Technical Support
Bulletin Nr. 15 – Instrumentation Problems

Contents

Introduction

This document explains how to identify a potential fault or problem and determine its causes. The details provided will help you to distinguish faults from potential errors or non compatibility issues.

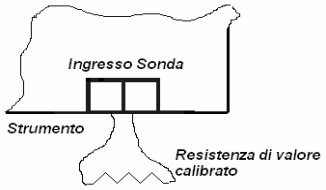
Troubleshooting reading/display problems

- If the device displays an incorrect temperature
- If the device displays a probe error
- If the device displays a temperature, which does not change or changes incorrectly
- If the device displays a "reversed" temperature, i.e. the displayed value decreases while the temperature increases (for thermocouples only)

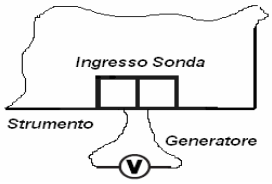
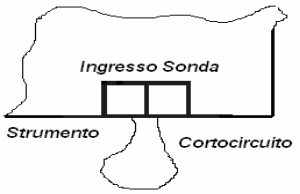
In this specific case the problem may originate from the probe or controller. Check the points described below, then follow the instructions in the tables:

- Verify that the probe selection parameter has been correctly set (H00, PSE…see the relevant technical data sheet).
- Verify that connections have been correctly made and that the device is supplied with the correct voltage/power.
- Verify that the correct sensor has been selected for the controller. Eliwell's instrumentation is compatible with several types of probes, depending on the type of controller. This information is usually provided on the labels of the controllers (see Bulletin 05 - Labels).
- Verify that the measuring range has been correctly selected (top and bottom scale, for mA and V inputs only) using parameters H03/H04, Lci/Hci.

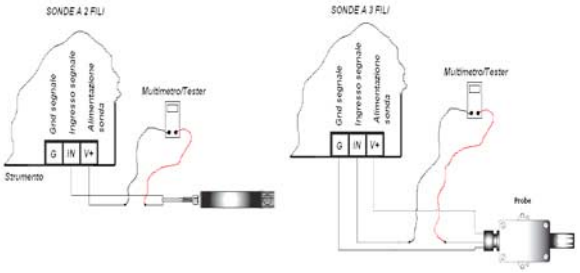
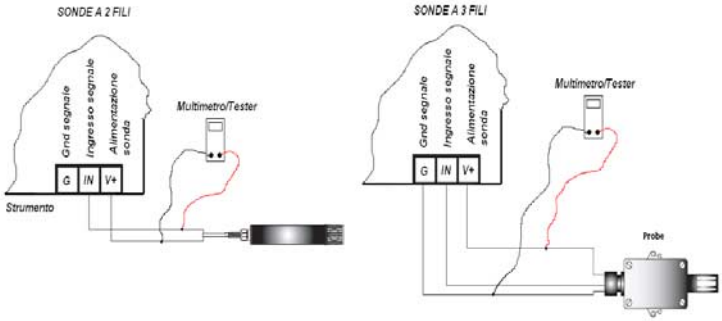
PTC/NTC/Pt100/Pt100/Ni100

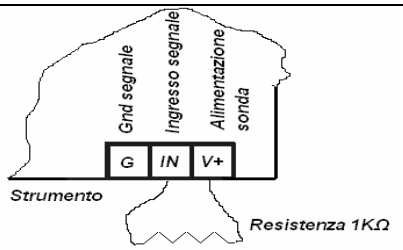
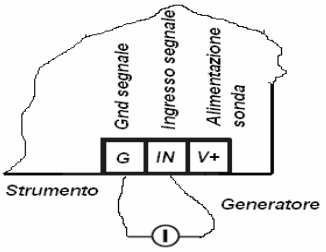
Probe check	**Device check**
Measure the resistance when the probe IS NOT CONNECTED:  1KΩ@25°C* → is a PTC 10KΩ@25°C* → is a NTC 100Ω@0°C* → is a Pt100-Ni100 1KΩ@0°C* → is a Pt1000 If no signal is present, replace the probe. **NOTE**: for PTC, NTC, Pt100 and Ni100 models, it is generally advisable to perform the measurements at different temperatures using as reference the tables in the Appendix at the end of this document.	Connect an electric heater with a rating equivalent to the reference value and check the measured value (Example: for the PTC input, connect a 1KΩ electric heater and verify that the device reads about 25°C).  If no measurement is output, replace the device.

TCJ, K, S…(thermocouples)

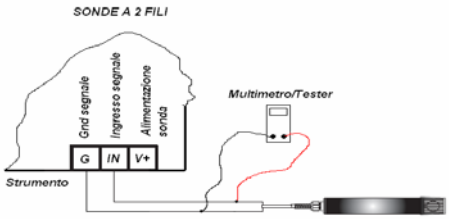
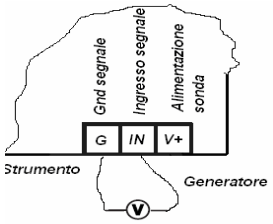
Probe check	Device check
Measure the voltage in mV (direct current) when the probe is NOT CONNECTED:  1.019mV@20°C* → is a TCJ 0.798mV@20°C* → is a TCK 0.113mV@20°C* → is a TCS 0.111mV@20°C* → is a TCR 0.790mV@20°C* → is a TCT If no signal is present, replace the probe.	1. Using a generator, apply a voltage equivalent to the reference one and check the measured value (example: for the TCJ input the device should read approximately 20°C when you apply a voltage of 1.019mV).  2. Short-circuit the probe input and verify that it is possible to measure the temperature of the cold coupling (that should approximately correspond to the ambient temperature or to the internal temperature of the controller that houses the cold coupling).  3. Verify that the probe connections match the correct polarity using the cable colors as reference (see table at the end of the page) and following the instructions on the controller label. If no measurement is output, replace the device.

EWHS280, 300, 310, EWPA 007, 030, or 0/4…20mA input

Probe check	Device check
Measure the direct current in mA connecting a multimeter in series to the signal cable. The current value should be proportional to the measured value:  If no signal is available, replace the probe.	1. Check the supply voltage transmitted from the device to the probe using a multimeter. If the device is fitted with an external transformer, it is necessary to verify that the power of the latter is suitable and not below the required one.  2. If the device is fitted with an output that powers the sensor, connect a 1KΩ electric heater and verify that the device reads a value proportional to the specified measuring range.

	 3. Using a generator, apply a current within the 4…20mA range (verifying that the polarity is correct), then check the measured value.  If no measurement is output, replace the device.

0…1/5/10V input

Probe check	Device check
Measure the continuous voltage in V by connecting a multimeter in parallel to the signal cables. The voltage value must be proportional to the measured value.  If no signal is present, replace the probe	1. Using a generator, apply (verifying that the polarity is correct) a voltage within the specified range and verify that the measured value is correct.  If no measurement is output, replace the device.

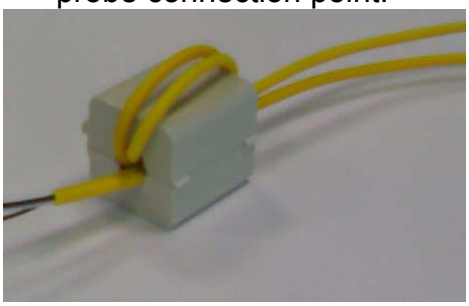
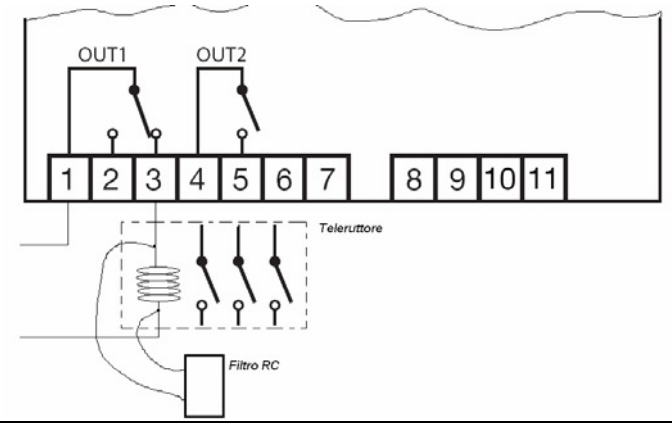
*Typical of single probes (value in Ω or mV at a reference temperature). For additional details, see the tables at the end of the document:

-If the device displays an "unstable" temperature
-If the device displays an "unstable" temperature when the relay enables

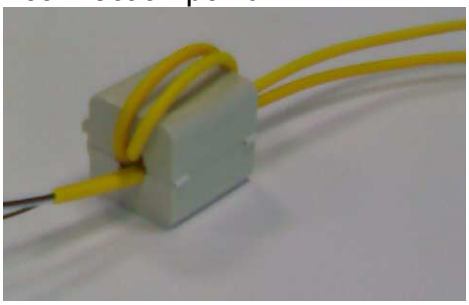
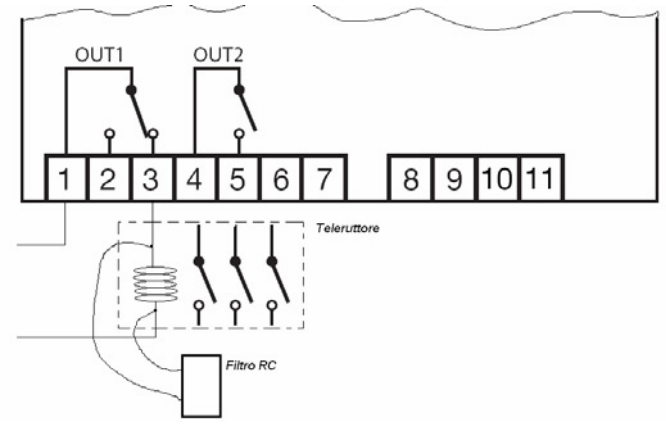
In the vast majority of cases, these problems originate from electromagnetic noise transmitted to the device through the probe cable and not filtered. In this specific case, check the points described below, then follow the instructions in the tables:

1. Separate the probe cables and the digital inputs from cable with ac voltage (motors, lamps, reactors or starters…).
2. Reduce to the minimum the length of the connection cables of probes and digital inputs.
3. Use a shielded cable, if noise persists. Check that the loop and grounding circuit work correctly, then connect the cable shielding to it.

PTC/NTC/Pt100/Pt100/Ni100

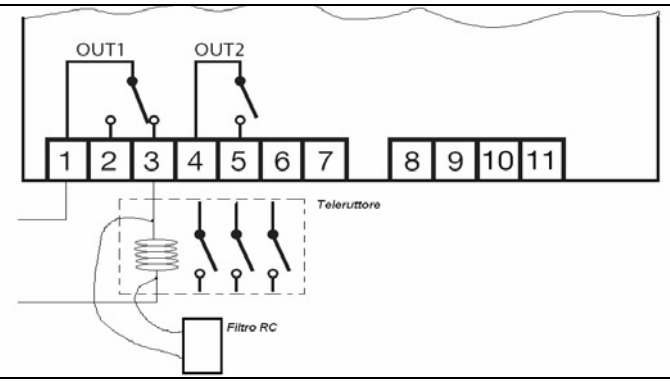
Probe check	Device check
1. Apply noise filters (ferrites) to the probe placing them as close as possible to the device, as shown in the figure, in order to create a "loop" in the ferrite. If several probes are present, they can be filtered using the same ferrite. When using probes with cables in Vetrotex, remove the Vetrotex from the probe connection point. 	1. If the power supply is shared with other electronic devices or teleruptors and similar equipment, separate the power supply with a dedicated transformer/line. 2. Apply an RC filter (100Ω+0,1uF) connecting it in parallel to the coil of the driven teleruptor. When using several teleruptors, it is necessary to apply one filter per coil. 

TCJ, K, S…(thermocouples)

Probe check	Device check
1. Apply noise filters (ferrites) to the probe placing them as close as possible to the device, as shown in the figure, in order to create a "loop" in the ferrite. If several probes are present, they can be filtered using the same ferrite. When using probes with cables in Vetrotex, remove the Vetrotex from the probe connection point.  2. Use "insulated" probes.	1. If the power supply is shared with other electronic devices or teleruptors and similar equipment, separate the power supply with a dedicated transformer/line. 2.Apply an RC (100Ω+0,1uF) filter connecting it in parallel with the driven teleruptor. When using several teleruptors, apply a filter to each coil. 

EWHS280, 300, 310, EWPA 007, 030 or 0/4…20mA, 0…1/5/10V input

Probe check	Device check
None, because the signals are low voltage current and/or voltage signals.	1. If the power supply is shared with other electronic devices or teleruptors and similar equipment, separate the power supply with a dedicated transformer/line. 2.Apply an RC filter (100Ω+0,1uF) connecting it in parallel with the coil of the driven teleruptor.

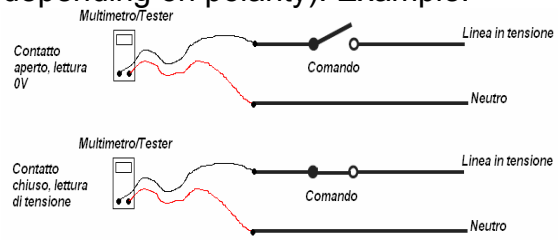
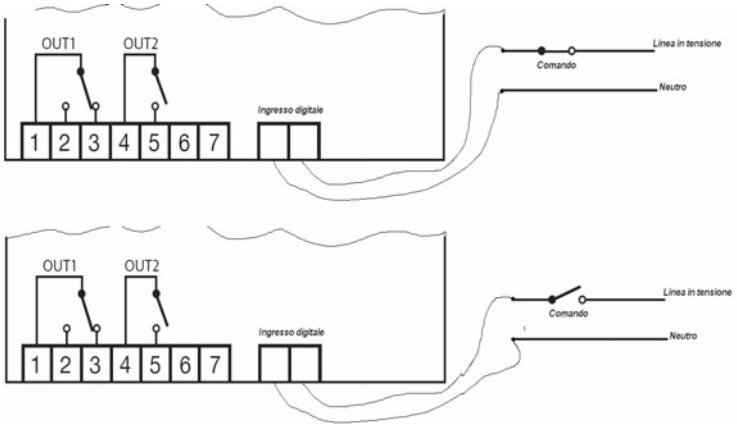
Troubleshooting problems related to digital inputs

- If the digital input does not perform the related action
- If the digital input performs the related action in "reverse" order
- If the digital input enables "randomly"

In this specific case, the problem may originate from the device that enables the digital input (switch, protection…, called command in the sections that follow) or the controller. Check the points described below, then follow the instructions in the tables:

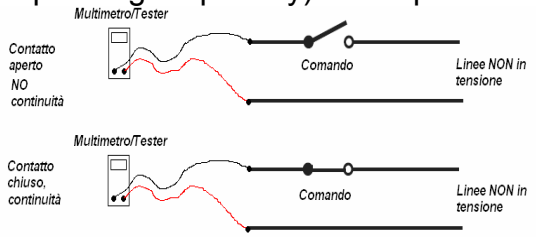
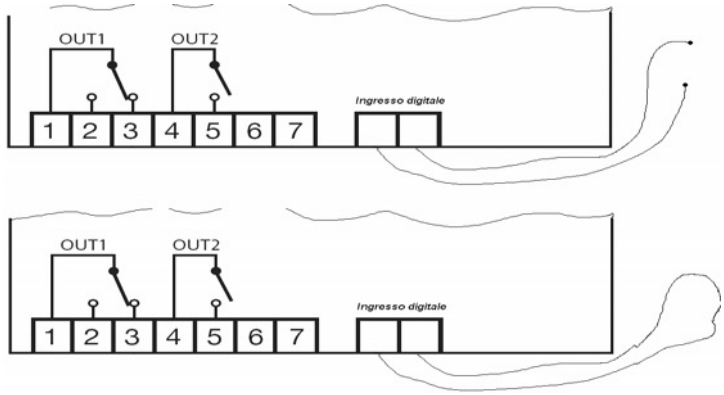
- Verify that the digital input selection parameter has been correctly set (H11, H12, see technical data sheet) and that the polarity is correct.
- Verify that connections have been correctly made and that the device is supplied with the correct voltage/power.
- Verify that the correct command has been applied to the digital input. Remember that there are devices with "powered" digital inputs (which require the application of voltage to obtain the desired result) and "free from voltage" digital inputs (that do NOT require the application of voltage to obtain the desired result). In this specific case a command is any device (limit switch, micro-door, protection device.) able to interrupt/supply voltage (for powered inputs) or continuity (for free from voltage inputs).

"Powered" digital input

Command check	**Device check**
Disconnect the wires from the device input and use a multimeter to verify that the command delivers the required voltage (the command applies or removes the voltage, depending on polarity). Example:  If there is no variation and if no voltage is detected, the command will not work or is a "free of voltage" command, when the required on e should be a "powered" one.	Apply the required voltage to the input (using the appropriate command or suitable cabling), then check the operation of the controller. Remove the voltage and check the reaction of the controller.  If no variation is detected, the input will not operate or the applied voltage will be below the required one. **NOTES** 1. If the voltage applied is significantly above the maximum one (for example 230V as opposed to the required 24V, the input may suffer

	permanent damage). 2. The application of a voltage below the required one does not cause damage.

"Free of voltage" digital input

Command check	Device check
Disconnect the wires from the device and use a multimeter to verify that the command guarantees the necessary continuity (the command may generate an open/close contact depending on polarity). Example:  1. If no variation occurs, the command does not work or there is a cable fault. 2. If the multimeter detects a voltage, the input is "powered" while the required one should be "free from voltage".	Simulate the enabling of the digital input on the device by short-circuiting the terminals with a wire. Remove the wire and check the reaction of the controller.  If no variation is detected, the input is not working correctly NOTE 1. The application of voltage (for example 230V) to a "free from voltage" input may cause permanent damage to the input and controller).

The wiring of "free from voltage" digital inputs must be carried out following the references applicable to signal/low voltage cables (separation and insulation of powered cables from power ones).

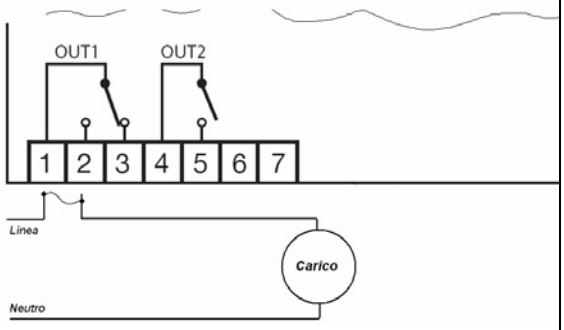
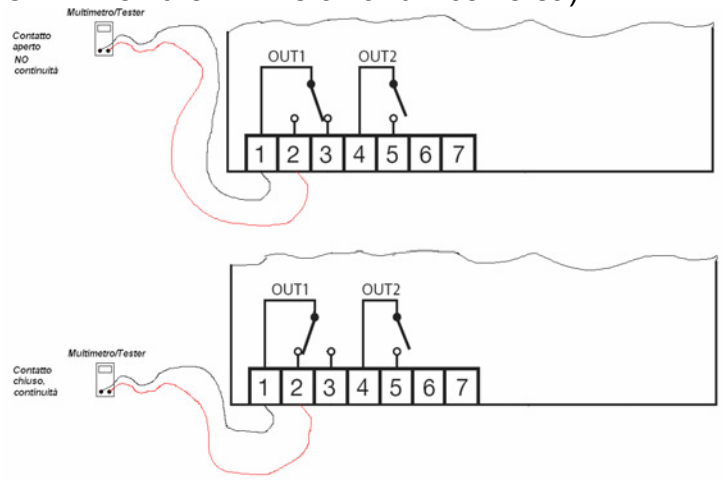
Troubleshooting problems related to digital outputs (powered relays and outputs)

-If the load does not enable

In this specific case the problem may originate from the driven load of the controller. Check the points described below, then follow the instructions in the tables:

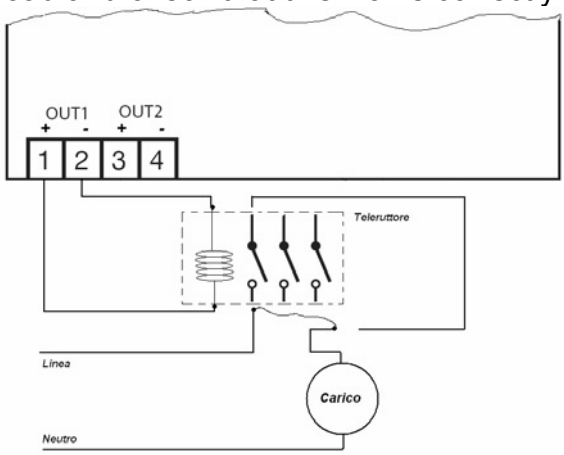
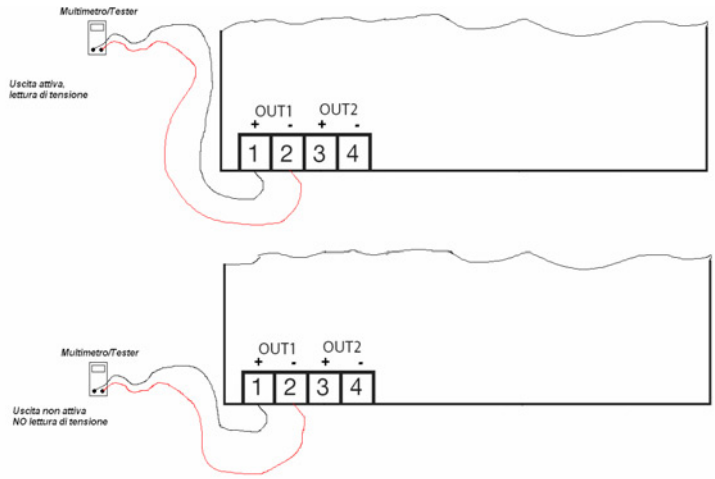
- Verify that the digital output selection parameter has been correctly set (H21, H22, see technical data sheet) and that the polarity is correct.
- Verify that connections have been correctly made and that the device is supplied with the correct voltage/power.
- Verify that the load applied to the output has been correctly selected and complies with label data: maximum relay current, and maximum voltage/current for voltage outputs. It is useful to remember that unless otherwise required, relays are generally suitable to drive alternate current loads.

Relay output

Load check	Device check
Disconnect the wires from the relay output of the controller, supply directly the load and verify that it works correctly. 	Disconnect the load and use a multimeter to check that the relay contact enables/disables. The enabling/disabling status must correspond to the LED on the front panel of the device (the output should be OFF when the LED is off and vice versa).  **NOTES** 1. If the LED is on and the output is disabled, the output is presumably damaged. 2. If the LED is off and the output is disabled, check the programming (set point, operating mode…).

Powered output

As specified at the beginning of the chapter, these are digital outputs (i.e. outputs that operate on an ON/OFF basis and not on modulation) that generate a voltage signal instead of a contact. Example: a disabled output generates 0V, while an enabled output generates 12V (with direct current). The output generally controls an auxiliary external teleruptor/relay or SSR, but never the load.

Load check	Device check
Disconnect the wires from the powered output of the controller, supply directly the load and check that this works correctly. 	Disconnect the load and use a multimeter to check the presence of voltage, depending on the status of the output. The enabling/disabling status must correspond to the one of the LED on the front panel of the device (the output should be OFF when the LED is off and vice versa). 

	NOTES 1. If the LED is on but the output is disabled, the relay is probably damaged. 2. If the LED is off and the output disabled, check the programming (set point, operating mode…). 3. Verify that the current absorbed by the auxiliary external teleruptor/relay or SSR does NOT exceed the maximum current that can be generated, as this condition could prevent the auxiliary external teleruptor/relay or SSR from enabling.

Troubleshooting problems related to TRIAC outputs

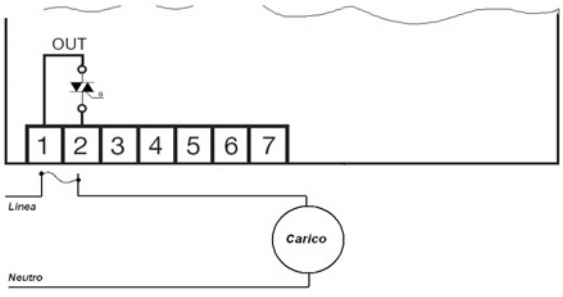
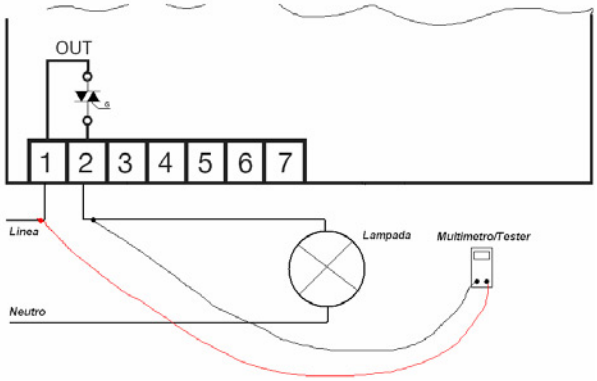
- If the load does not enable

- If the load remains permanently active

In this case the problem may originate from the driven load or the controller. Check the points described below, then follow the instructions in the tables:

- Verify that the TRIAC output selection and operation parameters have been correctly set (see the relevant datasheets and the manual).
- Verify that the connections have been correctly made and that the device is supplied at the required voltage/power.
- Verify that the correct load has been applied to the output and that it complies with label data: maximum current, maximum voltage.

TRIAC outputs can generally be used to drive loads with ON/OFF or proportional adjustment. The type of adjustment varies according to the electronic controller used. When an ON/OFF adjustment is used, the effect on the load is equivalent to that of a relay, except for the fact that there is no contact that opens or closes, but only a device (the TRIAC) that applies or removes the current from the load. When a proportional adjustment is used, the TRIAC applies/removes the current with a series of pulses. The higher the frequency and amplitude, and the wider is the interval of time during which the load could be enabled (it could correspond to a higher motor speed) and vice versa. This adjustment is called cut-off (see Bulletin 13-Glossary).

Load check	**Device check**
Disconnect the wires from the TRIAC output of the controller, supply the load directly and verify that it is working correctly.  **NOTE**: if the TRIAC is configured for a proportional adjustment, this connection forces it to maximum speed.	It is advisable to disconnect the load and replace it with a 100W@230V incandescence lamp. When the reference unit changes (for example temperature), the intensity of the light emitted by the lamp should also change. Use a multimeter connected in parallel to measure voltage variations.  **NOTES** 1. The TRIAC output cannot be tested without a load, because it always requires the

	application of a load. 2. It is generally advisable to connect the multimeter as close as possible to the output to be able to verify its operation and exclude the controller from possible causes. 3. If the output is working correctly, the connected load may not be suitable to be adjusted with a cut-off control. 4. For the ON/OFF adjustment (directed to the load or teleruptor) if this is always active: the load or teleruptor generates a very small impedance and the recirculation currents enable the TRIAC. Replace the load with a suitable one.

Troubleshooting problems related to low voltage analog outputs (PWM, TK)

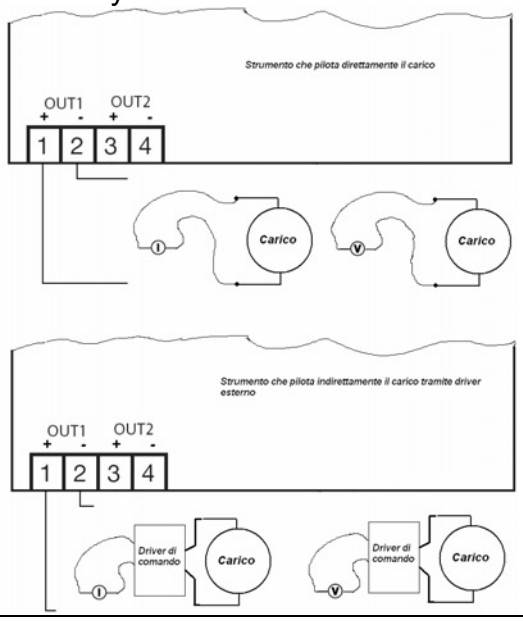
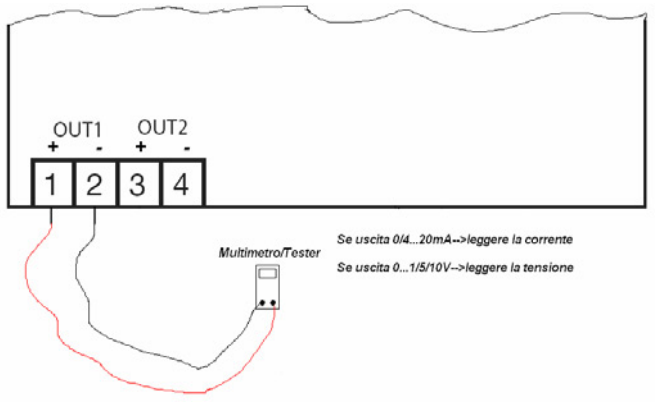
- If the load does not enable

- If the load remains permanently active

In this specific case the problem may originate from the driven load, the controller or the driver controlled by the low voltage analog output. Check the points described below, then follow the instructions in the tables:

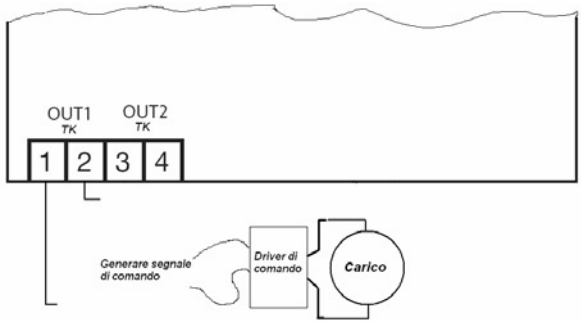
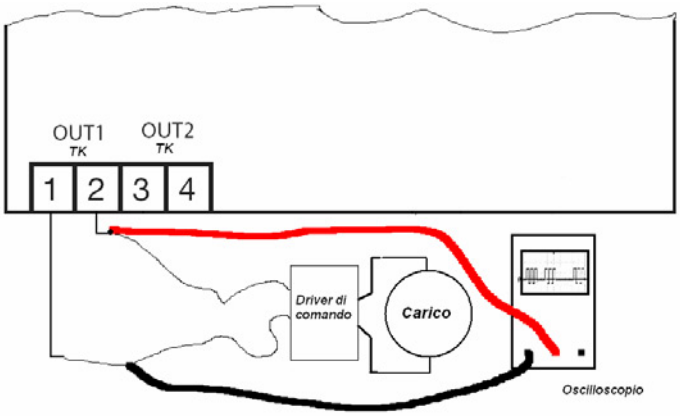
- Verify that the output selection and operation parameters have been correctly set (type, top and bottom scale; see the relevant datasheets and manual).
- Verify that the connections have been made correctly and that the device is supplied at the required voltage/power.
- Verify that the load applied to the output has been correctly applied and complies with the label data: maximum current, maximum voltage, maximum or minimum applicable resistance.

Analog outputs (0/4…20mA, 0…1/5/10V)

Load check	**Device check**
Disconnect the wires from the analog output and use a current or voltage generator (depending on the load) to simulate the command signal. Verify that the load is working correctly. The examples below refer to cases in which the load is managed directly and indirectly. 	Disconnect the load and use a multimeter to measure the supplied current or voltage (depending on the type of output). This will vary according to the reference value used.  **NOTE** 1. If the output works correctly, the connected load may have an excessively high resistance (for current signals) or an excessively low one (for voltage signals) as compared to the controller data.

Low voltage outputs (PWM, TK)

This type of output acts as command signal for power drivers, but it generally never controls a load directly.

Load check	Device check
Disconnect the wires from the output and simulate a command signal equivalent to the one of the controller, verifying that the load works correctly.  **NOTE**: as this kind of test is rather complex, it is generally easier to try using a second command driver.	After connecting the load, use an oscilloscope to check the output variation. The variation mode changes according to the settings. However, in this phase, it is generally sufficient to measure the signal amplitude variation or the variation that occurs when the signal is generated.  **NOTE**: as this kind of test is rather complex, it is generally easier to try using a second controller.

Appendixes

1. Table for PTC probe. Source: Philips ®, reference KTY 81-121

Silicon temperature sensors KTY81-1 series

Table 2 Ambient temperature, corresponding resistance, temperature coefficient and maximum expected temperature error for KTY81-121 and KTY81-122

I_{cont} = 1 mA.

AMBIENT TEMPERATURE		TEMP. COEFF.	KTY81-121				KTY81-122			
(°C)	(°F)	(%/K)	RESISTANCE (Ω)			TEMP. ERROR (K)	RESISTANCE (Ω)			TEMP. ERROR (K)
			MIN.	TYP.	MAX.		MIN.	TYP.	MAX.	
–55	–67	0.99	471	485	500	±3.02	480	495	510	±3.02
–50	–58	0.98	495	510	524	±2.92	505	520	535	±2.92
–40	–40	0.96	547	562	576	±2.74	558	573	588	±2.74
–30	–22	0.93	603	617	632	±2.55	615	630	645	±2.55
–20	–4	0.91	662	677	691	±2.35	676	690	705	±2.35
–10	14	0.88	726	740	754	±2.14	741	755	769	±2.14
0	32	0.85	794	807	820	±1.91	810	823	836	±1.91
10	50	0.83	865	877	889	±1.67	883	895	907	±1.67
20	68	0.80	941	951	962	±1.41	960	971	982	±1.41
25	77	0.79	980	990	1000	±1.27	1000	1010	1020	±1.27
30	86	0.78	1018	1029	1041	±1.39	1039	1050	1062	±1.39
40	104	0.75	1097	1111	1125	±1.64	1120	1134	1148	±1.64
50	122	0.73	1180	1196	1213	±1.91	1204	1221	1238	±1.91
60	140	0.71	1266	1286	1305	±2.19	1291	1312	1332	±2.19
70	158	0.69	1355	1378	1402	±2.49	1382	1406	1430	±2.49
80	176	0.67	1447	1475	1502	±2.8	1477	1505	1533	±2.8
90	194	0.65	1543	1575	1607	±3.12	1574	1607	1639	±3.12
100	212	0.63	1642	1679	1716	±3.46	1676	1713	1750	±3.46
110	230	0.61	1745	1786	1828	±3.83	1780	1823	1865	±3.83
120	248	0.58	1849	1896	1943	±4.33	1886	1934	1982	±4.33
125	257	0.55	1900	1950	2000	±4.66	1938	1989	2041	±4.66
130	266	0.52	1950	2003	2056	±5.07	1989	2044	2098	±5.07
140	284	0.45	2044	2103	2162	±6.28	2085	2146	2206	±6.28
150	302	0.35	2124	2189	2254	±8.55	2167	2233	2299	±8.55

2. Table for NTC probe. Source: SEMITEC ®, reference 103-AT 2 and/or 103-AT II

Temperature (°C)	Type					
	102AT	202AT	502AT	103AT	203AT	503AT
−50	24.46	55.66	154.6	329.5	1253	3168
−45	18.68	42.17	116.5	247.7	890.5	2257
−40	14.43	32.34	88.91	188.5	642.0	1632
−35	11.23	24.96	68.19	144.1	465.8	1186
−30	8.834	19.48	52.87	111.3	342.5	872.8
−25	6.998	15.29	41.21	86.43	253.6	646.3
−20	5.594	12.11	32.44	67.77	190.0	484.3
−15	4.501	9.655	25.66	53.41	143.2	364.6
−10	3.651	7.763	20.48	42.47	109.1	277.5
−5	2.979	6.277	16.43	33.90	83.75	212.3
0	2.449	5.114	13.29	27.28	64.88	164.0
5	2.024	4.188	10.80	22.05	50.53	127.5
10	1.684	3.454	8.840	17.96	39.71	99.99
15	1.408	2.862	7.267	14.69	31.36	78.77
20	1.184	2.387	6.013	12.09	24.96	62.56
25	1.000	2.000	5.000	10.00	20.00	50.00
30	0.8486	1.684	4.179	8.313	16.12	40.20
35	0.7229	1.424	3.508	6.940	13.06	32.48
40	0.6189	1.211	2.961	5.827	10.65	26.43
45	0.5316	1.033	2.509	4.911	8.716	21.59
50	0.4587	0.8854	2.137	4.160	7.181	17.75
55	0.3967	0.7620	1.826	3.536	5.941	14.64
60	0.3446	0.6587	1.567	3.020	4.943	12.15
65	0.3000	0.5713	1.350	2.588	4.127	10.13
70	0.2622	0.4975	1.168	2.228	3.464	8.482
75	0.2285	0.4343	1.014	1.924	2.916	7.129
80	0.1999	0.3807	0.8835	1.668	2.468	6.022
85	0.1751	0.3346	0.7722	1.451	2.096	5.105
90	0.1536	0.2949	0.6771	1.266	1.788	4.345
95			0.5961	1.108	1.530	3.712
100			0.5265	0.9731	1.315	3.185
105			0.4654	0.8572	1.134	2.741
110			0.4128	0.7576	0.9807	2.369

Unit(kΩ)

3. Table for NTC probe with extended range. Source: SAMITAL ®

Temperature °C	R nominal (Ohm)	R minimum (Ohm)	R maximum (Ohm)
-40	333562.40	321653.63	345877.49
-35	241071.91	233032.08	249364.19
-30	176081.50	170610.62	181709.63
-25	129925.34	126175.88	133772.84
-20	96807.31	94221.29	99454.36
-15	72808.80	71015.42	74640.00
-10	55252.84	54003.53	56525.40
-5	42292.22	41418.92	43179.62
0	32639.86	32028.04	33260.04
5	25390.50	24961.55	25824.25
10	19901.65	19601.20	20204.69
15	15713.31	15503.54	15924.32
20	12493.34	12347.77	12639.36
25	10000.00	9900.00	10100.00
30	8055.92	7962.44	8149.68
35	6530.00	6444.07	6616.41
40	5324.61	5246.50	5403.33
45	4366.54	4296.09	4437.70
50	3600.53	3537.32	3664.51
55	2984.58	2928.06	3041.89
60	2486.57	2436.14	2537.78
65	2081.77	2036.84	2127.48
70	1751.07	1711.05	1791.84
75	1479.56	1443.92	1515.93
80	1255.60	1223.85	1288.05
85	1070.01	1041.71	1098.98
90	915.55	890.28	941.43
95	786.43	763.86	809.59
100	678.07	657.87	698.81
105	586.75	568.66	605.36
110	509.52	493.28	526.23
115	443.94	429.35	458.98
120	388.06	374.93	401.61
125	340.29	328.45	352.52
130	299.31	288.62	310.36
135	264.04	254.37	274.05
140	233.58	224.82	242.66
145	207.21	199.26	215.46
150	184.31	177.08	191.81

4. Table for Pt100 probe

Temp °C	Resistance (Ohm)
-200	18,52
-190	22,83
-180	27,10
-170	31,34
-160	35,54
-150	39,72
-140	43,88
-130	48,00
-120	52,11
-110	56,19
-100	60,26
-90	64,30
-80	68,33
-70	72,33
-60	76,33
-50	80,31
-40	84,27
-30	88,22
-20	92,16
-10	96,09
0	100,00
10	103,90
20	107,79
30	111,67
40	115,54
50	119,40
60	123,24
70	127,08
80	130,90
90	134,71
100	138,51
110	142,29
120	146,07
130	149,83
140	153,58
150	157,33

Temp °C	Resistance (Ohm)
160	161,05
170	164,77
180	168,48
190	172,17
200	175,86
210	179,53
220	183,19
230	186,84
240	190,47
250	194,10
260	197,71
270	201,31
280	204,90
290	208,48
300	212,05
310	215,61
320	219,15
330	222,68
340	226,21
350	229,72
360	233,21
370	236,70
380	240,18
390	243,64
400	247,09
410	250,53
420	253,96
430	257,38
440	260,78
450	264,18
460	267,56
470	270,93
480	274,29
490	277,64
500	280,98
510	284,30

Temp °C	Resistance (Ohm)
520	287,62
530	290,92
540	294,21
550	297,49
560	300,75
570	304,01
580	307,25
590	310,49
600	313,71
610	316,92
620	320,12
630	323,30
640	326,48
650	329,64
660	332,79
670	335,93
680	339,06
690	342,18
700	345,28
710	348,38
720	351,46
730	354,53
740	357,59
750	360,64
760	363,67
770	366,70
780	369,71
790	372,71
800	375,70
810	378,68
820	381,65
830	384,60
840	387,55
850	390,48

5. Table for Ni100 probe

Temp °C	Resistance
-60	69,5
-50	74,3
-40	79,1
-30	84,2
-20	89,3
-10	94,6
0	100,0
10	105,6
20	111,2
30	117,1
40	123,0
50	129,1
60	135,3
70	141,7
80	148,3
90	154,9
100	161,8
110	168,8
120	176,0
130	183,3
140	190,9
150	198,7
160	206,6
170	214,8
180	232,2

6. Table for Pt1000 probe

Temperatura	R nominal (Ohm)
-200	185,281
-190	228,327
-180	271,029
-170	313,408
-160	355,484
-150	397,277
-140	438,803
-130	480,081
-120	521,127
-110	561,954
-100	602,578
-90	643,012
-80	683,267
-70	723,355
-60	763,286
-50	803,068
-40	842,71
-30	882,218
-20	921,6
-10	960,859
0	1000
10	1039,025
20	1077,936
30	1116,731
40	1155,411
50	1193,976
60	1232,426
70	1270,761
80	1308,981
90	1347,085
100	1385,075
110	1422,949
120	1460,709
130	1498,353
140	1535,882
150	1573,296

Temperatura	R nominal (Ohm)
160	1610,595
170	1647,779
180	1684,848
190	1721,801
200	1758,64
210	1795,363
220	1831,972
230	1868,465
240	1904,843
250	1941,106
260	1977,254
270	2013,287
280	2049,205
290	2085,007
300	2120,695
310	2156,267
320	2191,725
330	2227,067
340	2262,294
350	2297,406
360	2332,403
370	2367,285
380	2402,052
390	2436,703
400	2471,24
410	2505,661
420	2539,968
430	2574,159
440	2608,235
450	2642,196
460	2676,042
470	2709,773
480	2743,389
490	2776,889
500	2810,275
510	2843,545

Temperatura	R nominal (Ohm)
520	2876,701
530	2909,741
540	2942,666
550	2975,476
560	3008,171
570	3040,751
580	3073,216
590	3105,565
600	3137,8
610	3169,919
620	3201,924
630	3233,813
640	3265,587
650	3297,246
660	3328,79
670	3360,219
680	3391,533
690	3422,731
700	3453,815
710	3484,783
720	3515,637
730	3546,375
740	3576,998
750	3607,506
760	3637,899
770	3668,177
780	3698,34
790	3728,387
800	3758,32
810	3788,137
820	3817,84
830	3847,427
840	3876,899
850	3906,256

7. Table for TCJ, K, S…probe (thermocouples, f.em in mV)

TCK

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-200	-5,891	-6,035	-6,158	-6,262	-6,344	-6,404	-6,441	-6,458		
-100	-3,554	-3,852	-4,138	-4,411	-4,669	-4,913	-5,141	-5,354	-5,550	-5,730
0	0,000	-0,392	-0,778	-1,156	-1,527	-1,889	-2,243	-2,587	-2,920	-3,243
	10	20	30	40	50	60	70	80	90	100
0	0,000	0,397	0,798	1,203	1,612	2,023	2,436	2,851	3,267	3,682
100	4,096	4,509	4,920	5,328	5,735	6,138	6,540	6,941	7,340	7,739
200	8,138	8,539	8,940	9,343	9,747	10,153	10,561	10,971	11,382	11,795
300	12,209	12,624	13,040	13,457	13,874	14,293	14,713	15,133	15,554	15,975
400	16,397	16,820	17,243	17,667	18,091	18,516	18,941	19,366	19,792	20,218
500	20,644	21,071	21,497	21,924	22,350	22,776	23,203	23,629	24,055	24,480
600	24,905	25,330	25,755	26,179	26,602	27,025	27,447	27,869	28,289	28,710
700	29,129	29,548	29,965	30,382	30,798	31,213	31,628	32,041	32,453	32,865
800	33,275	33,685	34,093	34,501	34,908	35,313	35,718	36,121	36,524	36,925
900	37,326	37,725	38,124	38,522	38,918	39,314	39,708	10,101	40,490	40,885
1000	41,276	41,665	42,053	42,440	42,826	43,211	43,595	43,978	44,359	44,740
1100	45,119	45,497	45,873	46,249	46,623	46,995	47,367	47,737	48,105	48,473
1200	48,838	49,202	49,565	49,926	50,286	50,644	51,000	51,355	51,708	52,060
1300	52,410	52,759	53,106	53,451	53,795	54,138	54,479	54,819		

TCJ

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-200	-7,890	-8,095								
-100	-4,633	-5,037	-5,426	-5,801	-6,159	-6,500	-6,821	-7,123	-7,403	-7,659
0	0,000	-0,501	-0,995	-1,482	-1,961	-2,431	-2,893	-3,344	-3,786	-4,215
	10	20	30	40	50	60	70	80	90	100
0	0,000	0,507	1,019	1,537	2,059	2,585	3,116	3,650	4,187	4,726
100	5,269	5,814	6,360	6,909	7,459	8,010	8,562	9,115	9,669	10,224
200	10,779	11,334	11,889	12,445	13,000	13,555	14,110	14,665	15,219	15,773
300	16,327	16,881	17,434	17,986	18,538	19,090	19,642	20,194	20,745	21,297
400	21,848	22,400	22,952	23,504	24,057	24,610	25,164	25,720	26,276	26,834
500	27,393	27,953	28,516	29,080	29,647	30,216	30,788	31,362	31,939	32,519
600	33,102	33,689	34,279	34,873	35,470	36,071	36,675	37,284	37,896	38,512
700	39,132	39,755	40,382	41,012	41,645	42,281	42,919	43,559	44,203	44,848
800	45,494	46,141	46,786	47,431	48,074	48,715	49,353	49,989	50,622	51,251
900	51,877	52,500	53,119	53,735	54,347	54,956	55,561	56,164	56,763	57,360
1000	57,953	58,545	59,134	59,721	60,307	60,890	61,473	62,054	62,634	63,214
1100	63,792	64,370	64,948	65,525	66,102	66,679	67,255	67,831	68,406	68,980
1200	69,553									

TCS

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
0	0,000	-0,053	-0,103	-0,150	-0,194	-0,236				
	10	20	30	40	50	60	70	80	90	100
0	0,000	0,055	0,113	0,173	0,235	0,299	0,365	0,433	0,502	0,573
100	0,646	0,720	0,795	0,872	0,950	1,029	1,110	1,191	1,273	1,357
200	1,441	1,526	1,612	1,698	1,786	1,874	1,962	2,052	2,141	2,232
300	2,323	2,415	2,507	2,599	2,692	2,786	2,880	2,974	3,096	3,164
400	3,259	3,355	3,451	3,548	3,645	3,742	3,840	3,938	4,036	3,134
500	4,233	4,332	4,432	4,532	4,632	4,732	4,833	4,934	5,035	5,137
600	5,239	5,341	5,443	5,546	5,659	5,753	5,857	5,961	6,065	6,170
700	6,275	6,381	6,486	6,593	6,699	6,806	6,913	7,020	7,128	7,236
800	7,345	7,454	7,563	7,673	7,783	7,893	8,003	8,114	8,226	8,337
900	8,449	8,562	8,674	8,787	8,900	9,014	9,128	9,242	9,357	9,472
1000	9,587	9,703	9,819	9,935	10,051	10,168	10,285	10,403	10,520	10,638
1100	10,757	10,875	10,994	11,113	11,232	11,351	11,471	11,590	11,710	11,830
1200	11,951	12,071	12,191	12,312	12,433	12,554	12,675	12,796	12,917	13,038
1300	13,159	13,280	13,402	13,523	13,644	13,766	13,887	14,009	14,130	14,251
1400	14,373	14,494	14,615	14,736	14,857	14,978	15,099	15,220	15,341	15,461
1500	15,582	15,702	15,822	15,942	16,062	16,182	16,301	16,420	16,539	16,658
1600	16,777	16,895	17,013	17,131	17,249	17,366	17,483	17,600	17,717	17,832
1700	17,947	18,061	18,174	18,825	18,395	18,503	18,609			

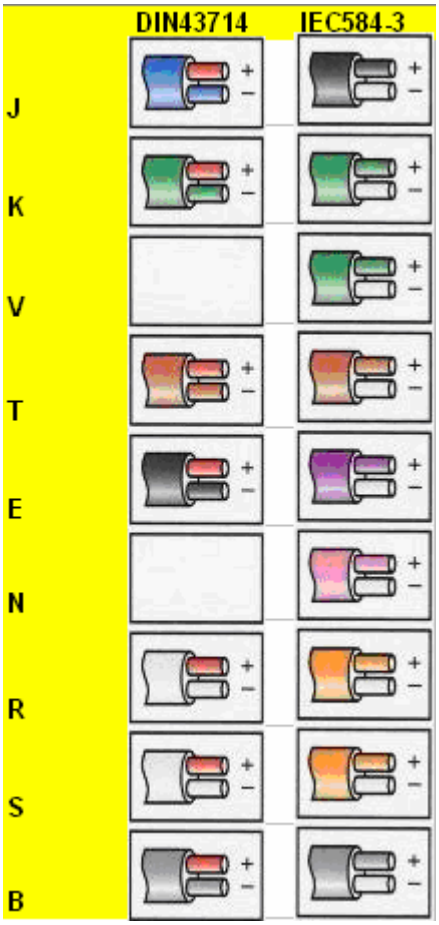
TCR

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
0	0,000	-0,051	-0,100	-0,145	-0,188	-0,226				
	10	20	30	40	50	60	70	80	90	100
0	0,000	0,054	0,111	0,171	0,232	0,296	0,363	0,431	0,501	0,573
100	0,647	0,723	0,800	0,879	0,959	1,041	1,124	1,208	1,294	1,381
200	1,469	1,558	1,648	1,739	1,831	1,923	2,017	2,112	2,207	2,304
300	2,401	2,498	2,597	2,696	2,796	2,896	2,997	3,099	3,201	3,304
400	3,408	3,512	3,616	3,721	3,827	3,933	4,040	4,147	4,255	4,363
500	4,471	4,580	4,690	4,800	4,910	5,021	5,133	5,245	5,357	5,470
600	5,583	5,697	5,812	5,926	6,041	6,157	6,237	6,390	6,507	6,625
700	6,743	6,861	6,980	7,100	7,220	7,340	7,461	7,583	7,705	7,827
800	7,950	8,073	8,197	8,321	8,446	8,571	8,697	8,823	8,950	9,077
900	9,205	9,333	9,461	9,590	9,720	9,850	9,980	10,111	10,242	10,374
1000	10,506	10,638	10,771	10,905	11,039	11,173	11,307	11,442	11,578	11,714
1100	11,850	11,986	12,123	12,260	12,397	12,535	12,673	12,812	12,950	13,089
1200	13,228	13,367	13,507	13,646	13,786	13,926	14,066	14,207	14,347	14,488
1300	14,629	14,770	14,911	15,052	15,193	15,334	15,475	15,616	15,758	15,899
1400	16,040	16,181	16,323	16,464	16,605	16,746	16,887	17,028	17,169	17,310
1500	17,451	17,591	17,732	17,872	18,012	18,152	18,292	18,431	18,571	18,710
1600	18,849	18,988	19,126	19,264	19,402	19,540	19,677	19,814	19,951	20,087
1700	20,222	20,356	20,488	20,620	20,749	20,877	21,003			

TCT

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-200	-5,603	-5,753	-5,888	-6,007	-6,105	-6,180	-6,232	-6,258		
-100	-3,379	-3,657	-3,923	-4,177	-4,419	-4,648	-4,865	-5,070	-5,261	-5,439
0	0,000	-0,383	-0,757	-1,121	-1,475	-1,819	-2,153	-2,476	-2,788	-3,089
	10	20	30	40	50	60	70	80	90	100
0	0,000	0,391	0,790	1,196	1,612	2,036	2,468	2,909	3,358	3,814
100	4,279	4,750	5,228	5,714	6,206	6,704	7,209	7,720	8,237	8,759
200	9,288	9,822	10,362	10,907	11,458	12,013	12,574	13,139	13,709	14,283
300	14,862	15,445	16,032	16,624	17,219	17,819	18,422	19,030	19,641	20,255
400	20,872									

8. Table of cable colors for TCJ, K, S…probes (thermocouples)



NOTES

- PTC is a generic term that indicates that the sensing element offers a resistance that increases with temperature. There are several types of PTC probes with a rating of 1KΩ@25°C that produce however different values at different temperatures. It is therefore necessary to perform other measurements at varying temperatures to determine whether the sensor is compatible with Eliwell's instrumentation that uses sensor Philips KTY 81-121® as reference. Other types of PTC probes with temperature-resistance characteristics that differ from those of the specified sensor are not compatible.
- NTC is a generic term that indicates that the sensing element offers a resistance that decreases as temperature increases. There are several types of NTC probes with a rating of 10KΩ@25°C that produce however different values at different temperatures. It is therefore necessary to perform other measurements at varying temperatures to determine whether the sensor is compatible with Eliwell's instrumentation that uses sensor SEMITEC 103-AT® as reference. Other types of NTC probes with temperature-resistance characteristics that differ from those of the specified sensor are not compatible.
- Pt100/Ni100 and Pt1000 are "standard" types of sensors. Therefore, all types of Pt100/Ni100 and Pt1000 sensors are compatible.
- If the measured resistance value differs from the specified one, the sensor is probably faulty. This applies also if a short-circuit or open circuit is detected.

Figures Legend

Alimentazione sonda = Probe supply
Carico = Load
Comando = Command
Contatto aperto, lettura 0 V = Open contact, 0V reading
Contatto aperto, NO continuità = Open contact, NO continuity
Contatto chiuso, continuità = Closed contact, continuity
Contatto chiuso, lettura di tensione = Closed contact, voltage reading
Cortocircuito = Short-circuit
Driver di comando = Command driver
Filtro RC = RC filter
Generare segnale di comando = Generate command signal
Generatore = Generator
Gnd segnale = Signal gnd
Ingresso digitale = Digital input
Ingresso segnale = Signal input
Ingresso sonda = Probe input
Lampada = Lamp
Linea = Line
Linea in tensione = Powered line
Linee NON in tensione = NOT powered lines
Multimetro/tester = Multimeter/Tester
Neutro = Neutral
Oscilloscopio = Oscilloscope
Resistenza = Eletric heater
Resistenza di valore calibrato = Electric heater with calibrated value
Se uscita 0...1/5/10 V leggere corrente = If the output is 0...1/5/10 V, read the voltage value
Se uscita 0/4...20mA leggere corrente = If the output is 0/4...20mA , read the current value
Sonda a 2 fili = 2-wire probe
Strumento = Device
Strumento che pilota direttamente il carico = Device that directly controls the load
Strumento che pilota direttamente il carico tramite driver esterno = Device that directly controls the load by means of an external driver
Teleruttore = Teleruptor
Uscita attiva, lettura di tensione = Enabled output, voltage measurement
Uscita non attiva, NO lettura di tensione = Disabled output, NO voltage measurement

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