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**4÷20mA CONFIGURABLE TEMPERATURE TRANSMITTERS**  
**HD 778 TR1, HD 978 TR1 Y HD 978 TR2 SERIES FOR K-J-T-N TYPE THERMOCOUPLE**  
**HD778-TCAL**  
**THERMOCOUPLE GENERATOR MANAGED BY PC THROUGH RS232C**

**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 3 1/2 digit display (height 10 mm) that allows the measured temperature to be displayed.

**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 3 1/2 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.



**TECHNICAL INFORMATION @ 25°C AND 24VDC**

INPUT	HD 778TR1	HD 978 TR1	HD 978 TR2
Sensor	Type of thermocouple: K, J, T and N		
Connection	Two-wired passive transmitter		
Measurement range	Thermocouple K -200 °C to 1200 °C Thermocouple J -200 °C to 800 °C Thermocouple T -200 °C to 300 °C Thermocouple N -200 °C to 1200 °C		
Linearization	EN 60584-1-1 ASTM E 230 – ANSI (MC96-1)		
Default range	Termopar K Range 0...1200 °C		
Minimum measurement range	50 °C		
Speed of conversion	2 measurements per second		
Accuracy	±0,04%FS±0,04% of the reading or 0.5°C (the greater of the two values)		
Cold coupling temperature range	-30 a 80 °C	0 a 70 °C	
Working temperature	-30 a 80 °C	0 a 70 °C	
Storage temperature	-40 a 80 °C		
<b>OUTPUT</b>			
TipType 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	4µA	4µA 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	0,4µA/V		
Load resistance	RLMax = Vcc-9/0,0022 => RLMax = 680 Ω@ Vcc = 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.

## 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".**

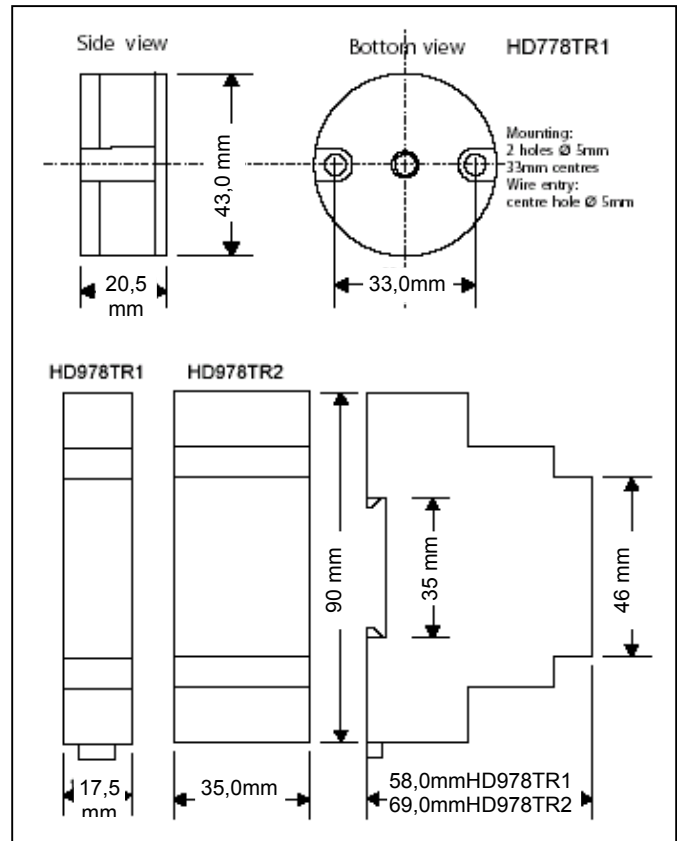


Fig. 1

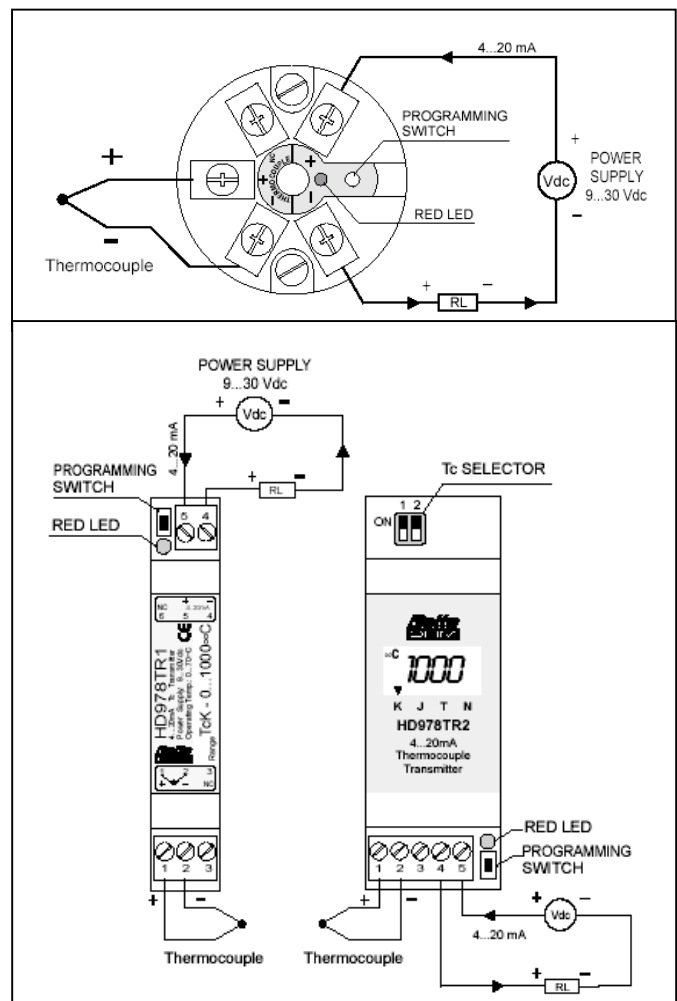


Fig. 2

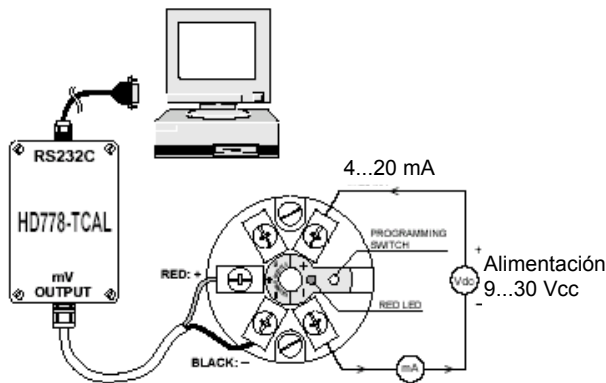
**PROGRAMMING THE RANGE OF FUNCTIONING.**

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.

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..

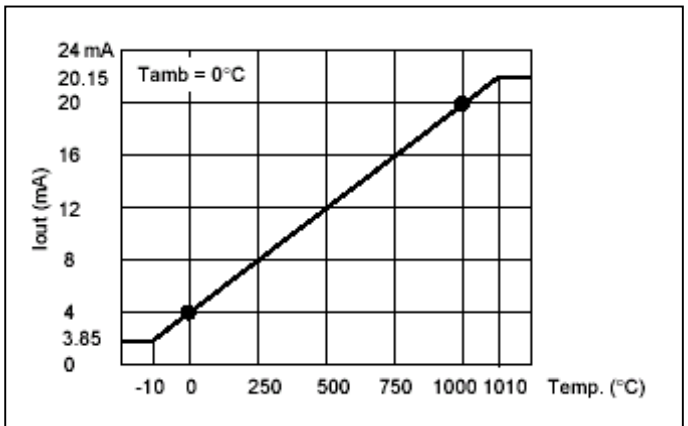


Fig. 3

Set up the gauge for the desired type of thermocouple (K, J, T o 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 linking.

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 linking.

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.**

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

°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV
-200	-5,891	0	0,000	200	8,137	400	16,395	600	24,902	800	33,277	1000	41,269
-190	-5,730	10	0,397	210	8,537	410	16,818	610	25,327	810	33,686	1010	41,657
-180	-5,550	20	0,798	220	8,938	420	17,241	620	25,751	820	34,095	1020	42,045
-170	-5,354	30	1,203	230	9,341	430	17,664	630	26,176	830	34,502	1030	42,432
-160	-5,141	40	1,611	240	9,745	440	18,088	640	26,599	840	34,909	1040	42,817
-150	-4,912	50	2,022	250	10,151	450	18,513	650	27,022	850	35,314	1050	43,202
-140	-4,669	60	2,436	260	10,560	460	18,938	660	27,445	860	35,718	1060	43,585
-130	-4,410	70	2,850	270	10,969	470	19,363	670	27,867	870	36,121	1070	43,968
-120	-4,138	80	3,266	280	11,381	480	19,788	680	28,288	880	36,524	1080	44,349
-110	-3,852	90	3,681	290	11,793	490	20,214	690	28,709	890	36,925	1090	44,729
-100	-3,553	100	4,095	300	12,207	500	20,640	700	29,128	900	37,325	1100	45,108
-90	-3,242	110	4,508	310	12,623	510	21,066	710	29,547	910	37,724	1110	45,486
-80	-2,920	120	4,919	320	13,039	520	21,493	720	29,965	920	38,122	1120	45,863
-70	-2,586	130	5,327	330	13,456	530	21,919	730	30,383	930	38,519	1130	46,238
-60	-2,243	140	5,733	340	13,874	540	22,346	740	30,799	940	38,915	1140	46,612
-50	-1,889	150	6,137	350	14,292	550	22,772	750	31,214	950	39,310	1150	46,985
-40	-1,527	160	6,539	360	14,712	560	23,198	760	31,629	960	39,703	1160	47,356
-30	-1,156	170	6,939	370	15,132	570	23,624	770	32,042	970	40,096	1170	47,726
-20	-0,777	180	7,338	380	15,552	580	24,050	780	32,455	980	40,448	1180	48,095
-10	-0,392	190	7,737	390	15,974	590	24,476	790	32,866	990	40,879	1190	48,462

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

°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV
-200	-7,890	0	0,000	200	10,777	400	21,846	600	33,096	800	45,498	1000	57,942
-190	-7,659	10	0,507	210	11,332	410	22,397	610	33,683	810	46,144	1010	58,533
-180	-7,402	20	1,019	220	11,887	420	22,949	620	34,273	820	46,790	1020	59,121
-170	-7,122	30	1,536	230	12,442	430	23,501	630	34,867	830	47,434	1030	59,708
-160	-6,821	40	2,058	240	12,998	440	24,054	640	35,464	840	48,076	1040	60,293
-150	-6,499	50	2,585	250	13,553	450	24,607	650	36,066	850	48,716	1050	60,876
-140	-6,159	60	3,115	260	14,108	460	25,161	660	36,671	860	49,354	1060	61,459
-130	-5,801	70	3,649	270	14,663	470	25,716	670	37,280	870	49,989	1070	62,039
-120	-5,426	80	4,186	280	15,217	480	26,272	680	37,893	880	50,621	1080	62,619
-110	-5,036	90	4,725	290	15,771	490	26,829	690	38,510	890	51,249	1090	63,199
-100	-4,632	100	5,268	300	16,325	500	27,388	700	39,192	900	51,875	1100	63,777
-90	-4,215	110	5,812	310	16,879	510	27,949	710	39,754	910	52,496	1110	64,355
-80	-3,785	120	6,359	320	17,432	520	28,511	720	40,382	920	53,115	1120	64,933
-70	-3,334	130	6,907	330	17,984	530	29,075	730	41,013	930	53,729	1130	65,510
-60	-2,892	140	7,457	340	18,537	540	29,692	740	41,647	940	54,341	1140	66,087
-50	-2,431	150	8,008	350	19,089	550	30,210	750	42,283	950	54,948	1150	66,664
-40	-1,960	160	8,560	360	19,640	560	30,782	760	42,929	960	55,553	1160	67,240
-30	-1,481	170	9,113	370	20,162	570	31,356	770	43,563	970	56,155	1170	67,815
-20	-0,995	180	9,667	380	20,743	580	31,933	780	44,207	980	56,753	1180	68,390
-10	-0,501	190	10,222	390	21,295	590	32,513	790	44,852	990	57,340	1190	68,964

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

°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV
-200	-5,603	-130	-4,177	-60	-2,152	10	0,391	80	3,357	150	6,702	220	10,360
-190	-5,439	-120	-3,923	-50	-1,819	20	0,789	90	3,813	160	7,207	230	10,905
-180	-5,261	-110	-2,788	-40	-1,475	30	1,196	100	4,277	170	7,718	240	11,543
-170	-5,069	-100	-3,378	-30	-1,121	40	1,611	110	4,749	180	8,235	250	12,011
-160	-4,865	-90	-3,089	-20	-0,757	50	2,035	120	5,227	190	8,757	260	12,572
-150	-4,648	-80	-2,788	-10	-0,383	60	2,447	130	5,712	200	9,286	270	13,137
-140	-4,419	-70	-2,475	0	0,000	70	2,908	140	6,204	210	9,820	280	13,707

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

°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV
-200	-3,990	0	0,000	200	5,913	400	12,974	600	20,613	800	28,455	1000	36,256
-190	-3,884	10	0,261	210	6,245	410	13,346	610	21,003	810	28,847	1010	36,641
-180	-3,766	20	0,525	220	6,579	420	13,719	620	21,393	820	29,239	1020	37,027
-170	-3,634	30	0,793	230	6,916	430	14,094	630	21,784	830	29,632	1030	37,411
-160	-3,491	40	1,065	240	7,255	440	14,469	640	22,175	840	30,024	1040	37,795
-150	-3,336	50	1,340	250	7,597	450	14,846	650	22,566	850	30,416	1050	38,179
-140	-3,171	60	1,619	260	7,941	460	15,225	660	22,958	860	30,807	1060	38,562
-130	-2,994	70	1,902	270	8,288	470	15,604	670	23,350	870	31,199	1070	38,944
-120	-2,808	80	2,189	280	8,637	480	15,984	680	23,742	880	31,590	1080	39,326
-110	-2,612	90	2,480	290	8,988	490	16,366	690	24,134	890	31,981	1090	39,706
-100	-2,407	100	2,774	300	9,341	500	16,748	700	24,527	900	32,371	1100	40,087
-90	-2,193	110	3,072	310	9,696	510	17,131	710	24,919	910	32,761	1110	40,466
-80	-1,972	120	3,374	320	10,054	520	17,515	720	25,312	920	33,151	1120	40,845
-70	-1,744	130	3,680	330	10,413	530	17,900	730	25,705	930	33,541	1130	41,223
-60	-1,509	140	3,989	340	10,774	540	18,286	740	26,098	940	33,930	1140	41,600
-50	-1,269	150	4,302	350	11,136	550	18,672	750	26,491	950	34,319	1150	41,976
-40	-1,023	160	4,618	360	11,501	560	19,059	760	26,883	960	34,707	1160	42,352
-30	-0,772	170	4,937	370	11,867	570	19,447	770	27,276	970	35,095	1170	42,727
-20	-0,518	180	5,259	380	12,234	580	19,835	780	27,669	980	35,482	1180	43,101
-10	-0,260	190	5,585	390	12,603	590	20,224	790	28,062	990	35,869	1190	43,474