Nickel Temperature Sensors

TEMPERATURE

HUMIDITY

FLOW

General Information

In many industrial sectors and fields of research, temperature measurement is one of the most important parameters which determines product quality, security, and reliability. Temperature sensors are available in several types all of which have a unique performance characteristic. The performance capability of the various sensors are a result of the manufacturing process and component materials associated with their technologies and intended application. It is IST Charter to produce sensors that exceed the industry standard of temperature measurement with additional capability to directly replace older traditional methods and provide the maximum performance. To this end IST has concentrated its development and manufacturing on the process and materials of high-end thin-film temperature sensors. Additionally these processes, partially derived from the semiconductor industry allows IST to manufacture sensors in very small dimensions. Because of their low thermic mass thin-film temperature sensors exhibit a very short response time. IST core technology and processes results in thin-film sensors that combine the good features of traditional wire wound nickel sensors such as accuracy, long-term stability, repeatability, interchangeability and wide temperature range, with the advantages of mass-production, which contributes to their optimal price/performance ratio.

Sensor Construction

The temperature sensor consists of a photo-lithographically structured, high-purity nickel coating arranged in the shape of a meander. The nickel thin-film structures are laser trimmed to form resistive paths with very precisely defined basic value of the resistivity. The sensors are covered with a dielectric layer to protect the sensor against mechanical and chemical damage. The bonded leads, which are additionally fixed with a sealing compound, provide the electrical contact to the resistive path.

Typical Features

– brief response time
– excellent long-term stability
– low self-heating rate
– simple interchangeability
– small dimensions
– simple linearisation
– resistant against vibration and temperature shocks

Response Time

The response time $T_{0.63}$ is the time in seconds the sensors need to respond to 63% of the change in temperature. The response time depends on the sensor dimensions.

Long-Term Stability

The change of ohmage after 1,000 hrs at maximum operating temperature amounts to less than 0.1%.

Self Heating

To measure the resistance an electric current has to flow through the element, which will generate heat energy resulting in errors of measurement. To minimize the error the testing current should be kept low (approximately 1 mA for Ni-1000). Temperature error $\Delta T = RI^2 / E$; with E = self-heating coefficient in mW/K R = resistance in kΩ, I = measuring current in mA

Nominal Values

The nominal value of the sensor is the target value of the sensor resistance at 0° C. The temperature coefficient α is defined as $\alpha = \frac{R_{100} - R_0}{100 \cdot R_0}$ [K^{-1}] and has the numerical value of 0.00618 K^{-1} for the sensors which comply the old norm DIN 43760.

In practice, a value multiplied by 10^6 is often entered: TCR = $10^6 * \frac{R_{100} - R_0}{100 \cdot R_0}$ [ppm/K].
In this case, the numerical value is 6180 ppm/K.

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Measurement current

Measuring current heats the nickel thin-film sensor. The resulting temperature error is given by: $\Delta T = P/E$ with P, the power loss = I^2R and E, the self heating coefficient in mW/K.

The amount of thermal transfer from the sensor in application determines how much measuring current can be applied. There is no bottom limit of the measurement current with nickel thin film. The measurement current depend highly on the application in use.

We recommend at:

100 Ω:	typ. 1 mA	max. 5 mA
500 Ω:	typ. 0.5 mA	max. 3 mA
1000 Ω:	typ. 0.3 mA	max. 2 mA
2000 Ω:	typ. 0.2 mA	max. 1 mA
10000 Ω:	typ. 0.1 mA	max. 0.3 mA

Temperatur Characteristic Curve

After DIN 43760 the Temperature Characteristic Curve is defined with a Polynomal of the 6th order:

$$R(t) = R_0 (1 + A * t + B * t^2 + C * t^3 + D * t^4 + E * t^5 + F * t^6)$$

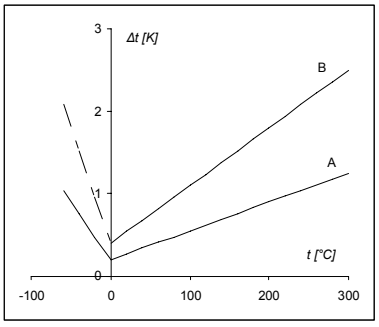
Coefficient for
Nickel NL (5000 ppm/K):
$A = 4.427 * 10^{-3}$ [°C^{-1}]; $B = 5.172 * 10^{-6}$ [°C^{-2}];
$C = 5.585 * 10^{-9}$ [°C^{-3}]; D = E = F = O

Nickel ND (6180 ppm/K):
$A = 5.485 * 10^{-3}$ [°C^{-1}]; $B = 6.65 * 10^{-6}$ [°C^{-2}]; C = 0;
$D = 2.805 * 10^{-11}$ [°C^{-4}]; E = O ; $F = -2 * 10^{-17}$ [°C^{-6}]

Nickel NJ (6370)
$A = 5.64742 * 10^{-3}$ [°C^{-1}]; $B = 6.69504 * 10^{-6}$ [°C^{-2}];
$C = 5.68816 * 10^{-9}$ [°C^{-3}]; D = E = F = 0

Nickel NA (6720)
$A = 5.88025 * 10^{-3}$ [°C^{-1}]; $B = 8.28385 * 10^{-6}$ [°C^{-2}]; C = 0;
$D = 7.67175 * 10^{-12}$ [°C^{-4}]; E = O ; $F = -1.5 * 10^{-16}$ [°C^{-6}]

R_0 = Nominal Resistance in Ohm at 0°C;
t = Temperature at ITS 90



Tolerance field

Tolerance classes

Class	+/- limit deviations in °C (K)		IST AG designation
	t<0°C	t>0°C	
DIN 43760	0.4 + 0.028 x |T|	0.4 + 0.007 x |T|	B
½ DIN 43760	0.2 + 0.014 x |T|	0.2 + 0.0035 x |T|	A

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Response Time and Self Heating

Dimension Number	Sensor Size	Response Time in seconds						Self Heating			
	L x W x T / H mm	Water V=0.4 m/s			Air V=1m/s			Water v=0 m/s		Air V=0 m/s	
		$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	$T_{0.5}$	$T_{0.63}$	$T_{0.9}$	mW/K	ΔT[mK]*	mW/K	ΔT[mK]*
232	2.3 x 2.0 x 0.25 / 0.8	0.09	0.12	0.33	2.7	3.6	7.5	40	2.3	4	22.5
232	2.3 x 2.0 x 0.65 / 1.3	0.15	0.2	0.55	4.5	6	12	40	2.3	4	22.5
325	3.0 x 2.5 x 0.65 / 1.3	0.25	0.3	0.7	5.5	7.5	16	90	1	8	11.3
516	5.0 x 1.6 x 0.65 / 1.3	0.25	0.3	0.7	5.5	7.5	16	80	1.1	7	12.9
520	5.0 x 2.0 x 0.65 / 1.3	0.25	0.3	0.75	6	8.5	18	80	1.1	7	12.9
525	5.0 x 2.5 x 0.65 / 1.3	0.33	0.4	0.85	6.5	9	19	90	1	8	11.3
102	10.0 x 2.0 x 0.65 / 1.3	0.33	0.4	0.85	7.5	10.5	20	140	0.6	10	9
538	5.0 x 3.8 x 0.65 / 1.3	0.35	0.4	0.9	7.5	10	20	140	0.6	10	9
505	5.0 x 5.0 x 0.65 / 1.3	0.4	0.5	1.1	8	11	21	150	0.6	11	0.6
SMD 1206	3.2 x 1.6 x 0.4	0.15	0.25	0.45	3.5	4.2	10	55	1.8	7	14.3
SMD 0805	2.0 x 1.2 x 0.4	0.10	0.12	0.33	2.5	3	8	38	2.6	4	25

*self heating ΔT[mK] measured for Ni1000 at 0.3mA measurement current at 0°C

Tolerances of Dimensions

Sensor width (W) ± 0.2 mm
Sensor length (L) ± 0.2 mm
Sensor height (H) ± 0.2 mm
Sensor thickness (T) ± 0.1 mm

Wire length ± 1.0 mm
Tube length ± 0.2 mm
Tube diameter ± 0.1 mm

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Nickel Temperature Sensors

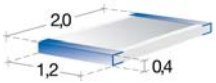
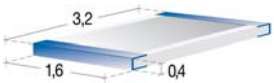
1P - Product Series

Temperature Range: –60°C .. +150°C

Temperature sensors in SMD constructions, TCR 6180 ppm/K, other curves on request
Soldering depot, RoHs conform (reflow soderable)

Technical Data

Temperature range:	-50°C to +150°C (1P, 2P)
Soldering connection:	Contacts: 1P = Contacts tin coated (62Sn/36Pb/2Ag), LMP lead contained 2P = Contacts tin coated (96.5Sn/3Ag/0.5Cu), LMP lead free, RoHS conform - The soldering process might lead to changed resistance values, therefore the original DIN class can not be guaranteed. - bondable contacts without bumps available on request.
Solderability:	235°C ≤ 8s (DIN IEC 68 2-20, Ta Meth 1)
Resistance to soldering heat:	260°C 10x (DIN IEC 68 2-20, Ta Meth. 1A)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100 500 1000	Nx0K1.0805.xP.x Nx0K5.0805.xP.x Nx1K0.0805.xP.x
	100 500 1000	Nx0K1.1206.xP.x Nx0K5.1206.xP.x Nx1K0.1206.xP.x

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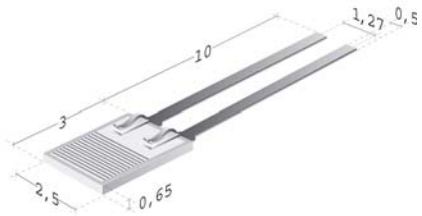
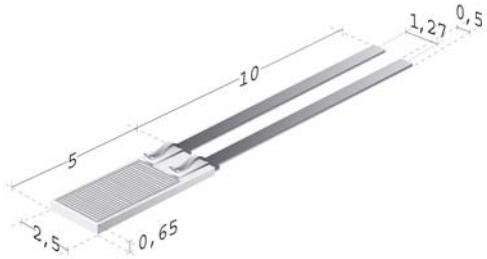
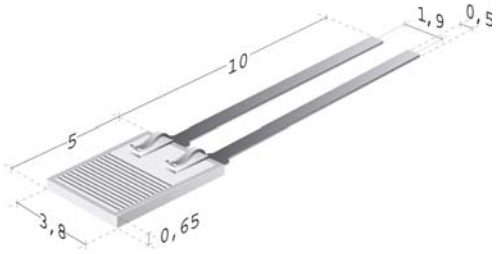
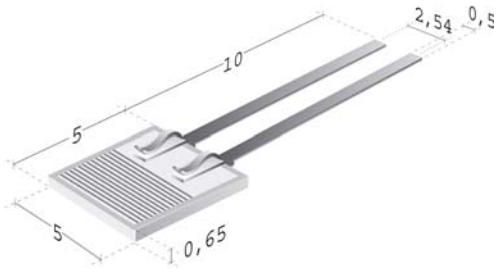
Nickel Temperature Sensors

1S - Product Series — Temperature Range: –60°C .. +150°C

Temperature sensors with SIL-Contacts (solderable, crimpable)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100 500 1000	Nx0K1.325.1S.x Nx0K5.325.1S.x Nx1K0.325.1S.x
	100 500 1000 10000	Nx0K1.525.1S.x Nx0K5.525.1S.x Nx1K0.525.1S.x Nx10K.525.1S.x
	100 500 1000	Nx0K1.538.1S.x Nx0K5.538.1S.x Nx1K0.538.1S.x
	100 500 1000	Nx0K1.505.1S.x Nx0K5.505.1S.x Nx1K0.505.1S.x

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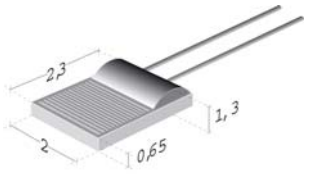
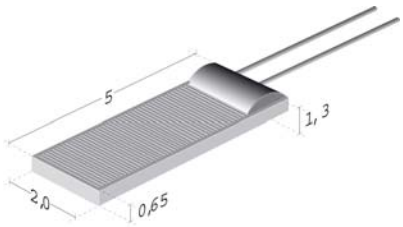
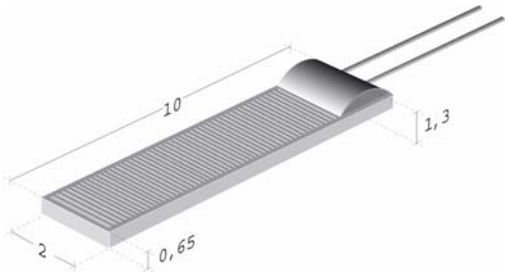
Nickel Temperature Sensors

2W - Product Series — Temperature Range: –60°C .. +200°C

Temperature sensors with wire connections
Silver wire connection 0.25 mm x 10 mm (solderable, weldable)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100 500 1000	Nx0K1.232.2W.x.010 Nx0K5.232.2W.x.010 Nx1K0.232.2W.x.010
	100 500 1000	Nx0K1.520.2W.x.010 Nx0K5.520.2W.x.010 Nx1K0.520.2W.x.010
	100 500 1000	Nx0K1.102.2W.x.010 Nx0K5.102.2W.x.010 Nx1K0.102.2W.x.010

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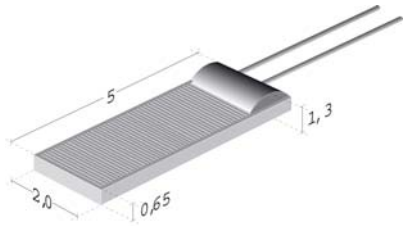
Nickel Temperature Sensors

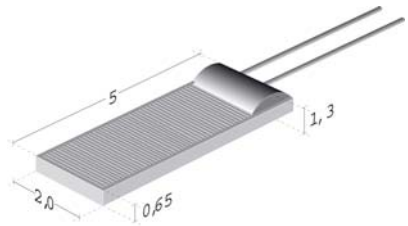
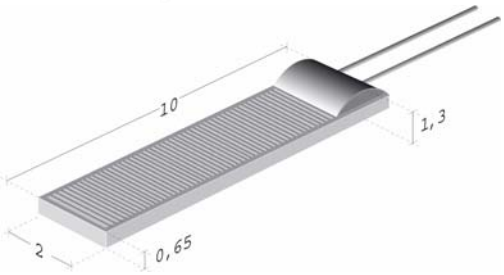
2FW - Product Series — Temperature Range: –60°C .. +200°C

Temperature sensors with Flat Wire (FW) connections
Au/Ni wire 0.2 x 0.4 x 7 mm (H x W x L), (solderable, weldable, crimpable)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100 500 1000	Nx0K1.520.2FW.x Nx0K5.520.2FW.x Nx1K0.520.2FW.x

2I / 2K - Product Series — Temperature Range: –60°C .. +200°C

Temperature sensors with PTFE-insulated connections
2 I Au/Cu wire, PTFE- insulated, AWG 30 (solderable, weldable), wire length at your choice
2 K Au/Cu wire, PTFE- insulated, AWG 26 (solderable, weldable), wire length at your choice

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100 500 1000	Nx0K1.520.2x.x Nx0K5.520.2x.x Nx1K0.520.2x.x
	100 500 1000	Nx0K1.102.2x.x Nx0K5.102.2x.x Nx1K0.102.2x.x

3W - Product Series — Temperature Range: –60°C .. +300°C

Temperature sensors for increased temperature range
Nickel wire connection 0.20 mm x 10 mm (solderable, weldable, crimpable)

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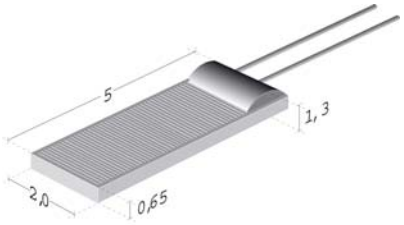
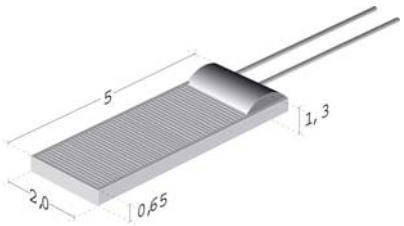
Nickel Temperature Sensors

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100	Nx0K1.520.3W.x.010
	500	Nx0K5.520.3W.x.010
	1000	Nx1K0.520.3W.x.010

NJ - Product Series — Temperature Range: –60°C .. +200°C

Temperature sensors with TCR 6370 ppm/K
Silver wire connections 0.25 mm x 10 mm (solderable, weldable)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	891	NJ891.520.2W.B.010

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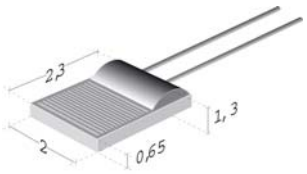
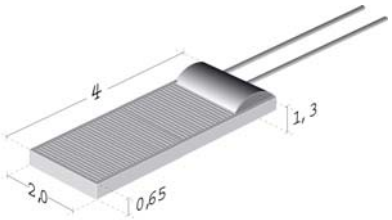
Nickel Temperature Sensors

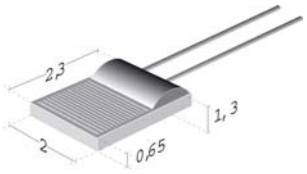
NA - Product Series — Temperature Range: –60°C .. +300°C

Temperature sensors with TCR 6720 ppm/K
Nickel wire 0.2 mm x 7 mm (solderable, weldable, crimpable)

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	120	NA120.232.3K.x.010
	120	NA120.420.3W.x.007

ND - Product Series — Temperature Range: –60°C... +200°C/300°C

Temperature sensors with TCR 6180 ppm/K
Silver-wire ∅ 0.25 mm, 200°C / Ni-wire, ∅ 0.2 mm, 300°C

Dimensions in mm	Nominal resistance at 0°C in Ohm	Description
	100	ND0K1.232.2W.x.010

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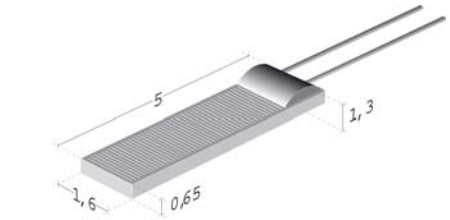
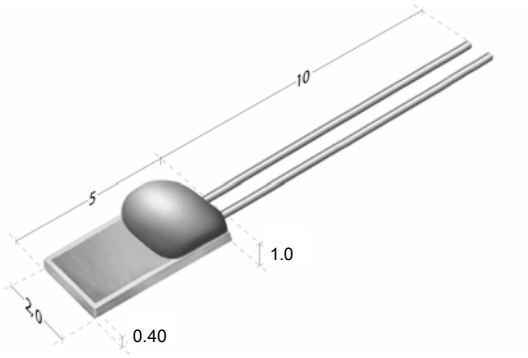


100	ND0K1.516.2W.x.010



5000	ND.5K0.520.2W.x.010
10000	ND.10K0.520.2W.x.010

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Nickel Temperature Sensors

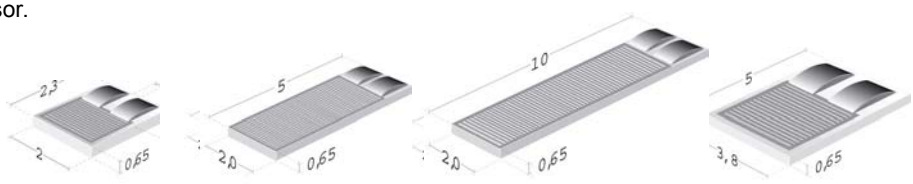
CustomSens

Thin-film temperature sensors with universal connection possibilities

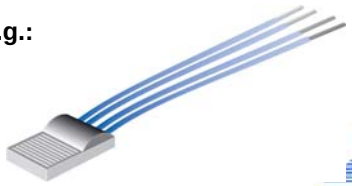
It is the policy of IST to put forward as many sensor options as possible to best serve the customers needs. True to this policy is the CustomSens product. We are bringing a new range of sensors on to the market which will provide enormous versatility. The highlight of these thin-film temperature sensors is the flexibility of determining your own wire termination type or style as required. You can decide how much work we should take off your hands in the assembly of the sensors. You can choose between short or long connections, whether they are to be bare or insulated and whether the sensor is to be completed in 2-, 3- or even 4-wire technology. It is not only the great choice of these variables which offers you many advantages. Through the customized connection structure, the sensors are also characterized by superior product properties, giving you a double benefit.

The universal possibilities

Below you will find all the variables at a single glance. When you combine these with your requirement profile, you will obtain a customized sensor.

1. Dimensions: in mm				
2. Nominal Resistance:	100 Ohm	500 Ohm	1000 Ohm	10000 Ohm
3. Temperature Range:	150°C	200°C	200°C	300°C
Wire Material:	Enameled Copper Wire	Teflon insulated	Silver bare	Nickel bare Nickel Teflon insulated
Wire Diameter:	0.2 mm	AWG 26/30 Stranded Wire AWG 28/7	0.25 mm	0.2 mm
4. Number of Wires:	2-Wires	3-Wires	4-Wires	
5. Wire Length:	5 mm	up to	1000 mm	
6. Tolerance:	DIN EN 43760	½ DIN EN 43760		
7. Metallised Backside	NiCr/Ni/Au			
	-60°C +200°C			

Your Sensor e.g.:



Special materials and sizes on request

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Nickel Temperature Sensors
Order Information

N	D	1 K 0	5 2 0	2	W	B	0 1 0	x	Example
								Specials	
								T	Substrate thickness 0.25 mm
								W	Sintered powder
								M	Metallised backside
								U	Inverted welding
								S	Special*
							Connection Length in mm		
						Tolerance classes			
						A	½ DIN 43760		
						B	DIN 43760		
						C	2 DIN 43760		
						K	Customer specific*		
					Extension Type				
					S	SIL (Single in line)			
					P	Tin solder overall (SMD) →			
					W	Wire			
					I	Insulated contacts			
					K	Customer specific*			
				Temperature range					
				1	-60°C to 150°C				
				2	-60°C to 200°C				
				3	-60°C to 300°C				
			Dimension number (see various dimensions) in mm						
		Resistance value in Ohm at 0°C							
	Characteristic curve								
	D	DIN 6180 ppm/K							
	L	5000 ppm/K							
	J	6370 ppm/K							
	A	6720 ppm/K							
	C	4280 ppm/K (Copper)							
	S	Special*							
Material Identification									
N Nickel									

1P = Contacts tin coated, LMP lead contained
2P = Contacts tin coated, LMP lead free, RoHS conform

*** Additional details, specifications required from the customer.**

Order Example:

N	**D.**	**1K0.**	**520.**	**2**	**W.**	**B.**	**010**
1	2	3	4	5	6	7	8

1:	Material Identification	= Nickel Temperature Sensor
2:	Characteristic Curve	= DIN 6180 ppm/K
3:	Resistance Value in Ohm	= 1'000 Ω / 0°C
4:	Chip Dimension	= 5 mm x 2 mm
5:	Temperature Range	= -60°C to +200°C
6:	Extension	= Wire connections
7:	Tolerance Class	= DIN 43760
8:	Connection Length	= 10 mm

Specifications are subject to change without notice
Preliminary datasheet

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