



**HD 778TR1 - HD 978TR1  
HD 778-TCAL - HD 978TR2**



# 4÷20mA CONFIGURABLE TEMPERATURE TRANSMITTERS FOR K-J-T-N TYPE THERMOCOUPLE THERMOCOUPLE GENERATOR MANAGED BY PC THROUGH RS232C HD778-TCAL

HD 778TR1, HD 978TR1 and HD 978TR2 are 4...20mA two-wired passive transmitters with a microprocessor. These can be configured for thermocouple sensors type K, J, T and N. They convert the voltage value generated by the thermocouple into an electric linear signal within the 4...20mA range. The use of digital devices obtains excellent precision and stability in time. The user can set the 4...20mA (or 20...4mA) output in any temperature range included in the measurement range of the individual thermocouples with a **minimum range of 50 °C**. The range and type of thermocouple are simply set by using one button. A led signals the alarm situation (out of order or unconnected sensor) and helps the user during the programming phases. The transmitters are also protected against polarity inversion. HD778TR1 is specifically designed to be installed on DIN B connection heads; HD978TR1 and HD978TR2 are suitable for mounting on 35 mm DIN bars. In addition to the 4...20mA output, HD978TR2 has a 3½ digit display (height 10 mm) that allows the measured temperature to be displayed.

## Technical information @ 25°C and 24Vdc

INPUT	HD778TR1	HD978TR1	HD978TR2
Sensor	Type of thermocouple: K, J, T and N		
Connection	Two-wired passive transmitter		
Measurement range	Thermocouple K: -200°C ... +1200°C Thermocouple J: -200°C ... +800°C Thermocouple T: -200°C ... +300°C Thermocouple N: -200°C ... +1200°C		
Linearization	EN 60584-1-2 ASTM E 230 - ANSI (MC96-1)		
Default range	Tc = K - Range = 0...1000°C		
Minimum measurement range	50°C		
Speed of conversion	2 measurements per second		
Precision	±0,04%FS±0,04% of the reading or 0.5°C (the greater of the two values)		
Cold coupling temperature range	-30 ... +80°C	0 ... +70°C	
Functioning temperature	-30 ... +80°C	0 ... +70°C	
Storage temperature	-40 ... +80°C		
<b>OUTPUT</b>			
Type of output (note 1)	4...20 mA (or 20...4 mA) two-wired 22 mA, in case of out of order or unconnected sensor		
Resolution	4 µA	4 µA Display: 0.1°C T<200°C 1°C T>200°C	
Power voltage	9...30V dc (protection against polarity inversion)		
Sensitivity to Vdc power voltage variations	0.4 µA/V		
Load resistance	R <sub>L</sub> Max = (Vdc-9)/0.022 R <sub>L</sub> Max = 625Ω with Vdc = 24 Vdc		
Input/output galvanic insulation	50Vdc (checked at 250V)		
Red led	Turns on during the programming phase if the thermocouple is out of order or unconnected.		
Warm-up time	2 minutes		

Note 1) If the measured temperature T goes out of the T1...T2 (T1<T2) set range, the transmitters linearly regulate the current for T<T1 and T>T2 for an interval of 10°C. (See the current diagram.)

## INSTALLATION AND CONNECTION

Fig. 1 shows the mechanical dimensions of the HD778TR1 transmitter and shows the 5 mm holes for DIN head locking and the central hole for the thermocouple wires input. Fig. 1 also reports the mechanical dimensions of HD978TR1 and HD978TR2.

HD978TR1 width is a DIN module (17.5 mm), HD978TR2 2 DIN modules (35 mm). The working temperature must be included in the defined range of function. Fig. 4 and 5 report the HD778TR1, HD978TR1 and HD978TR2 connection schemes. In order to obtain the maximum precision, the connection to the thermocouple should not exceed 3 meters in length. In the diagrams attached, the RL (Load) symbol represents any device inserted in the current loop, that is to say, an indicator, a controller, a data logger or a register.

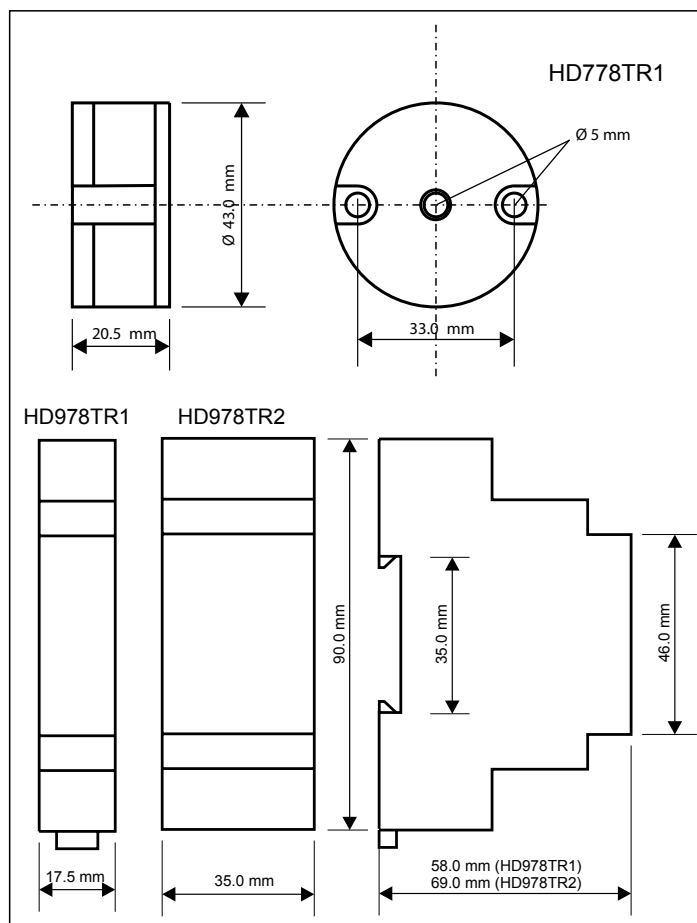


Fig.1 Mechanical dimensions.

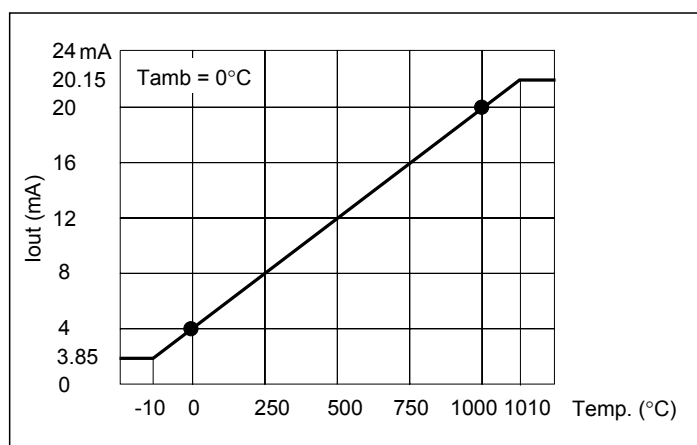


Fig.2 Range 0...1000°C, current output with relation to temperature.

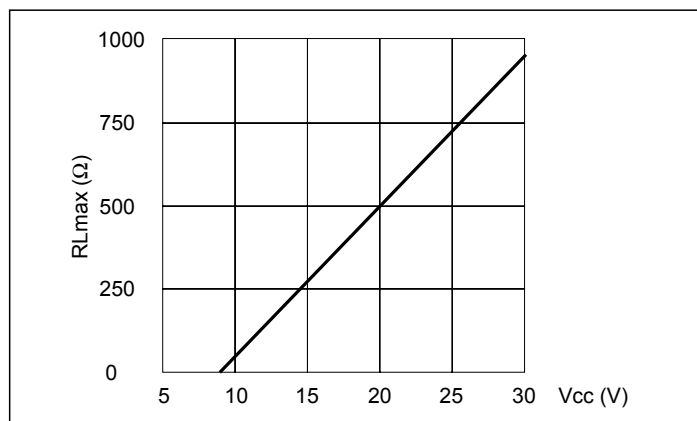


Fig.3 Load resistance with relation to temperature.

## CHOOSING THE TYPE OF THERMOCOUPLE

The transmitter accepts four types of thermocouples. The set thermocouple is indicated by the number of led blinks when the power is turned on.

Number of led blinks	Type of thermocouple
1	K
2	J
3	T
4	N

**The transmitters are supplied with the default setting of: K thermocouple and 4...20mA = 0...1000°C range.**

The user can modify the type of thermocouple and the range of functioning with the following procedures.

**Note: after modifying the type of thermocouple, the range of functioning must be programmed.**

### HD778TR1 and HD978TR1

When turning on the transmitter, the led blinks for a certain number of times equal to the type of thermocouple previously set.

In order to modify the setting, turn the transmitter off and back on again **keeping the button pressed down**.

This opens the program for selecting the type of thermocouple. If the **K thermocouple** has been selected the led blinks once.

If you release the button and press it down again within 10 seconds, the led will blink twice: the **J thermocouple** is now selected.

If you press the button again within 10 seconds, the led will blink 3 times: the **T thermocouple** is now selected.

If you press the button again within 10 seconds, the led will blink 4 times: the **N thermocouple** is now selected.

If you press again the button within 10 seconds, the led will blink once to indicate that the K thermocouple has been selected again and the cycle repeats.

In order to save the selected thermocouple, do not press the button and wait 15 seconds. As the transmitter saves the type of thermocouple, the led blinks for a number of times equal to the type of thermocouple selected.

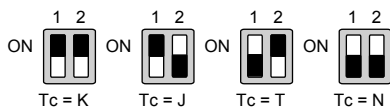
**If you modified the type of thermocouple the range of functioning must be reprogrammed. See the paragraph entitled "PROGRAMMING THE RANGE OF FUNCTIONING".**

### HD978TR2

This transmitter is fitted with a dual dip-switch for the selection of the thermocouple type. The selection must be made before turning it on and it is set when the device is turned on: a dip-switch change does not produce any effect when the device is powered on until the next time it is turned off and on.

Procedure:

With the device turned off, select the type of thermocouple by setting the switches as shown in the following figure.



When powering the transmitter, the led blinks for a number of times equal to the type of thermocouple previously set.

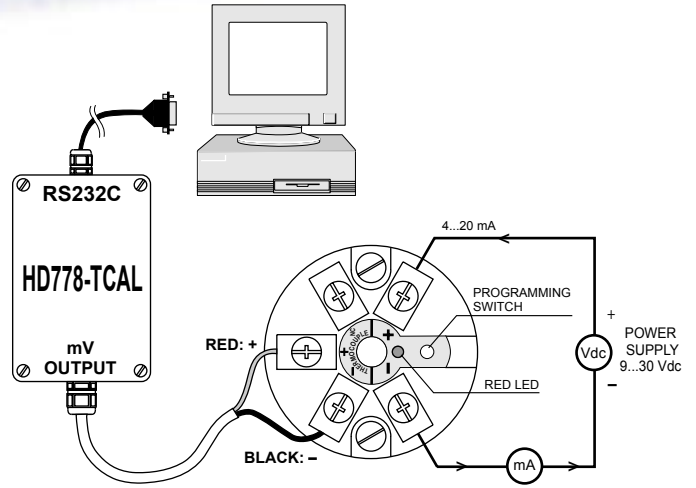
**If you modified the type of thermocouple the range of functioning must be reprogrammed. See the paragraph entitled "PROGRAMMING THE RANGE OF FUNCTIONING".**

### PROGRAMMING THE RANGE OF FUNCTIONING.

**The HD778TR1, HD978TR1 and HD978TR2 transmitters are supplied with a default setting of: K thermocouple and 0...1000°C range.** The user can set a different range according to his requirements with a minimum span of 50°C. The correspondence between the read temperature and the output current can be direct (e.g. 4mA = 0°C and 20mA = 1000°C) or inverse (e.g. 4mA = 1000°C and 20mA = 0°C).

Avail yourself of the following programming tools:

- 9...30 Vdc direct current power source,
- Thermocouple gauge,
- Copper connection cables,
- Precision ammeter with 0...25 mA minimum range.



In place of the thermocouple gauge, it is possible to use the **HD778-TCAL** Delta Ohm. This device must be connected to the PC's serial port, and by using the special software it automates all the steps described below for the programmed range of functioning.

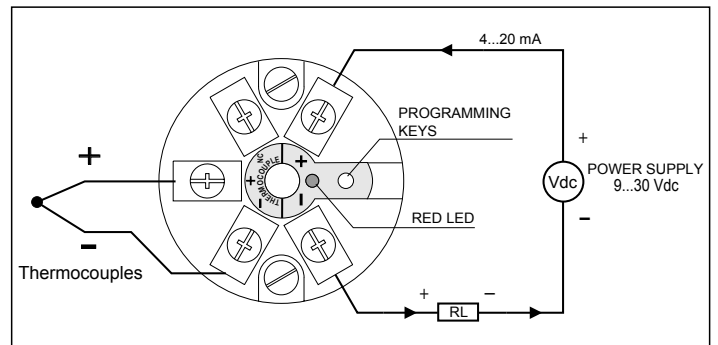


Fig.4 Connection diagram of HD778TR1.

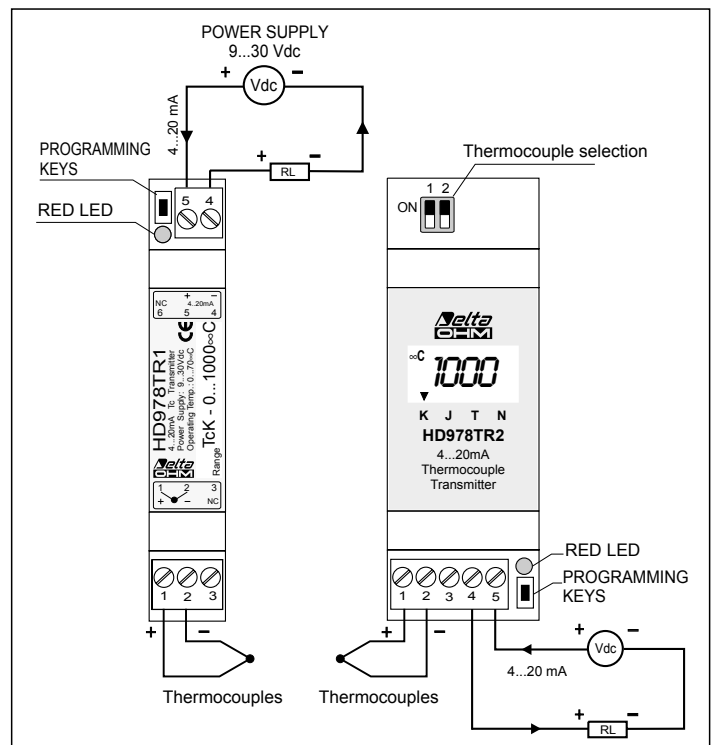


Fig.5 Connection diagram of HD978TR1 and HD978TR2

If you have a thermocouple gauge then the steps are as follows:  
To set the type of thermocouple proceed as described in the "CHOOSING THE TYPE OF THERMOCOUPLE" paragraph.

**The voltage values generated by the gauge must not be balanced.**

**The set up process must be carried out with the device already turned on.**

Set up the gauge for the desired type of thermocouple (K, J, T or N); connect the gauge to the transmitter's thermocouple input, according to its polarity. **(Pay attention to the polarity.)**

Set the gauge so that it generates the voltage corresponding to the temperature at 4mA, and wait 30 seconds until the voltage stabilizes. The table Tab. 1 reports the voltages generate by the HD778-TCAL gauge according to the type of thermocouple corresponding to the temperature value.

**Press and keep the button pressed** until the led starts blinking. Release the button. The device acquires the first value of the transmitter work range, and the led continues blinking. The tool now waits for the second data of the end of scale range.

Set the gauge so that it generates the voltage corresponding to the temperature at 20mA.

**Press and keep the button pressed** until the led stops blinking.

Release the button and wait 20 seconds, **without modifying the gauge data**, so that the transmitter memorizes the calibration data and is ready to function normally. The operation is complete when the led blinks once.

The device has acquired the second point corresponding to the range you wish to configure and starts to function normally.

**The minimum span value accepted by the device is 50°C.** If, after entering the first value T1 of the range, the user tries to enter a second value T2 with (T2-T1)<50, the device does not accept it and remains in the waiting status with the led continuing to blink.

**HD778-TCAL is provided with its own software. After it is connected to a PC serial port by the programmer, the operator can follow the instructions on the screen to configure the transmitter.**

**ORDER CODES**

**HD778TR1:** 4...20mA/20...4mA 2 wire temperature transmitter for K, J, T and N thermocouples, configurable with minimum amplitude range 50°C, in a container for DIN B 43760 heads.

**HD978TR1:** 4...20mA/20...4mA 2 wire temperature transmitter for K, J, T and N thermocouples, configurable with minimum amplitude range 50°C, in a container for 35 mm DIN bar connection, dimension 1 module.

**HD978TR2:** 4...20mA/20...4mA 2 wire temperature transmitter for K, J, T and N thermocouples, configurable with minimum amplitude range 50°C, in a container for 35 mm DIN bar connection dimension 2 modules, with 3½ digit display, height 10 mm.

**HD778-TCAL:** power generator in the range -60mV...+60mV, regulated by PC through RS232C serial port, DELTALOG7 software for setting K, J, T and N thermocouple transmitters.

Tab.1 - Voltage generated by a thermocouple with relation to the temperature (°C), by thermocouples type K, J, T and N in accordance with the standards EN 60584-1-2 ASTM E 230 - ANSI (MC96.1). Reference joint and 0°C.

Tc K (Ref @ 0°C)		Tc J (Ref @ 0°C)		Tc T (Ref @ 0°C)		Tc N (Ref @ 0°C)			
°C	mV	°C	mV	°C	mV	°C	mV		
-200	-5.891	520	21.487	-200	-5.603	-200	-3.990	520	17.515
-190	-5.730	530	21.924	-190	-5.439	-190	-3.884	530	17.900
-180	-5.550	540	22.350	-180	-5.261	-180	-3.766	540	18.286
-170	-5.354	550	22.776	-170	-5.070	-170	-3.634	550	18.672
-160	-5.141	560	23.203	-160	-4.865	-160	-3.491	560	19.059
-150	-4.913	570	23.629	-150	-4.648	-150	-3.336	570	19.447
-140	-4.669	580	24.055	-140	-4.419	-140	-3.171	580	19.835
-130	-4.411	590	24.480	-130	-4.177	-130	-2.994	590	20.224
-120	-4.138	600	24.905	-120	-3.923	-120	-2.808	600	20.613
-110	-3.852	610	25.330	-110	-3.657	-110	-2.612	610	21.003
-100	-3.554	620	25.755	-100	-3.379	-100	-2.407	620	21.393
-90	-3.243	630	26.179	-90	-3.089	-90	-2.193	630	21.784
-80	-2.920	640	26.602	-80	-2.788	-80	-1.972	640	22.175
-70	-2.587	650	27.025	-70	-2.476	-70	-1.744	650	22.566
-60	-2.243	660	27.447	-60	-2.153	-60	-1.509	660	22.958
-50	-1.889	670	27.869	-50	-1.819	-50	-1.269	670	23.350
-40	-1.527	680	28.289	-40	-1.475	-40	-1.023	680	23.742
-30	-1.156	690	28.710	-30	-1.121	-30	-0.772	690	24.134
-20	-0.778	700	29.129	-20	-0.757	-20	-0.518	700	24.527
-10	-0.392	710	29.548	-10	-0.383	-10	-0.260	710	24.919
0	0.000	720	29.965	0	0.000	0	0.000	720	25.312
10	0.397	730	30.382	10	0.391	10	0.261	730	25.705
20	0.798	740	30.798	20	0.790	20	0.525	740	26.098
30	1.203	750	31.213	30	1.196	30	0.793	750	26.491
40	1.612	760	31.628	40	1.612	40	1.065	760	26.883
50	2.023	770	32.041	50	2.036	50	1.340	770	27.276
60	2.436	780	32.453	60	2.468	60	1.619	780	27.669
70	2.851	790	32.865	70	2.909	70	1.902	790	28.062
80	3.267	800	33.275	80	3.358	80	2.189	800	28.455
90	3.682	810	33.685	90	3.814	90	2.480	810	28.847
100	4.096	820	34.093	100	4.279	100	2.774	820	29.239
110	4.509	830	34.501	110	4.750	110	3.072	830	29.632
120	4.920	840	34.908	120	5.228	120	3.374	840	30.024
130	5.328	850	35.313	130	5.714	130	3.680	850	30.416
140	5.735	860	35.718	140	6.206	140	3.989	860	30.807
150	6.138	870	36.121	150	6.704	150	4.302	870	31.199
160	6.540	880	36.524	160	7.209	160	4.618	880	31.590
170	6.941	890	36.925	170	7.720	170	4.937	890	31.981
180	7.340	900	37.326	180	8.237	180	5.259	900	32.371
190	7.739	910	37.725	190	8.759	190	5.585	910	32.761
200	8.138	920	38.124	200	9.288	200	5.913	920	33.151
210	8.539	930	38.522	210	9.822	210	6.245	930	33.541
220	8.940	940	38.918	220	10.362	220	6.579	940	33.930
230	9.343	950	39.314	230	10.907	230	6.916	950	34.319
240	9.747	960	39.708	240	11.458	240	7.255	960	34.707
250	10.153	970	40.101	250	12.013	250	7.597	970	35.095
260	10.561	980	40.494	260	12.574	260	7.941	980	35.482
270	10.971	990	40.885	270	13.139	270	8.288	990	35.869
280	11.382	1000	41.276	280	13.709	280	8.637	1020	37.027
290	11.795	1010	41.665	290	14.283	290	8.988	1030	37.411
300	12.209	1020	42.053	300	14.862	300	9.341	1040	37.795
310	12.624	1030	42.440	310	15.446	310	9.696	1050	38.179
320	13.040	1040	42.826	320	16.035	320	10.054	1060	38.562
330	13.457	1050	43.211	330	16.629	330	10.413	1070	38.944
340	13.874	1060	43.595	340	17.228	340	10.774	1080	39.326
350	14.293	1070	43.978	350	17.832	350	11.136	1090	39.707
360	14.713	1080	44.359	360	18.441	360	11.501	1100	40.087
370	15.133	1090	44.740	370	19.055	370	11.867	1110	40.466
380	15.554	1100	45.119	380	19.674	380	12.234	1120	40.845
390	15.975	1110	45.497	390	20.298	390	12.603	1130	41.223
400	16.397	1120	45.873	400	20.927	400	12.974	1140	41.600
410	16.820	1130	46.249	410	21.561	410	13.346	1150	41.976
420	17.243	1140	46.623	420	22.200	420	13.719	1160	42.352
430	17.667	1150	46.995	430	22.844	430	14.094	1170	42.727
440	18.091	1160	47.367	440	23.493	440	14.469	1180	43.101
450	18.516	1170	47.737	450	24.147	450	14.846	1190	43.474
460	18.941	1180	48.105	460	24.806	460	15.225	1200	43.846
470	19.366	1190	48.473	470	25.470	470	15.604		
480	19.792	1200	48.838	480	26.139	480	15.984		
490	20.218			490	26.813	490	16.366		
500	20.644			500	27.492	500	16.748		
510	21.071			510	28.175	510	17.131		