May 2002	Typical values				Typical values			
			PENCL HT2		PENCL HT3		PENCL HT2		PENCL HT3	
Peel strength	2.4.9	≥ 0.7	1	N/mm	5.7	lb/in	1	N/mm	5.7	lb/in
Dimensional stability (after etching and 30 min. at 150°C/300°F)	2.2.4 Method C	≤ 0.3	≤ 0.7	%	≤ 0.7	%	≤ 0.3	%	≤ 0.3	%
Solder-bath stability (Reflow)	-	N/A	5 min at 250 °C		5 min at 480 °F		5 min at 250 °C		5 min at 480 °F	

Properties of the PEN film	Test method	Typical values		Typical values	
		HT2	HT3	HT2	HT3
Dimensional stability MD/TD (30 min. at 150°C/300°F)	ASTM D1204	0.5	0.1 %	0.5	0.1 %
Tensile strength MD	ASTM D882	> 140	N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>	psi
TD	ASTM D882	> 140	N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>	psi
Failure strain MD	ASTM D882	> 50	%	> 50	%
TD	ASTM D882	> 50	%	> 50	%
Volume resistivity	ASTM D257	10 <sup>18</sup>	Ω · cm	10 <sup>18</sup>	Ω · cm
Surface resistivity	ASTM D257	10 <sup>17</sup>	Ω / □	10 <sup>17</sup>	Ω / □
Breakdown voltage	ASTM D149	> 220	kV/mm	> 5600	V/mil
Dielectric constant (ε <sub>r</sub> ) (23°C/73°F; 1kHz)	ASTM D150	2.9	--	2.9	--
Dielectric loss factor (tan δ) (23°C/73°F; 1kHz)	ASTM D150	0.005	--	0.005	--
Melting point	-	266	°C	510	°F
Glass transition temperature	DSC	120	°C	248	°F
Coefficient of linear thermal ex- pansion (between 30°C/86°F and 50°C/122°F)	ASTM D696	1.3 x 10 <sup>-5</sup>	1/K	1.3 x 10 <sup>-5</sup>	1/K
Max. service temperature	UL 746B	160	°C	320	°F
Max. water absorption Immersion, 24 h at 23°C/73°F)	ASTM D570	0.4	%	0.4	%

## Technical data for AKAFLEX® PENCL 2-35/75 HT2 and HT3

### 35 µm copper foil / 75 µm PEN film

Laminate properties	Test method IPC-TM 650	IPC-4204/23 May 2002	Typical values				Typical values			
			PENCL HT2				PENCL HT3			
Peel strength	2.4.9	≥ 0.7	1	N/mm	5.7	lb/in	1	N/mm	5.7	lb/in
Dimensional stability (after etching and 30 min. at 150°C/300°F)	2.2.4 Method C	≤ 0.3	≤ 0.7	%	≤ 0.7	%	≤ 0.4	%	≤ 0.4	%
Solder-bath stability (Reflow)	-	N/A	5 min at 250 °C		5 min at 480 °F		5 min at 250 °C		5 min at 480 °F	

Properties of the PEN film	Test method	Typical values			Typical values		
		HT2	HT3		HT2	HT3	
Dimensional stability MD/TD (30 min. at 150°C/300°F)	ASTM D1204	0.5	0.1	%	0.5	0.1	%
Tensile strength MD	ASTM D882	> 140		N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>		psi
TD	ASTM D882	> 140		N/mm <sup>2</sup>	> 20.3x10 <sup>3</sup>		psi
Failure strain MD	ASTM D882	> 50		%	> 50		%
TD	ASTM D882	> 50		%	> 50		%
Volume resistivity	ASTM D257	10 <sup>18</sup>		Ω · cm	10 <sup>18</sup>		Ω · cm
Surface resistivity	ASTM D257	10 <sup>17</sup>		Ω / □	10 <sup>17</sup>		Ω / □
Breakdown voltage	ASTM D149	> 220		kV/mm	> 5600		V/mil
Dielectric constant (ε <sub>r</sub> ) (23°C/73°F; 1kHz)	ASTM D150	2.9		--	2.9		--
Dielectric loss factor (tan δ) (23°C/73°F; 1kHz)	ASTM D150	0.005		--	0.005		--
Melting point	-	266		°C	510		°F
Glass transition temperature	DSC	120		°C	248		°F
Coefficient of linear thermal expansion (between 30°C/86°F and 50°C/122°F)	ASTM D696	1.3 x 10 <sup>-5</sup>		1/K	1.3 x 10 <sup>-5</sup>		1/K
Max. service temperature	UL 746B	160		°C	320		°F
Max. water absorption Immersion, 24 h at 23°C/73°F)	ASTM D570	0.4		%	0.4		%

3.3.5

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