

COMMON THERMOMETRY FIXED POINTS

Fixed Points from the Practical International Temperature Scale ITS-90		
	°C	°F
Triple Point of Hydrogen	-259.35	-434.82
Boiling Point of Hydrogen	-256.15	-429.07
Triple Point of Neon	-248.59	-415.47
Triple Point of Oxygen	-218.79	-361.82
Triple Point of Argon	-189.34	-308.81
Triple Point of Mercury	-38.83	-37.90
Triple Point of Water	0.01	32.02
Melting Point of Gallium	29.76	85.57
Freezing Point of Indium	156.59	313.86
Freezing Point of Tin	231.93	449.47
Freezing Point of Zinc	419.53	787.15
Freezing Point of Aluminum	660.32	1220.58
Freezing Point of Silver	961.78	1763.20
Freezing Point of Gold	1064.18	1947.52
Freezing Point of Copper	1084.62	1984.32

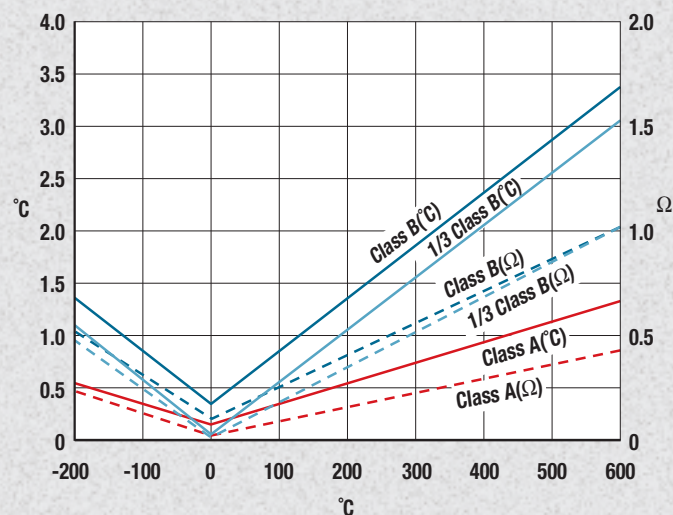
AMERICAN WIRE GAUGE SIZE TO INCHES

American Wire Gauge(AWG)	Size O.D Inches	American Wire Gauge(AWG)	Size O.D Inches
6/0	0.5800	23	0.0226
5/0	0.5165	24	0.0201
4/0	0.4600	25	0.0179
3/0	0.4096	26	0.0159
2/0	0.3648	27	0.0142
1/0	0.3249	28	0.0126
1	0.2893	29	0.0113
2	0.2576	30	0.0100
3	0.2294	31	0.00893
4	0.2043	32	0.00795
5	0.1819	33	0.00708
6	0.1620	34	0.00630
7	0.1443	35	0.00561
8	0.1285	36	0.00500
9	0.1144	37	0.00445
10	0.1019	38	0.00396
11	0.0907	39	0.00353
12	0.0808	40	0.00314
13	0.0720	41	0.00280
14	0.0641	42	0.00249
15	0.0571	43	0.00222
16	0.0508	44	0.00198
17	0.0453	45	0.00176
18	0.0403	46	0.00157
19	0.0359	47	0.00140
20	0.0320	48	0.00124
21	0.0285	49	0.00111
22	0.0253	50	0.00099

TOLERANCES FOR A 100Ω PLATINUM RTD PER IEC 751-95

Temperature Deg (C)	Tolerance					
	Class B		1/3 Class B		Class A	
	(±C) ⁽¹⁾	(±0hm)	(±C)	(±0hm)	(±C) ⁽²⁾	(±0hm)
-200	1.30	0.56	1.10	0.48	0.55	0.24
-100	0.80	0.32	0.60	0.24	0.35	0.14
0	0.30	0.12	0.10	0.04	0.15	0.06
100	0.80	0.30	0.60	0.23	0.35	0.13
200	1.30	0.48	1.10	0.40	0.55	0.20
300	1.80	0.64	1.60	0.57	0.75	0.27
400	2.30	0.79	2.10	0.72	0.95	0.33
500	2.80	0.93	2.60	0.87	1.15	0.38
600	3.30	1.06	3.10	1.00	1.35	0.43

Notes: (1) C=±(0.3+0.005*[t]) • (2) C=±(0.15+0.002*[t])



Thermocouple-RTD Technical Information



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THERMOCOUPLE CHARACTERISTICS TABLE						
ANSI/ASTM	Symbol Single	Generic Names	Color Coding		Magnetic Yes/No	Environment (Bare Wire)
			Individual Conductor	Overall Jacket Extension Grade Wire		
T	TP TN	Copper Constantan, Nominal Composition: 55% Cu, 45% Ni	● Blue ● Red	● Blue	X X	Mild Oxidizing, Reducing. Vacuum or Inert. Good where moisture is present.
J	JP JN	Iron Constantan, Nominal Composition: 55% Cu, 45% Ni	○ White ● Red	● Black	X X	Reducing Vacuum, Inert. Limited use in oxidizing at High Temperatures. Not recommended for low temps.
E	EP EN	Chromel®, Nominal Composition: 90% Ni, 10% Cr Constantan, Nominal Composition: 55% Cu, 45% Ni	● Purple ● Red	● Purple	X X	Oxidizing or Inert. Limited use in Vacuum or Reducing.
K	KP KN	Chromel, Nominal Composition: 90% Ni, 10% Cr Alumel®, Nominal Composition: 95% Ni, 2% Mn, 2% Al	● Yellow ● Red	● Yellow	X X	Clean Oxidizing and Inert. Limited use in Vacuum or Reducing
N	NP NN	Nicrosil®, Nominal Compositions: 84.6% Ni, 14.2% Cr, 1.4% Si Nisil®, Nominal Composition: 95.5% Ni, 4.4% Si, 1% Mg	● Orange ● Red	● Orange	X X	Clean Oxidizing and Inert. Limited use in Vacuum or Reducing
S	SP SN	Platinum 10% Rhodium Pure Platinum	● Black ● Red	● Green	X X	Oxidizing or Inert Atmospheres. Do not insert in metal tubes. Beware of contamination.
R	RP RN	Platinum 13% Rhodium Pure Platinum	● Black ● Red	● Green	X X	Oxidizing or Inert Atmospheres. Do not insert in metal tubes. Beware of contamination.
B	BP BN	Platinum 30% Rhodium Platinum 6% Rhodium	● Gray ● Red	● Gray	X X	Oxidizing or Inert Atmospheres. Do not insert in metal tubes. Beware of contamination.
C*	P N	Tungsten 5% Rhenium Tungsten 26% Rhenium	● Green ● Red	● Red	X X	Vacuum, Inert, Hydrogen Atmospheres. Beware of Embrittlement.

*Type C was previously designated as W5.

METRIC-ENGLISH CONVERSION TABLE
1 mm = 0.03937 in.
1 meter = 3.281 ft.
1 Bar = 14.503 PSI
1 Kg = 2.205 lbs.

An expanded, interactive conversion program can be found at www.conaxbuffalo.com/tech under the listing "Conversion Tables".

FACTORS AND PREFIXES FOR FORMING DECIMAL MULTIPLES AND SUB-MULTIPLES FOR THE SI UNITS									
Multiplication			Multiplication			Multiplication			
Factor	Prefix	Symbol	Factor	Prefix	Symbol	Factor	Prefix	Symbol	
10 ¹²	tera	T	10	deka	da	10 ⁻⁹	nano	n	
10 ⁹	giga	G	10 ⁻¹	deci	d	10 ⁻¹²	pico	p	
10 ⁶	mega	M	10 ⁻²	centi	c	10 ⁻¹⁵	femto	f	
10 ³	kilo	k	10 ⁻³	milli	m	10 ⁻¹⁸	atto	a	
10 ²	hecto	h	10 ⁻⁶	micro	μ				

TOLERANCE OF THERMOCOUPLES						
ANSI/ASTM	°C			°F		
	Temperature Range	Standard	Special	Temperature Range	Standard	Special
T	-200° to -67° -67° to -62° -62° to 125° 125° to 133° 133° to 370°	± 1.5% T ± 1° ± 1° ± 1° ± 0.75% T	± 0.8% T* ± 0.8% T* ± 0.5° ± 0.4% T ± 0.4% T	-328° to -88° -88° to -80° -80° to 257° 257° to 272° 272° to 700°	± 1.5% (T - 32) ± 1.8° ± 1.8° ± 1.8° ± 0.75% (T - 32)	± 0.8% (T - 32)* ± 0.8% (T - 32)* ± 0.9°* ± 0.4% (T - 32) ± 0.4% (T - 32)
J	0° to 275° 275° to 293° 293° to 760°	± 2.2° ± 2.2° ± 0.75% T	± 1.1° ± 0.4% T ± 0.4% T	32° to 527° 527° to 560° 560° to 1400°	± 3.96° ± 3.96° ± 0.75% (T - 32)	± 1.98° ± 0.4% (T - 32) ± 0.4% (T - 32)
E	-200° to -170° -170° to 250° 250° to 340° 340° to 870°	± 1% T ± 1.7° ± 1.7° ± 0.5% T	± 1°* ± 1°* ± 0.4% T ± 0.4% T	-328° to -274° -274° to 482° 482° to 644° 644° to 1600°	± 1% (T - 32) ± 3.06° ± 3.06° ± 0.5% (T - 32)	± 1.8°* ± 1.8°* ± 0.4% (T - 32) ± 0.4% (T - 32)
K	-200° to -110° -100° to 0° 0° to 275° 275° to 293° 293° to 1260°	± 2% T ± 2.2° ± 2.2° ± 2.2° ± 0.75% T	— — ± 1.1° ± 0.4% T ± 0.4% T	-328° to -166° -166° to 32° 32° to 527° 527° to 560° 560° to 2300°	± 2% (T - 32) ± 3.96° ± 3.96° ± 3.96° ± 0.75% (T - 32)	— — ± 1.98° ± 0.4% (T - 32) ± 0.4% (T - 32)
N	0° to 275° 275° to 293° 293° to 1250°	± 2.2° ± 2.2° ± 0.75% T	± 1.1° ± 0.4% T ± 0.4% T	32° to 527° 527° to 560° 560° to 2300°	± 3.96° ± 3.96° ± 0.75% (T - 32)	± 1.98° ± 0.4% (T - 32) ± 0.4% (T - 32)
R or S	0° to 1260° 1260° to 1480°	± 1.5° ± 0.25% T	± 0.6° ± 0.1% T	32° to 1112° 1112° to 2700°	± 2.7° ± 0.25% (T - 32)	± 1.08° ± 0.1% (T - 32)
B	870° to 1700°	± 0.5% T	± 0.25%	1600° to 3100°	± 0.5% (T - 32)	± 0.25% (T - 32)
C**	0° to 426° 426° to 2315°	± 4.4° ± 1% T	— —	32° to 800° 800° to 4200°	± 8° ± 1% (T - 32)	— —

*Special tolerances below 0° C (32° F) are unofficial and are provided as a basis of discussion between Conax and our customers.

**Type C was previously designated as W5.

THERMOCOUPLE WIRE SIZE AND RESISTANCE TABLE								
AWG No.	Diameter Inches	ISA Type K Chromel/Alumel	ISA Type J Iron/Constantan	ISA Type T Copper/Constantan	ISA Type E Chromel/Constantan	ISA Type N Nicrosil/Nisil	ISA Type S PT/PT 10% RH	ISA Type R PT/PT 13% RH
8	0.1285	0.0365	0.2185	0.0186	0.0437	0.0485	0.011	0.011
12	0.0808	0.0916	0.0533	0.0455	0.1099	0.1225	0.028	0.029
14	0.0641	0.1466	0.085	0.0735	0.1752	0.1947	0.045	0.047
16	0.0508	0.2331	0.136	0.117	0.2775	0.3100	0.071	0.073
18	0.0403	0.3706	0.218	0.1874	0.4454	0.4926	0.116	0.119
20	0.0320	0.5894	0.349	0.2991	0.7030	0.7812	0.185	0.190
22	0.0253	0.9368	0.544	0.4751	1.1206	1.2498		
24	0.0201	1.4901	0.878	0.7526	1.78	1.980	0.464	0.478
26	0.0159	2.3811	1.405	1.204	2.836	3.164	0.740	0.760
28	0.0126	3.768	2.235	1.9159	4.512	5.039		
30	0.0100	5.984	3.551	3.0431	7.169	8.000	1.85	1.91

Resistance in Ohms per Double Foot at 68° F. For explanation of How to Use this Table, see Example:

EXAMPLE: What is the external resistance to my instrument if I use a 20 gauge Chromel/Alumel thermocouple 3 feet long and 14 gauge Chromel/Alumel lead wire 20 feet in length?

ANSWER: 3 x .5894 = 1.7682 ohms
20 x .1466 = 2.932 ohms
Total 4.7002 ohms

NOTE: Type S and R utilize extension lead wire type Copper/Copper 11.
Type B utilizes extension lead wire type Copper/Copper.



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TEMPERATURE CONVERSION CHART

Enter the table in the center column marked "Temp" with the temperature either Celsius or Fahrenheit that you wish to convert into the other scale. If converting from Fahrenheit to Celsius, the equivalent temperature will be found in the column to the left, and if converting from Celsius to Fahrenheit, the equivalent temperature will be found in the column to the right.

Celsius= $5/9(°F-32)$ Fahrenheit= $9/5(°C)+32$ Kelvin= $°C+273.15$ Rankine= $°F+459.67$

°C	Temp	°F	°C	Temp	°F	°C	Temp	°F	°C	Temp	°F	°C	Temp	°F	°C	Temp	°F
-17.8	0	32.0	7.8	46	114.8	33.3	92	197.6	243.3	470	878.0	498.9	930	1706.0	971.1	1780	3236.0
-17.2	1	33.8	8.3	47	116.6	33.9	93	199.4	248.9	480	896.0	504.4	940	1724.0	982.2	1800	3272.0
-16.7	2	35.6	8.9	48	118.4	34.4	94	201.2	254.4	490	914.0	510.0	950	1742.0	993.3	1820	3308.0
-16.1	3	37.4	9.4	49	120.2	35.0	95	203.0	260.0	500	932.0	515.6	960	1760.0	1004.4	1840	3344.0
-15.6	4	39.2	10.0	50	122.0	35.6	96	204.8	265.6	510	950.0	521.1	970	1778.0	1015.6	1860	3380.0
-15.0	5	41.0	10.6	51	123.8	36.1	97	206.6	271.1	520	968.0	526.7	980	1796.0	1026.7	1880	3416.0
-14.4	6	42.8	11.1	52	125.6	36.7	98	208.4	276.7	530	986.0	532.2	990	1814.0	1037.8	1900	3452.0
-13.9	7	44.6	11.7	53	127.4	37.2	99	210.2	282.2	540	1004.0	537.8	1000	1832.0	1048.9	1920	3488.0
-13.3	8	46.4	12.2	54	129.2	37.8	100	212.0	287.8	550	1022.0	548.9	1020	1868.0	1060.0	1940	3524.0
-12.8	9	48.2	12.8	55	131.0	43.3	110	230.0	293.3	560	1040.0	560.0	1040	1904.0	1071.1	1960	3560.0
-12.2	10	50.0	13.3	56	132.8	48.9	120	248.0	298.9	570	1058.0	571.1	1060	1940.0	1082.2	1980	3596.0
-11.7	11	51.8	13.9	57	134.6	54.4	130	266.0	304.4	580	1076.0	582.2	1080	1976.0	1093.3	2000	3632.0
-11.1	12	53.6	14.4	58	136.4	60.0	140	284.0	310.0	590	1094.0	593.3	1100	2012.0	1098.9	2010	3650.0
-10.6	13	55.4	15.0	59	138.2	65.6	150	302.0	315.6	600	1112.0	604.4	1120	2048.0	1104.4	2020	3668.0
-10.0	14	57.2	15.6	60	140.0	71.1	160	320.0	321.1	610	1130.0	615.6	1140	2084.0	1110.0	2030	3686.0
-9.4	15	59.0	16.1	61	141.8	76.7	170	338.0	326.7	620	1148.0	626.7	1160	2120.0	1115.6	2040	3704.0
-8.9	16	60.8	16.7	62	143.6	82.2	180	356.0	332.2	630	1166.0	637.8	1180	2156.0	1121.1	2050	3722.0
-8.3	17	62.6	17.2	63	145.4	87.8	190	374.0	337.8	640	1184.0	648.9	1200	2192.0	1126.7	2060	3740.0
-7.8	18	64.4	17.8	64	147.2	93.3	200	392.0	343.3	650	1202.0	660.0	1220	2228.0	1132.2	2070	3758.0
-7.2	19	66.2	18.3	65	149.0	98.9	210	410.0	348.9	660	1220.0	671.1	1240	2264.0	1137.8	2080	3776.0
-6.7	20	68.0	18.9	66	150.8	100.0	212	413.6	354.4	670	1238.0	682.2	1260	2300.0	1143.3	2090	3794.0
-6.1	21	69.8	19.4	67	152.6	104.4	220	428.0	360.0	680	1256.0	693.3	1280	2336.0	1148.9	2100	3812.0
-5.6	22	71.6	20.0	68	154.4	110.0	230	446.0	365.6	690	1274.0	704.4	1300	2372.0	1154.4	2110	3830.0
-5.0	23	73.4	20.6	69	156.2	115.6	240	464.0	371.1	700	1292.0	715.6	1320	2408.0	1160.0	2120	3848.0
-4.4	24	75.2	21.1	70	158.0	121.1	250	482.0	376.7	710	1310.0	726.7	1340	2444.0	1165.6	2130	3866.0
-3.9	25	77.0	21.7	71	159.8	126.7	260	500.0	382.2	720	1328.0	737.8	1360	2480.0	1171.1	2140	3884.0
-3.3	26	78.8	22.2	72	161.6	132.2	270	518.0	387.8	730	1346.0	748.9	1380	2516.0	1176.7	2150	3902.0
-2.8	27	80.6	22.8	73	163.4	137.8	280	536.0	393.3	740	1364.0	760.0	1400	2552.0	1182.2	2160	3920.0
-2.2	28	82.4	23.3	74	165.2	143.3	290	554.0	398.9	750	1382.0	771.1	1420	2588.0	1187.8	2170	3938.0
-1.7	29	84.2	23.9	75	167.0	148.9	300	572.0	404.4	760	1400.0	782.2	1440	2624.0	1193.3	2180	3956.0
-1.1	30	86.0	24.4	76	168.8	154.4	310	590.0	410.0	770	1418.0	793.3	1460	2660.0	1198.9	2190	3974.0
-0.6	31	87.8	25.0	77	170.6	160.0	320	608.0	415.6	780	1436.0	804.4	1480	2696.0	1204.4	2200	3992.0
0.0	32	89.6	25.6	78	172.4	165.6	330	626.0	421.1	790	1454.0	815.6	1500	2732.0	1210.0	2210	4010.0
0.6	33	91.4	26.1	79	174.2	171.1	340	644.0	426.7	800	1472.0	826.7	1520	2768.0	1215.6	2220	4028.0
1.1	34	93.2	26.7	80	176.0	176.7	350	662.0	432.2	810	1490.0	837.8	1540	2804.0	1221.1	2230	4046.0
1.7	35	95.0	27.2	81	177.8	182.2	360	680.0	437.8	820	1508.0	848.9	1560	2840.0	1226.7	2240	4064.0
2.2	36	96.8	27.8	82	179.6	187.8	370	698.0	443.3	830	1526.0	860.0	1580	2876.0	1232.2	2250	4082.0
2.8	37	98.6	28.3	83	181.4	193.3	380	716.0	448.9	840	1544.0	871.1	1600	2912.0	1237.8	2260	4100.0
3.3	38	100.4	28.9	84	183.2	198.9	390	734.0	454.4	850	1562.0	882.2	1620	2948.0	1243.3	2270	4118.0
3.9	39	102.2	29.4	85	185.0	204.4	400	752.0	460.0	860	1580.0	893.3	1640	2984.0	1248.9	2280	4136.0
4.4	40	104.0	30.0	86	186.8	210.0	410	770.0	465.6	870	1598.0	904.4	1660	3020.0	1254.4	2290	4154.0
5.0	41	105.8	30.6	87	188.6	215.6	420	788.0	471.1	880	1616.0	915.6	1680	3056.0	1260.0	2300	4172.0
5.6	42	107.6	31.1	88	190.4	221.1	430	806.0	476.7	890	1634.0	926.7	1700	3092.0	1265.6	2310	4190.0
6.1	43	109.4	31.7	89	192.2	226.7	440	824.0	482.2	900	1652.0	937.8	1720	3128.0	1271.1	2320	4208.0
6.7	44	111.2	32.2	90	194.0	232.2	450	842.0	487.8	910	1670.0	948.9	1740	3164.0			
7.2	45	113.0	32.8	91	195.8	237.8	460	860.0	493.3	920	1688.0	960.0	1760	3200.0			

SPEED OF RESPONSE

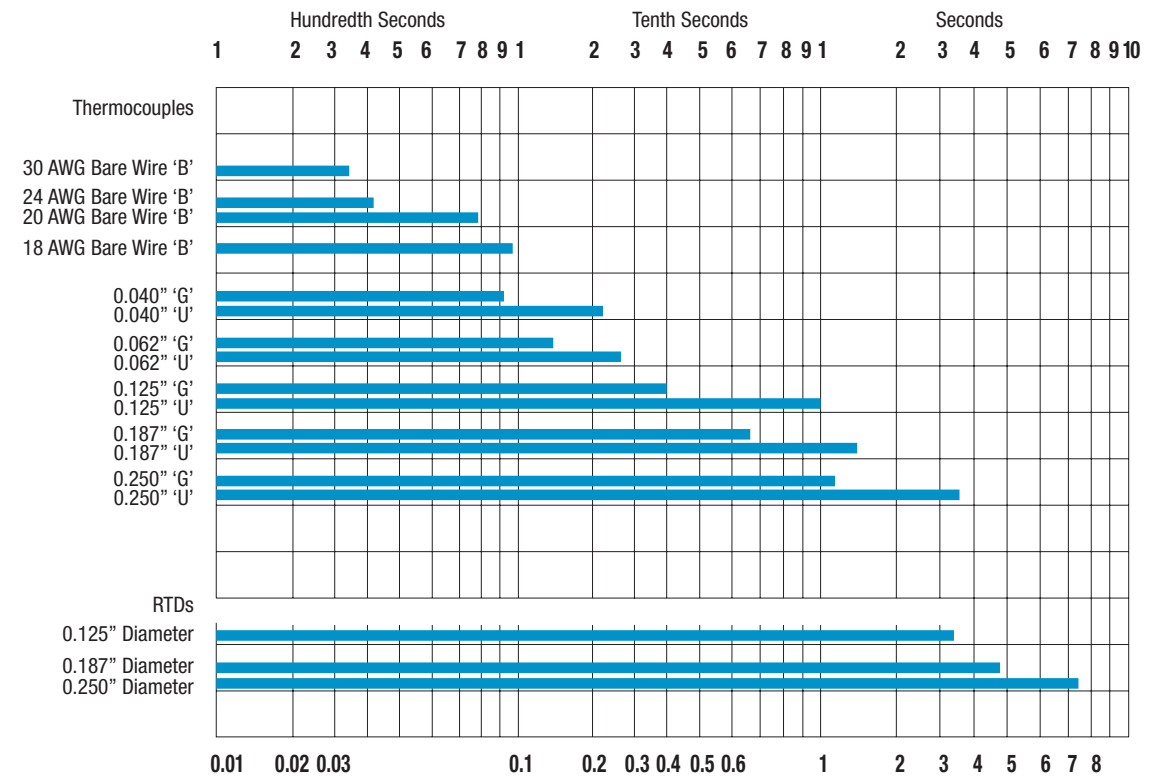
The purpose of the information on this page is to give you some general guidelines in estimating the speed of response you might expect from a thermocouple or an RTD.

In defining any transient condition such as a temperature change, it is important that a standard measuring point be established to provide a basis of comparison. In temperature transducers, the time constant is defined as the time required, in seconds, for the temperature sensor to respond through 63.2% of the total temperature change.

The factors affecting the response rate of a temperature probe in a fluid are:

- a) the mass of the probe surrounding the active temperature sensitive point
- b) the thermoconductivity of materials used in manufacturing the transducer
- c) the mass and conductivity of the measured fluid
- d) the velocity of the fluid over the probe

From the above, it is obvious that a probe of small diameter made of highly conductive materials will respond most rapidly to temperature change. Since thermocouple materials will have shorter conductive paths, a thermocouple probe will respond more rapidly than an RTD probe of equal diameter. This is verified by the bar charts:



In determining time constants for the bar charts above, tests were performed in still water going through an instantaneous step change from 32° F to 212° F.

For guidelines for determining the time constant for specific probes under other conditions, multiply the time constant from the chart by the following factors:

Condition	Still Air	Air @ 10 ft/Sec.	Water @ 15 ft/Sec.
Factor	20X	4X	0.25X

DIAMETER indicated in decimals refers to standard Conax Buffalo probe diameters. Letters G, U and B correspond with various styles of tip configurations.