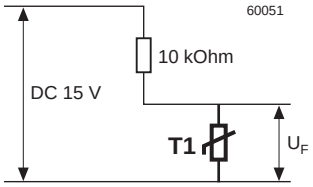
T1 measuring element and circuit

T1



T1 measuring element

- **Positive temperature coefficient (PTC)**
- **Covers the full temperature range for HVAC applications**

Resistance and sensor voltage table

t [°C]	R_F [Ω]	U_F [V]	t [°C]	R_F [Ω]	U_F [V]	t [°C]	R_F [Ω]	U_F [V]	t [°C]	R_F [Ω]	U_F [V]
– 30	1934	2.431	10	2326	2.831	50	2745	3.231	90	3194	3.631
– 29	1944	2.441	11	2337	2.841	51	2756	3.241	91	3206	3.641
– 28	1953	2.451	12	2347	2.851	52	2767	3.251	92	3217	3.651
– 27	1963	2.461	13	2357	2.861	53	2778	3.261	93	3229	3.661
– 26	1972	2.471	14	2367	2.871	54	2789	3.271	94	3240	3.671
– 25	1982	2.481	15	2377	2.881	55	2800	3.281	95	3252	3.681
– 24	1991	2.491	16	2388	2.891	56	2811	3.291	96	3264	3.691
– 23	2001	2.501	17	2398	2.901	57	2822	3.301	97	3276	3.701
– 22	2011	2.511	18	2408	2.911	58	2833	3.311	98	3287	3.711
– 21	2020	2.521	19	2418	2.921	59	2844	3.321	99	3299	3.721
– 20	2030	2.531	20	2429	2.931	60	2855	3.331	**100**	**3311**	**3.731**
–19	2040	2.541	21	2439	2.941	61	2866	3.341	101	3323	3.741
–18	2049	2.551	22	2449	2.951	62	2877	3.351	102	3335	3.751
–17	2059	2.561	23	2460	2.961	63	2888	3.361	103	3347	3.761
–16	2069	2.571	24	2470	2.971	64	2899	3.371	104	3358	3.771
–15	2078	2.581	25	2480	2.981	65	2910	3.381	105	3370	3.781
–14	2088	2.591	26	2491	2.991	66	2921	3.391	106	3382	3.791
–13	2098	2.601	27	2501	3.001	67	2932	3.401	107	3394	3.801
–12	2108	2.611	28	2512	3.011	68	2943	3.411	108	3406	3.811
–11	2117	2.621	29	2522	3.021	69	2955	3.421	109	3418	3.821
–10	2127	2.631	30	2532	3.031	70	2966	3.431	110	3430	3.831
– 9	2137	2.641	31	2543	3.041	71	2977	3.441	111	3442	3.841
– 8	2147	2.651	32	2553	3.051	72	2988	3.451	112	3454	3.851
– 7	2157	2.661	33	2564	3.061	73	3000	3.461	113	3466	3.861
– 6	2166	2.671	34	2574	3.071	74	3011	3.471	114	3478	3.871
– 5	2176	2.681	35	2585	3.081	75	3022	3.481	115	3491	3.881
– 4	2186	2.691	36	2596	3.091	76	3033	3.491	116	3503	3.891
– 3	2196	2.701	37	2606	3.101	77	3045	3.501	117	3515	3.901
– 2	2206	2.711	38	2617	3.111	78	3056	3.511	118	3527	3.911
– 1	2216	2.721	39	2627	3.121	79	3067	3.521	119	3539	3.921
0	**2226**	**2.731**	40	2638	3.131	80	3079	3.531	120	3552	3.931
1	2236	2.741	41	2649	3.141	81	3090	3.541	121	3564	3.941
2	2246	2.751	42	2659	3.151	82	3102	3.551	122	3576	3.951
3	2256	2.761	43	2670	3.161	83	3113	3.561	123	3588	3.961
4	2266	2.771	44	2681	3.171	84	3125	3.571	124	3601	3.971
5	2276	2.781	45	2692	3.181	85	3136	3.581	125	3613	3.981
6	2286	2.791	46	2702	3.191	86	3148	3.591	126	3625	3.991
7	2296	2.801	47	2713	3.201	87	3159	3.601	127	3638	4.001
8	2306	2.811	48	2724	3.211	88	3171	3.611	128	3650	4.011
9	2316	2.821	49	2735	3.221	89	3182	3.621	129	3663	4.021
									130	3675	4.031

Key:
t = Temperature [°C]
RF = Resistance of T1 element (only for use when setting up a temperature simulator)
UF = Voltage at sensor (linearised)

The T1 measuring element and its circuit

The T1 temperature sensor element is a universal measuring element, and is fitted into temperature sensors used in the control ranges supplied by the former Staefa Control System.
The high resistance of the T1 measuring element makes it particularly suitable for 2-wire installations.

Measuring principle

The T1 measuring element is a laser-trimmed silicon sensor with a positive temperature coefficient (PTC); i.e. the resistance of the sensor increases as the temperature rises.

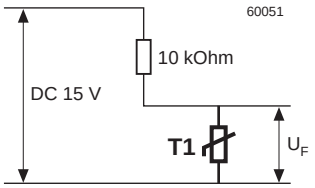
Technical data

Element	PTC, silicon sensor, calibrated in temperature bath
Measuring range	Theoretically designed for – 50 ... 150 °C
	Practical measuring range – 30 ... 130 °C
Electrical connection	2-wire, interchangeable

Principle of operation

The T1 element is normally connected to a voltage of DC 15 V from the controller in series with a 10 kΩ resistor, resulting in a signal with a direct linear relationship to the temperature:

U_F [mV] = 10 mV • T [K] = 10 mV • (t [°C] + 273.1)



This circuit produces a change in voltage of 10 mV for each 1 K temperature change. There is a directly linear relationship between the sensor voltage U_F and the temperature across the entire sensor measuring range.

The T1 sensor elements are designed for 2-wire connections. The connecting wires are interchangeable.

Measuring circuit

The relationship between the sensor voltage curve and the absolute temperature scale is such that conversions are easy:

273.1 K (= 0 °C) = 2.731 V [volts]

The temperature measured by the sensor can thus be calculated from the sensor voltage as follows:

$t = (U_F / 10) – 273.1$

where t = Temperature measured in °C
U_F = Sensor voltage in mV [millivolts]

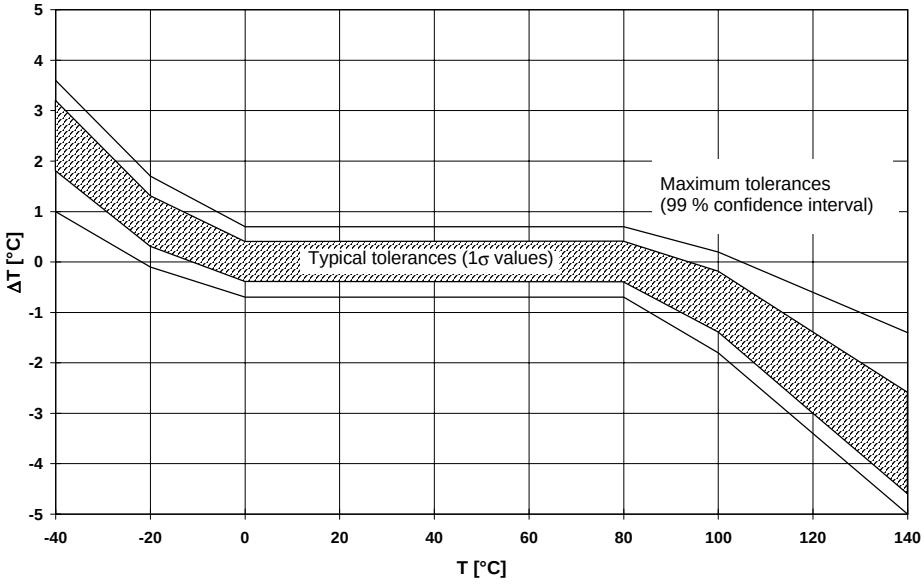
The sensor voltage, U_F, is the defining value for determining the temperature. The sensor resistance R_F is intended only for temperature simulation. Direct measurement of this resistance with an ohmmeter does not produce the correct values (owing to the intrinsic heat and current-dependency of the sensor element).

T1 sensor accuracy

Typical and maximum tolerances for the T1 measuring element are shown below.

The T1 element itself is defined for a temperature range from – 50 ...150 °C. However, specific measuring ranges (application ranges) for the various types of T1 sensors are specified in the relevant Landis & Staefa data sheets.

For the manufacture of the T1 measuring elements, a typical tolerance of ± 0.4 °C is maintained within the range 0 °C ... 80 °C (see diagram).



A conformance certificate for the T1 measuring element can be obtained from Landis & Staefa on request.

Cabling and measurement errors

Owing the high resistance of the T1 temperature sensor, the measurement error caused by the installation cable is very small, and can be ignored with short cable runs. The measurement errors shown in the table below apply to copper cable (Cu) at 20 °C.

	Measurement error per 10 m cable-length (Cu) (10 m cable-length = conductor length of 20 m)	
Conductor cross-section	Resistance error	Temperature error
2.5 mm^2	+ 0.14 Ω	+ 0.01 K
1.5 mm^2	+ 0.23 Ω	+ 0.02 K
1.0 mm^2	+ 0.34 Ω	+ 0.03 K
0.25 mm^2 (= telephone cable, diameter 0.6 mm)	+ 1.36 Ω	+ 0.13 K