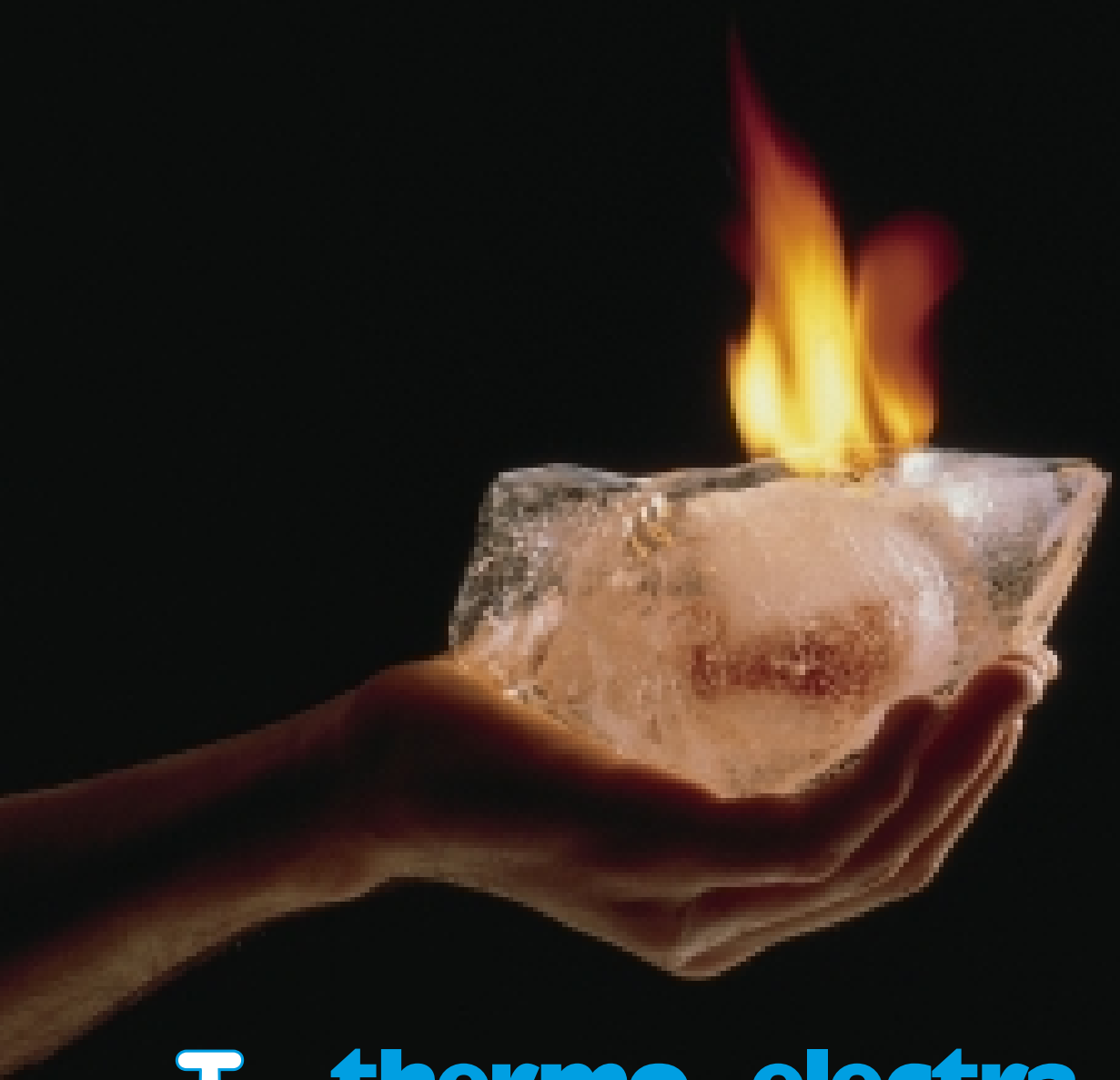
temperature sensor solutions



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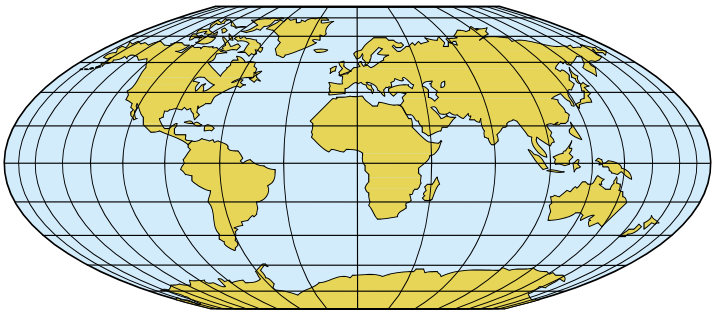


The company was established in 1962 and concentrated on temperature sensor manufacturing. It has grown into a young modern company with expertise for the application required.

Today we offer a complete range, from the temperature sensor and thermowell, to cable and connector systems, including instrumentation and traceable certificates.

All components needed for accuracy and speed are available.

For many applications, sensor design can be discussed with the client, to satisfy his exact requirements.

You can count on our proven experience and knowledge.

Our quality is certified to NEN-EN-ISO 9001

Explosion proof sensors and mulitipoint assemblies are certified Eexe, Eexi or Eexd to ATEX .

Purpose built products exactly fitting the applications are one of our strengths and give a major benefit to the end users.

Thermo-Electra offers, together with more than 25 sales channels throughout the world, a reliable production with technical support and service.

IEC 584-2 thermocouple tolerances

The table gives you information about the maximum allowable tolerances of thermocouples. Thermocouples are divided in 3 accuracy classes: 1, 2 and 3.
For the tolerance two values are given.
One is a fixed, the other is a formula.
The largest of the two should be taken as real tolerance.

Type	Class	Temperature range	Fixed value °C	Tolerance to temp. t (°C)
T	1	- 40°C to + 350°C	± 0,5	± 0,004 ·|t|
	2	- 40°C to + 350°C	± 1	± 0,0075·|t|
	3	- 200°C to + 40°C	± 1	± 0,015·|t|
E	1	- 40°C to + 800°C	± 1,5	± 0,004 ·|t|
	2	- 40°C to + 900°C	± 2,5	± 0,0075·|t|
	3	- 200°C to + 40°C	± 2,5	± 0,015·|t|
J	1	- 40°C to + 750°C	± 1,5	± 0,004·|t|
	2	- 40°C to + 750°C	± 2,5	± 0,0075·|t|
	3	-	-	-
K and N	1	- 40°C to + 1000°C	± 1,5	± 0,004·|t|
	2	- 40°C to + 1200°C	± 2,5	± 0,0075·|t|
	3	- 200°C to + 40°C	± 2,5	± 0,015·|t|
R and S	1	0°C to + 1600°C	± 1,0	± [1+0,003·(t-1100)]°C
	2	0°C to + 1600°C	± 1,5	± 0,0025·t
	3	-	-	-
B	1	-	-	-
	2	+ 600°C to + 1700°C	± 1,5	± 0,0025·t
	3	+ 600°C to + 1700°C	± 4	± 0,005·t

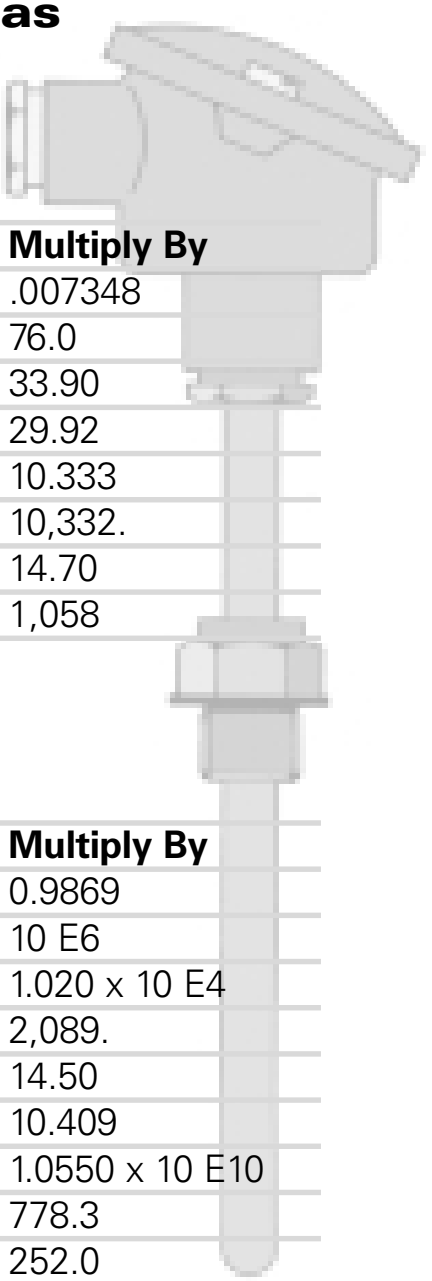
DIN 43710 tolerances

Type	Temperature range	Tolerance
U (Cu-CuNi)	50°C to + 400°C 400°C to + 600°C	± 3°C ± 0,75%
L (Fe-CuNi)	50°C to + 400°C 400°C to + 900°C	± 3°C ± 0,75%

DIN IEC 751 table for Pt100 detectors

Class	Range	Tolerance
A	- 200°C to + 650°C	0,15 + 0,002·|t|
B	- 200°C to + 850°C	0,3 + 0,005·|t|

Handy conversion formulas



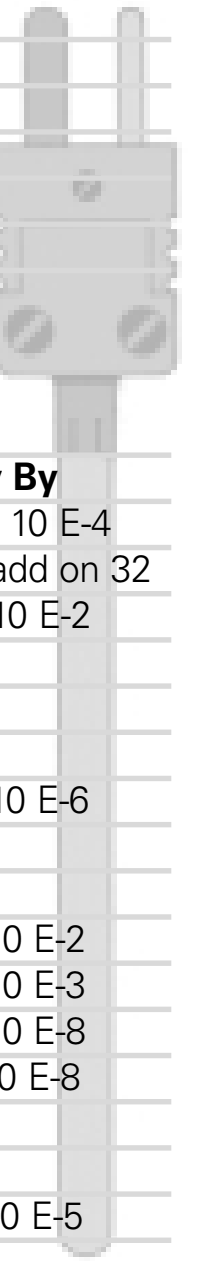
A

Convert from	Into	Multiply By
atmospheres	Ton/sq inch	.007348
atmospheres	cms of mercury	76.0
atmospheres	ft. of water (at 4C)	33.90
atmospheres	in. of mercury (at 0C)	29.92
atmospheres	kgs/sq cm	10.333
atmospheres	kgs/sq meter	10,332.
atmospheres	pounds/sq in.	14.70
atmospheres	tons/sq ft	1,058

B

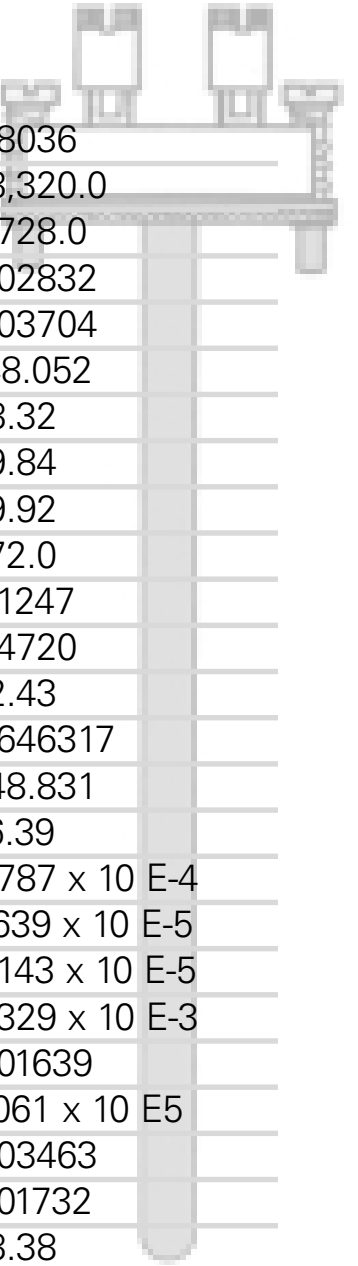
Convert from	Into	Multiply By
bars	atmospheres	0.9869
bars	dynes/sq cm	10 E6
bars	kgs/sq meter	1.020 x 10 E4
bars	pounds/sq ft	2,089.
bars	pounds/sq in.(psi)	14.50
Btu	Liter-Atmosphere	10.409
Btu	ergs	1.0550 x 10 E10
Btu	foot-lbs	778.3
Btu	gram-calories	252.0
Btu	horsepower-hrs	3.931 x 10 E-4
Btu	joules	1,054.8
Btu	kilogram-calories	0.2520
Btu	kilogram-meters	107.5
Btu	kilowatt-hrs	2.928 x 10 E-4
Btu/hr	foot-pounds/sec	0.2162
Btu/hr	gram-cal/sec	0.0700
Btu/hr	horsepower	3.929 x 10 E-4
Btu/hr	watts	0.2931

Btu/min	foot-pounds/sec	12.96
Btu/min	horsepower	0.02356
Btu/min	kilowatts	0.01757
Btu/min	watts	17.57
Btu/sq ft/min	watts/sq in.	0.1221
bushels	liters	35.24



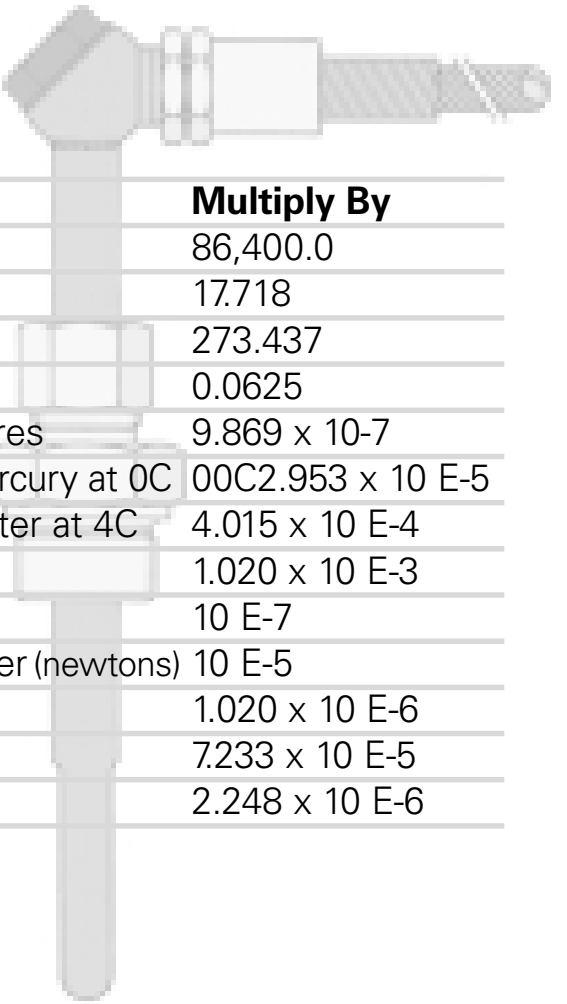
C

Convert from	Into	Multiply By
Calories, gram(mean)	B.T.U.(mean)	3.9685 x 10 E-4
Celcius	Fahrenheit	9/5 and add on 32
centimeters	feet	3.281 x 10 E-2
centimeters	inches	0.3937
centimeters	kilometers	10 E-5
centimeters	meters	0.01
centimeters	miles	6.214 x 10 E-6
centimeters	millimeters	10.0
centimeters	mills	393.7
centimeters	yards	1.094 x 10 E-2
centimeters-dynes	cm-grams	1.020 x 10 E-3
centimeters-dynes	meter-kgs	1.020 x 10 E-8
centimeters-dynes	pound-feet	7.376 x 10 E-8
centimeters-grams	cm-dynes	980.7
centimeters-grams	meter-kgs	10 E-5
centimeters-grams	pound-feet	7.233 x 10 E-5
centi poise	Pa s	0.001
centi stoke	sq millimeters/sec	1
cubic centimeters	cu feet	3.531 x 10 E-4
cubic centimeters	cu inches	0.06102
cubic centimeters	cu meters	10 E-6
cubic centimeters	cu yards	1.308 x 10 E-6
cubic centimeters	gallons (U.S. liq.)	2.642 x 10 E-4
cubic centimeters	liters	0.001
cubic centimeters	pints (U.S. liq.)	2.113 x 10 E-3
cubic centimeters	quarts (U.S. liq.)	1.057 x 10 E-3



cubic feet	bushels (dry)	0.8036
cubic feet	cu cms	28,320.0
cubic feet	cu inches	1,728.0
cubic feet	cu meters	0.02832
cubic feet	cu yards	0.03704
cubic feet	gallons (U.S. liq.)	748.052
cubic feet	liters	28.32
cubic feet	pints (U.S. liq.)	59.84
cubic feet	quarts (U.S. liq.)	29.92
cubic feet/min	cu cms/sec	472.0
cubic feet/min	gallons/sec	0.1247
cubic feet/min	liters/sec	0.4720
cubic feet/min	pounds of water/min	62.43
cubic feet/sec	million gals/day	0.646317
cubic feet/sec	gallons/min	448.831
cubic inches	cu cms	16.39
cubic inches	cu feet	5.787 x 10 E-4
cubic inches	cu meters	1.639 x 10 E-5
cubic inches	cu yards	2.143 x 10 E-5
cubic inches	gallons (U.S. liq.)	4.329 x 10 E-3
cubic inches	liters	0.01639
cubic inches	mil-feet	1.061 x 10 E5
cubic inches	pints (U.S. liq.)	0.03463
cubic inches	quarts (U.S. liq.)	0.01732
cubic inches	bushels (dry)	28.38
cubic meters	cu cms	10 E6
cubic meters	cu feet	35.31
cubic meters	cu inches	61,023.0
cubic meters	cu yards	1.308
cubic meters	gallons (U.S. liq.)	264.2
cubic meters	liters	1,000.0
cubic meters	pints (U.S. liq.)	2,113.0
cubic meters	quarts (U.S. liq.)	1,057.
cubic yards	cu cms	7.646 x 10 E5
cubic yards	cu feet	27.0
cubic yards	cu inches	46,656.0
cubic yards	cu meters	0.7646

cubic yards	gallons (U.S. liq.)	202.0
cubic yards	liters	764.6
cubic yards	pints (U.S. liq.)	1,615.9
cubic yards	quarts (U.S. liq.)	807.9
cubic yards/min	cubic ft/sec	0.45
cubic yards/min	gallons/sec	3.367
cubic yards/min	liters/sec	12.74



D

Convert from	Into	Multiply By
days	seconds	86,400.0
drams	grams	17.718
drams	grains	273.437
drams	ounces	0.0625
Dyne/sq cm	Atmospheres	9.869 x 10-7
Dyne/sq cm	Inch of Mercury at 0C	00C2.953 x 10 E-5
Dyne/sq cm	Inch of Water at 4C	4.015 x 10 E-4
dynes	grams	1.020 x 10 E-3
dynes	joules/cm	10 E-7
dynes	joules/meter (newtons)	10 E-5
dynes	kilograms	1.020 x 10 E-6
dynes	poundals	7.233 x 10 E-5
dynes	pounds	2.248 x 10 E-6

E

Convert from	Into	Multiply By
ergs	Btu	9.480 x 10 E-11
ergs	dyne-centimeters	1.0
ergs	foot-pounds	7.367 x 10 E-8
ergs	gram-calories	0.2389 x 10 E-7
ergs	gram-cms	1.020 x 10 E-3
ergs	horsepower-hrs	3.7250 x 10 E-14
ergs	joules	10 E-7

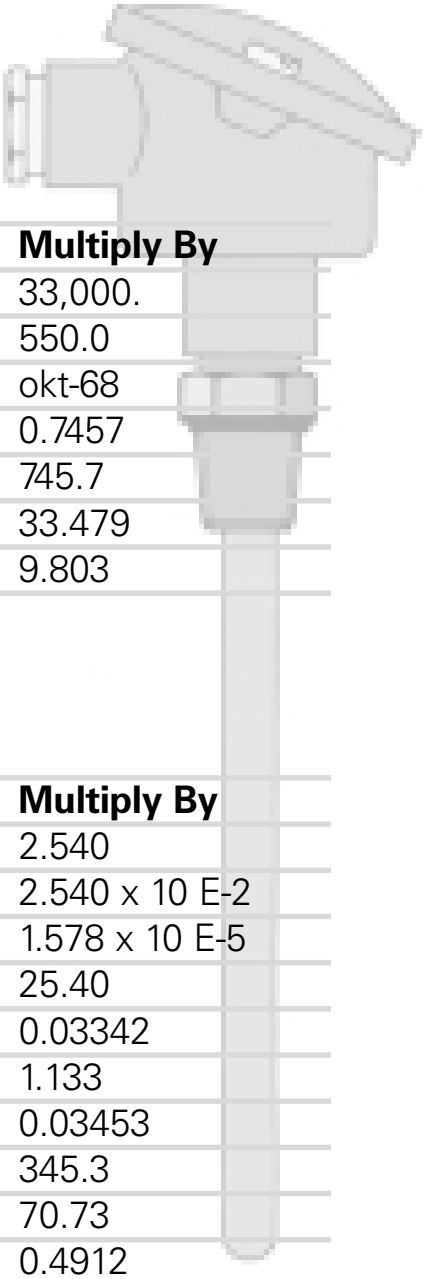
ergs	kg-calories	2.389 x 10 E-11
ergs	kg-meters	1.020 x 10 E-8
ergs	kilowatt-hrs	0.2778 x 10 E-13
ergs	watt-hours	0.2778 x 10 E-10

F

Convert from	Into	Multiply By
Fahrenheit	Celcius	5/9 after F-32
feet	centimeters	30.48
feet	kilometers	3.048 x 10 E-4
feet	meters	0.3048
feet	miles (naut.)	1.645 x 10 E-4
feet	miles (stat.)	1.984 x 10 E-4
feet	millimeters	304.8
feet	mils	1.2 x 10 E4
feet H2O	atmospheres	0.02950
feet H2O	in.Hg	0.8826
feet H2O	kgs/sq cm	0.03048
feet H2O	kgs/sq meter	304.8
feet H2O	pounds/sq ft	62.43
feet H2O	pounds/sq in.	0.4335
feet/sec	cms/sec	30.48
feet/sec	kms/hr	1.097
feet/sec	knots	0.5921
feet/sec	meters/min	18.29
feet/sec	miles/hr	0.6818
feet/sec	miles/min	0.01136
foot-pounds	Btu	1.286 x 10 E-3
foot-pounds	ergs	1.356 x 10 E7
foot-pounds	gram-calories	0.3238
foot-pounds	hp-hrs	5.050 x 10 E-7
foot-pounds	joules	1.356
foot-pounds	kg-calories	3.24 x 10 E-4
foot-pounds	kg-meters	0.1383
foot-pounds	kilowatt-hrs	3.766 x 10 E-7

G

Convert from	Into	Multiply By
gallons	cu yards	4.951 x 10 E-3
gallons	liters	3.785
gallons (liq. Br. Imp.)	gallons (U.S. liq.)	120.095
gallons (U.S.)	gallons (Imp.)	0.83267
gallons of water	pounds of water	83.453
gallons/min	cu ft/sec	2.228 x 10 E-3
gallons/min	liters/sec	0.06308
gallons/min	cu ft/hr	80.208
grams	dynes	980.7
grams	grains	15.43
grams	joules/cm	9.807 x 10 E-5
grams	joules/m (newtons)	9.807 x 10 E-3
grams	kilograms	0.001
grams	milligrams	1,000.
grams	ounces (avdp)	0.03527
grams	ounces (troy)	0.03215
grams	poundals	0.07093
grams	pounds	2.205 x 10 E-3
grams/cu cm	pounds/cu ft	62.43
grams/cu cm	pounds/cu in.	0.03613
grams/cu cm	pounds/mil-foot	3.405 x 10 E-7
grams/liter	grains/gal	58.417
grams/liter	pounds/1,000 gal	8.345
grams/liter	pounds/cu ft	0.062427
grams/liter	parts/million	1,000.0
gram-calories	Btu	3.9683 x 10 E-3
gram-calories	ergs	4.1868 x 10 E7
gram-calories	foot-pounds	30.880
gram-calories	horsepower-hrs	1.5596 x 10 E-6
gram-calories	kilowatt-hrs	1.1630 x 10 E-6
gram-calories	watt-hrs	1.1630 x 10 E-3



H

Convert from	Into	Multiply By
horsepower	foot-lbs/min	33,000.
horsepower	foot-lbs/sec	550.0
horsepower	kg-calories/min	okt-68
horsepower	kilowatts	0.7457
horsepower	watts	745.7
horsepower (boiler)	Btu/hr	33.479
horsepower (boiler)	kilowatts	9.803

I

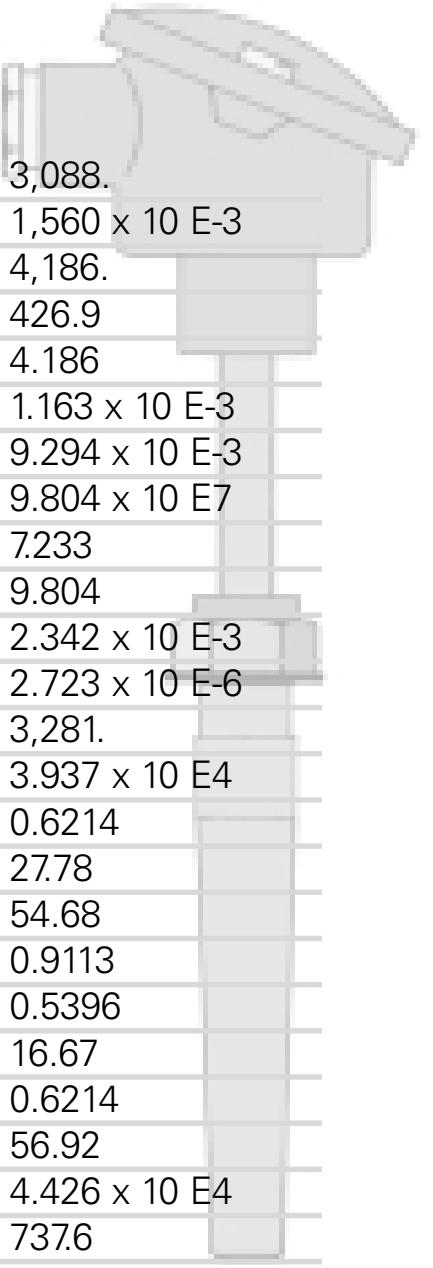
Convert from	Into	Multiply By
inches	centimeters	2.540
inches	meters	2.540 x 10 E-2
inches	miles	1.578 x 10 E-5
inches	millimeters	25.40
inches Hg	atmospheres	0.03342
inches Hg	feet H2O	1.133
inches Hg	kgs/sq cm	0.03453
inches Hg	kgs/sq meter	345.3
inches Hg	pounds/sq ft.	70.73
inches Hg	pounds/sq in.	0.4912
inches H2O (at 4C)	atmospheres	2.458 x 10 E-3
inches H2O (at 4C)	inches Hg	0.07355
inches H2O (at 4C)	kgs/sq cm	2.540 x 10 E-3
inches H2O (at 4C)	ounces/sq in.	0.5781
inches H2O (at 4C)	pounds/sq ft	5.204
inches H2O (at 4C)	pounds/sq in.	0.03613

J

Convert from	Into	Multiply By
joules	Btu	9.480 x 10 E-4
joules	ergs	10 E7
joules	foot-pounds	0.7376
joules	kg-calories	2.389 x 10 E-4
joules	kg-meters	0.1020
joules	watt-hrs	2.778 x 10 E-4

K

Convert from	Into	Multiply By
kilograms	grams	1,000.0
kilograms	joules/cm	0.09807
kilograms	joules/meter (newtons)	9.807
kilograms	poundals	70.93
kilograms	pounds	2.205
kilograms	tons (long)	9.842 x 10 E-4
kilograms	tons (short)	1.102 x 10 E-3
kilograms/sq cm	Dynes	980,665.
kilograms/sq cm	atmospheres	0.9678
kilograms/sq cm	feet of water	32.81
kilograms/sq cm	inches of mercury	28.96
kilograms/sq cm	kilo pascal (kPa)	98.067
kilograms/sq cm	pounds/sq ft	2,048.
kilograms/sq cm	pounds/sq in	14.223
kilograms/sq meter	atmospheres	9.678 x 10 E-5
kilograms/sq meter	bars	98.07 x 10 E-6
kilograms/sq meter	feet of water	3.281 x 10 E-3
kilograms/sq meter	inches of mercury	2.896 x 10 E-3
kilograms/sq meter	pounds/sq ft	0.2048
kilograms/sq in.	pounds/sq in.	1.422 x 10 E-3
kilogram-calories	Btu	3.968



kilogram-calories	foot-pounds	3,088.
kilogram-calories	hp-hrs	1,560 x 10 E-3
kilogram-calories	joules	4,186.
kilogram-calories	kg-meters	426.9
kilogram-calories	kilojoules	4.186
kilogram-calories	kilowatt-hrs	1.163 x 10 E-3
kilogram meters	Btu	9.294 x 10 E-3
kilogram meters	ergs	9.804 x 10 E7
kilogram meters	foot-pounds	7.233
kilogram meters	joules	9.804
kilogram meters	kg-calories	2.342 x 10 E-3
kilogram meters	kilowatt-hrs	2.723 x 10 E-6
kilometers	feet	3,281.
kilometers	inches	3.937 x 10 E4
kilometers	miles	0.6214
kilometers/hr	cms/sec	27.78
kilometers/hr	feet/min	54.68
kilometers/hr	feet/sec	0.9113
kilometers/hr	knots	0.5396
kilometers/hr	meters/min	16.67
kilometers/hr	miles/hr	0.6214
kilowatts	Btu/min	56.92
kilowatts	foot-lbs/min	4.426 x 10 E4
kilowatts	foot-lbs/sec	737.6
kilowatts	horsepower	1.341
kilowatts	kg-calories/min	14.34
kilowatts	watts	1,000.0
kilowatt-hrs	Btu	3,413.
kilowatt-hrs	ergs	3.600 x 10 E13
kilowatt-hrs	foot-lbs	2.655 x 10 E6
kilowatt-hrs	gram-calories	859,850.
kilowatt-hrs	horsepower-hrs	1.341
kilowatt-hrs	joules	3.6 x 10 E6
kilowatt-hrs	kg-calories	859.85
kilowatt-hrs	kg-meters	3.671 x 10 E6
kilowatt-hrs	pounds of water evaporated from & at 212F	3.53

kilowatt-hrs	pounds of water raised from 62 to 212F	22.75
kilo pascal (kPa)	bars	0.0100

L

Convert from	Into	Multiply By
liters	bushels (U.S. dry)	0.02838
liters	cu cm	1,000.0
liters	cu feet	0.03531
liters	cu inches	61.02
liters	cu meters	0.001
liters	cu yards	1.308 x 10 E-3
liters	gallons (U.S. liq.)	0.2642
liters	pints (U.S. liq.)	2.113
liters	quarts (U.S. liq.)	1.057
liters/min	cu ft/sec	5.886 x 10 E-4
liters/min	gals/sec	4.403 x 10 E-3

M

Convert from	Into	Multiply By
meters	centimeters	100.0
meters	feet	3.281
meters	inches	39.37
meters	kilometers	0.001
meters	miles (naut.)	5.396 x 10 E-4
meters	miles (stat.)	6.214 x 10 E-4
meters	millimeters	1,000.0
meters	yards	1.094
meters	varas	1.179
meters/min	cms/sec	1.667
meters/min	feet/min	3.281
meters/min	feet/sec	0.05468
meters/min	kms/hr	0.06

meters/min	knots	0.03238
meters/min	miles/hr	0.03728
meters/sec	feet/min	196.8
meters/sec	feet/sec	3.281
meters/sec	kilometers/hr	3.6
meters/sec	kilometers/min	0.06
meters/sec	miles/hr	2.237
meters/sec	miles/min	0.03728
miles (statute)	centimeters	1.609 x 10 E5
miles (statute)	feet	5,280.
miles (statute)	inches	6.336 x 10 E4
miles (statute)	kilometers	1.609
miles (statute)	meters	1,609.
miles (statute)	miles (naut.)	0.868357
miles (statute)	yards	1,760.
miles/hr	cms/sec	44.70
miles/hr	feet/min	88.
miles/hr	feet/sec	1.467
miles/hr	kms/hr	1.609
miles/hr	kms/min	0.02682
miles/hr	knots	0.8684
miles/hr	meters/min	26.82
miles/hr	miles/min	0.1667
mil-feet	cu inches	9.425 x 10 E-6
milliliters	liters	0.001
millimeters	centimeters	0.1
millimeters	feet	3.281 x 10 E-3
millimeters	inches	0.03937
millimeters	kilometers	10 E-6
millimeters	meters	0.001
millimeters	miles	6.214 x 10 E-7
millimeters	mils	39.37
millimeters	yards	1.094 x 10 E-3
million gals/day	cu ft/sec	154.723
millimeters H2O	bars	0.0001
millimeters H2O	kPa	0.0098
millimeters H2O	psi	0.0014

millimeters Hg	bars	0.0013
millimeters Hg	kPa	0.1333
millimeters Hg	psi	0.0193

O

Convert from	Into	Multiply By
ounces	drams	16.0
ounces	grains	437.5
ounces	grams	28.349.527
ounces	pounds	0.0625
ounces	ounces (troy)	0.9115
ounces	tons (long)	2.790 x 10 E-5
ounces	tons (metric)	2.835 x 10 E-5
ounces (fluid)	cu inches	1.805
ounces (fluid)	liters	0.02957
ounces (troy)	grains	480.0
ounces (troy)	grams	31.103.481
ounces (troy)	ounces (avdp.)	109.714
ounces (troy)	pennyweights (troy)	20.0
ounces (troy)	pounds (troy)	0.08333
ounces/sq. inch	Dynes/sq cm	.4309
ounces/sq in.	pounds/sq in.	0.0625

P

Convert from	Into	Multiply By
parts/million	grains/U.S. gal	0.0584
parts/million	grains/Imp. gal	0.07016
parts/million	pounds/million gal	8.345
poise	Pa s	0.1
pounds	drams	256.
pounds	dynes	44.4823 x 10 E4
pounds	grains	7,000.
pounds	grams	4.535.924

pounds	joules/cm	0.04448
pounds	newtons (joules/meter)	4.448
pounds	kilograms	0.4536
pounds	ounces	16.0
pounds	ounces (troy)	145.833
pounds	poundals	32.17
pounds	pounds (troy)	121.528
pounds	tons (short)	0.0005
pounds (troy)	grains	5,760.
pounds (troy)	grams	37.324.177
pounds (troy)	ounces (avdp.)	131.657
pounds (troy)	ounces (troy)	12.0
pound-feet	cm-dynes	1.356 x 10 E-4
pound-feet	cm-grams	13,825.
pound-feet	meter-kgs	0.1383
pounds/cu ft	grams/cu cm	0.01602
pounds/cu ft	kgs/cu meter	16.02
pounds/cu ft	pounds/cu in.	5.787 x 10 E-4
pounds/cu ft	pounds/mil-foot	4.456 x 10 E-9
pounds/cu in.	kgs/cu cm	27.68
pounds/cu in.	kgs/cu meter	2.768 x 10 E4
pounds/cu in.	pounds/cu ft	1,728.
pounds/cu in.	pounds/mil-foot	9.425 x 10 E-6
pounds/sq ft	atmospheres	4.725 x 10 E-4
pounds/sq ft	feet of water	0.01602
pounds/sq ft	inches of mercury	0.01414
pounds/sq ft	kgs/sq meter	4.882
pounds/sq ft	pounds/sq in.	6.944 x 10 E-3
pounds/sq in. (psi)	atmospheres	0.06804
pounds/sq in. (psi)	bars	0.06895
pounds/sq in. (psi)	feet of water	2.307
pounds/sq in. (psi)	inches of mercury	2.036
pounds/sq in. (psi)	kgs/sq meter	703.1
pounds/sq in. (psi)	kPa	689.476
pounds/sq in. (psi)	pounds/sq ft	144.0

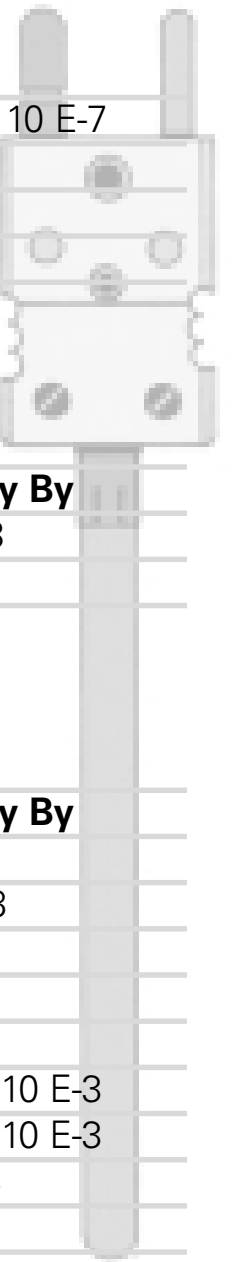
Q

Convert from	Into	Multiply By
quarts (liq.)	cu inches	57.75
quarts (liq.)	cu meters	9.464 x 10 E-4
quarts (liq.)	cu yards	1.238 x 10 E-3
quarts (liq.)	liters	0.9463

S

Convert from	Into	Multiply By
square centimeters	circular mils	1.973 x 10 E5
square centimeters	sq feet	1.076 x 10 E-3
square centimeters	sq inches	0.1550
square centimeters	sq meters	0.0001
square centimeters	sq miles	3.861 x 10.11
square centimeters	sq millimeters	100.0
square centimeters	sq yards	1.196 x 10 E-4
square feet	acres	2.296 x 10 E-5
square feet	circular mils	1.833 x 10 E8
square feet	sq cms	929.0
square feet	sq inches	144.0
square feet	sq meters	0.09290
square feet	sq miles	3.587 x 10 E-8
square feet	sq millimeters	9.290 x 10 E4
square feet	sq yards	0.1111
square inches	circular mils	1.273 x 10 E6
square inches	sq cms	6.452
square inches	sq feet	6.944 x 10 E-3
square inches	sq millimeters	645.2
square inches	sq mils	10 E6
square inches	sq yards	7.716 x 10 E-4
square meters	acres	2.471 x 10 E-4
square meters	sq cms	10 E4
square meters	sq feet	10.76

square meters	sq inches	1,550.
square meters	sq miles	3.861 x 10 E-7
square meters	sq millimeters	10 E6
square meters	sq yards	1.196
stoke	sq millimeters/sec	100



T

Convert from	Into	Multiply By
tons of water/24 hrs	gallons/min	0.16643
tons of water/24 hrs	cu ft/hr	13.349

W

Convert from	Into	Multiply By
watts	Btu/hr	3.413
watts	Btu/min	0.05688
watts	ergs/sec	10 E7
watts	foot-pounds/min	44.27
watts	foot-pounds/sec	0.7378
watts	horsepower	1.341 x 10 E-3
watts	horsepower (metric)	1.360 x 10 E-3
watts	kg-calories/min	0.01433
watts	kilowatts	0.001
watt-hours	Btu	3.413
watt-hours	ergs	3.60 x 10 E10
watt-hours	foot-pounds	2,656.
watt-hours	gram-calories	859.85
watt-hours	horsepower-hrs	1.341 x 10 E-3
watt-hours	kilogram-calories	0.8598
watt-hours	kilogram-meters	367.2
watt-hours	kilowatt-hrs	0.001

Decimal factor prefixes

yotta [Y] 1 000 000 000 000 000 000 000 000 = 10E24

zetta [Z] 1 000 000 000 000 000 000 000 = 10E21

exa [E] 1 000 000 000 000 000 000 = 10E18

peta [P] 1 000 000 000 000 000 = 10E15

tera [T] 1 000 000 000 000 = 10E12

giga [G] 1 000 000 000 (a thousand millions = a billion)

mega [M] 1 000 000 (a million)

kilo [k] 1 000 (a thousand)

hecto [h] 100 (a hundred)

deca [da]10 (ten)

1
deci [d] 0.1 (a tenth)

centi [c] 0.01 (a hundredth)

milli [m] 0.001 (a thousandth)

micro [µ] 0.000 001 (a millionth)

nano [n] 0.000 000 001 (a thousand millionth)

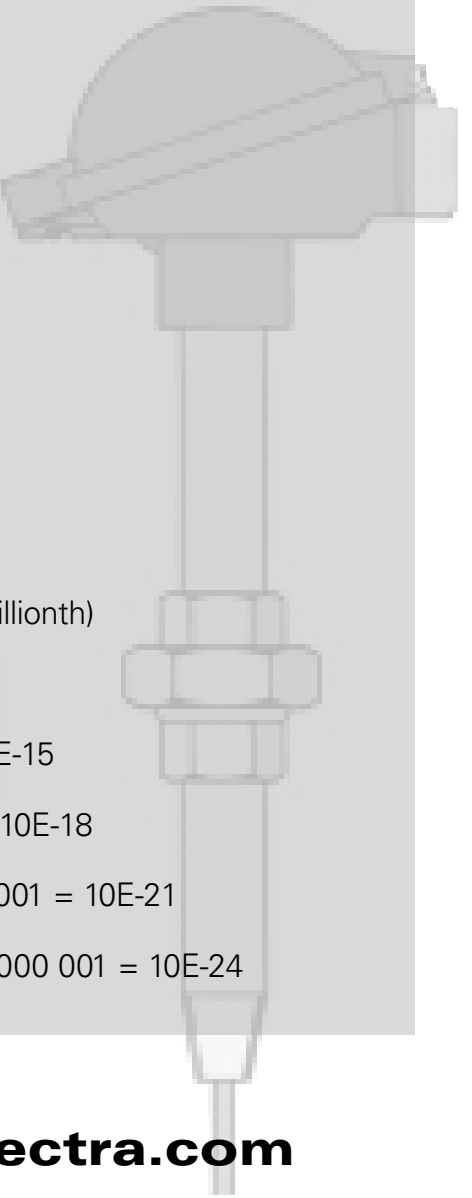
pico [p] 0.000 000 000 001 = 10E-12

femto [f] 0.000 000 000 000 001 = 10E-15

atto [a] 0.000 000 000 000 000 001 = 10E-18

zepto [z] 0.000 000 000 000 000 000 001 = 10E-21

yocto [y] 0.000 000 000 000 000 000 000 001 = 10E-24



Terminology

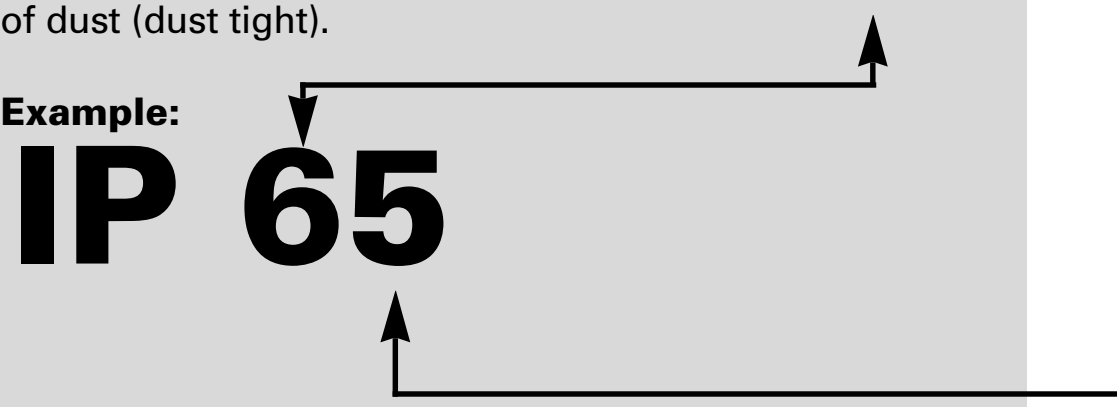
ac =	alternating current
ANSI =	American National Standards Institute
ATM =	Atmospheres
BSP =	British Standard Pipe
BSPT =	British Standard Pipe Taper
BTU =	British Thermal Units
cc/min =	Cubic Centimeters per Minute
CJC =	Cold Junction Compensation
Cp =	Specific heat
C.S. =	Carbon Steel
D =	Diameter
Dia. =	Diameter
Diam. =	Diameter
D/A =	Digital to Analog
EMI =	Electromagnetic Interference
EPR =	Ethylene Propylene Rubber
FDA =	Food and Drug Administration
FNPT =	Female National Pipe Thread
FPM =	Feet Per Minute
FPS =	Feet Per Second
F.S. =	Full Scale
FT =	Feet
gals =	Gallons
gpm =	Gallons Per Minute
gph =	Gallons Per Hour
Hf =	Latent Heat of Fusion
H/L =	High-Low
Hv =	Latent Heat of Vaporization
I.D. =	Inside Diameter
I/0 =	Input/Output
k =	Thermal Conductivity
lbs =	Pounds
lbs/in 2 =	Pounds Per Square Inch
lpm =	Liters Per Minute

L/min =	Liters Per Minute
mL/min =	Milliliters Per Minute
MNPT =	Male National Pipe Thread
ms =	Milliseconds
m/s =	Meters Per Second
MSEC =	Milliseconds
NiCad =	Nickel Cadmium
NO/NC =	Normally Open Normally Closed
NPT =	National Pipe Thread
PG =	Panzer Gewinde
PID =	Proportional-Integral-Derivative
P-P =	Peak to Peak
PSIA =	Pounds Per Square Inch Absolute
PSID =	Pounds Per Square Inch Differential
PSIG =	Pounds Per Square Inch Gage
PVC =	Polyvinyl Chloride
PVDF =	Polyvinylidene Fluoride
RF =	Raised Face
RFI =	Radio Frequency Interference
RMS =	Root Mean Square
SCCM =	Standard Cubic Centimeters per Minute
SCHED. NO. =	Schedule Number
SCFH =	Standard Cubic Feet per Hour
SCFM =	Standard Cubic Feet per Minute
SLM =	Standard Liters per Minute
SLPM =	Standard Liters per Minute
sq.ft. =	Square Feet
SSU =	Saybolt Seconds Universal
ΔT =	Temperature Difference
TTL =	Transistor-Transistor Logic
UNF =	Unified National Fine
W =	Watts
W-hr =	Watt-Hours
W/in2	Watt Density
WT =	Weight of Material

IP Ingress protection (IEC 60529)
(protection against accidental contact and of solid objects and water)

Degree of protection against access of hazardous parts and ingress of solid objects	first index figure
No protection.	0.
Protection against large, sized bodies. eg hands.	1.
Protection against drops of water up to 15 from the vertical (drip proof).	2.
Protection against small bodies, 2.5 mm or greater eg tools, wire.	3.
Protection against very small bodies, 1 mm or greater.	4.
Protection against harmful deposits of dust (dust proof).	5.
Complete protection against deposits of dust (dust tight).	6.

Example:



second index figure	Degree of protection against ingress of water
0.	No protection.
1.	Protection against vertically falling drops of water.
2.	Protection against medium, sized bodies. eg fingers.
3.	Protection against rain falling up to 60 deg. from the vertical (rain proof).
4.	Protection against splashed water from any angle (splash proof).
5.	Protection against jets of water from any angle (jet proof).
6.	Protection against water from heavy seas. eg water tight for marine deck use.
7.	Protected against immersion for a defined period.
8.	Protected against immersion for an indefinite period.

Pipesize Diameter			Wall thckness														
inch	OD in mm	OD in inch	5s	5	10s	10	20	30	STD 40s	40	60	XS 80s	80	100	120	140	160	XXS
									0.068			0.095					wall thickness in inches	
1/8	10.29	0.405							1.73			2.41					wall thickness in mm	
									0.36			0.46					weight in kg/meter	
									0.088			0.119						
1/4	13.72	0.540							2.24			3.02						
									0.63			0.80						
									0.091			0.126						
3/8	17.15	0.675							2.31			3.20						
									0.85			1.10						
			0.065	0.065	0.083	0.083			0.109			0.147					0.188	0.294
1/2	21.34	0.840	1.65	1.65	2.11	2.11			2.77			3.73					4.78	7.47
			0.80	0.80	1.00	1.00			1.27			1.62					1.95	2.55
			0.065	0.065	0.083	0.083			0.113			0.154					0.219	0.308
3/4	26.67	1.050	1.65	1.65	2.11	2.11			2.87			3.91					5.56	7.82
			1.02	1.02	1.28	1.28			1.68			2.19					2.89	3.63
			0.065	0.065	0.109	0.109			0.133			0.179					0.250	0.358
1	33.40	1.315	1.65	1.65	2.77	2.77			3.38			4.55					6.35	9.09
			1.29	1.29	2.09	2.09			2.50			3.23					4.23	5.45
			0.065	0.065	0.109	0.109			0.140			0.191					0.250	0.382
1 1/4	42.16	1.660	1.65	1.65	2.77	2.77			3.56			4.85					6.35	9.70
			1.65	1.65	2.70	2.70			3.38			4.47					5.60	7.76
			0.065	0.065	0.109	0.109			0.145			0.200					0.281	0.400
1 1/2	48.26	1.900	1.65	1.65	2.77	2.77			3.68			5.08					7.14	10.16
			1.90	1.90	3.10	3.10			4.05			5.41					7.24	9.55
			0.065	0.065	0.109	0.109			0.154			0.218					0.344	0.436
2	60.33	2.375	1.65	1.65	2.77	2.77			3.91			5.54					8.74	11.07
			2.39	2.39	3.93	3.93			5.44			7.48					11.11	13.45
			0.083	0.083	0.120	0.120			0.203			0.276					0.375	0.552
2 1/2	73.03	2.875	2.11	2.11	3.05	3.05			5.16			7.01					9.53	14.02
			3.68	3.68	5.26	5.26			8.62			11.41					14.91	20.39
			0.083	0.083	0.120	0.120			0.216			0.300					0.438	0.600
3	88.90	3.500	2.11	2.11	3.05	3.05			5.49			7.62					11.13	15.24
			4.51	4.51	6.46	6.46			11.29			15.27					21.33	27.67

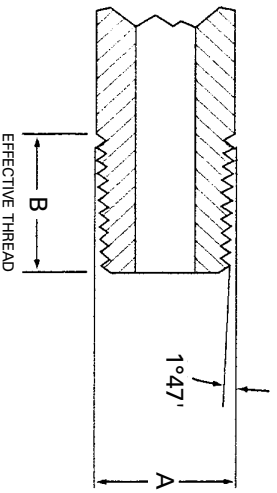
			0.083	0.083	0.120	0.120			0.226			0.318						0.636
3 1/2	101.60	4.000	2.11	2.11	3.05	3.05			5.74			8.08						16.15
			5.17	5.17	7.41	7.41			13.57			18.62						34.03
			0.083	0.083	0.120	0.120			0.237			0.337			0.438		0.531	0.674
4	114.30	4.500	2.11	2.11	3.05	3.05			6.02			8.56			11.13		13.49	17.12
			5.84	5.84	8.37	8.37			16.07			22.31			28.30		33.53	41.02
			0.109	0.109	0.134	0.134			0.258			0.375			0.500		0.652	0.750
5	141.30	5.563	2.77	2.77	3.40	3.40			6.55			9.53			12.70		15.88	19.05
			9.46	9.46	11.56	11.56			21.78			30.95			40.28		49.09	57.42
			0.109	0.109	0.134	0.134			0.280			0.432			0.562		0.719	0.864
6	168.28	6.625	2.77	2.77	3.40	3.40			7.11			10.97			14.27		18.26	21.95
			11.31	11.31	13.82	13.82			28.26			42.56			54.20		67.55	79.18
			0.109	0.109	0.148	0.148	0.250	0.277	0.322		0.406	0.500		0.594	0.719	0.812	0.906	0.875
8	219.08	8.625	2.77	2.77	3.76	3.76	6.35	7.04	8.18		10.31	12.70		15.09	18.26	20.62	23.01	22.23
			14.71	14.71	19.96	19.96	33.31	36.79	42.53		53.09	64.63		75.89	90.43	100.93	111.25	107.87
			0.134	0.134	0.165	0.165	0.250	0.307	0.365		0.500	0.500	0.594	0.719	0.844	1.000	1.125	1.000
10	273.05	10.750	3.40	3.40	4.19	4.19	6.35	7.80	9.27		12.70	12.70	15.09	18.26	21.44	25.40	28.58	25.40
			22.61	22.61	27.78	27.78	41.77	51.00	60.29		81.54	81.54	95.97	114.74	133.00	155.10	172.25	155.10
			0.156	0.165	0.180	0.180	0.250	0.330	0.375	0.406	0.562	0.500	0.688	0.844	1.000	1.125	1.312	1.000
12	323.85	12.750	3.96	4.19	4.57	4.57	6.35	8.38	9.53	10.31	14.27	12.70	17.48	21.44	25.40	28.58	33.32	25.40
			31.24	33.03	35.98	35.98	49.72	65.20	73.82	79.72	108.96	97.44	132.01	159.85	186.92	208.04	238.72	186.92
			0.156		0.188	0.250	0.312	0.375	0.375	0.438	0.594	0.500	0.750	0.938	1.094	1.250	1.406	
14	355.60	14.000	3.96		4.78	6.35	7.92	9.53	9.53	11.13	15.09	12.70	19.05	23.83	27.79	31.75	35.71	
			34.34		41.35	54.68	67.94	81.28	81.28	94.49	126.68	107.38	158.08	194.90	224.60	253.53	281.68	
			0.156		0.188	0.250	0.312	0.375	0.375	0.500	0.656	0.500	0.844	1.031	1.219	1.438	1.594	
16	406.40	16.000	4.19		4.78	6.35	7.92	9.53	9.53	12.70	16.66	12.70	21.44	26.19	30.96	36.53	40.49	
			41.56		47.34	62.63	77.86	93.21	93.21	123.29	160.12	123.29	203.48	245.50	286.62	333.11	365.30	
			0.165		0.188	0.250	0.312	0.438	0.375	0.562	0.750	0.500	0.938	1.156	1.375	1.562	1.781	
18	457.20	18.000	4.19		4.78	6.35	7.92	11.13	9.53	14.20	19.05	12.70	23.83	29.36	34.93	39.67	45.24	
			46.81		53.33	70.59	87.79	122.36	105.14	155.91	205.80	139.19	254.49	309.76	363.65	408.45	459.51	
			0.188		0.218	0.250	0.375	0.500	0.375	0.594	0.812	0.500	1.031	1.281	1.500	1.750	1.969	
20	508.00	20.000	4.78		5.54	6.35	9.53	12.70	9.53	15.09	20.62	12.70	26.19	32.54	38.10	44.45	50.01	
			59.32		68.64	78.54	117.07	155.10	117.07	183.37	247.85	155.10	311.18	381.53	441.59	508.11	564.61	
			0.188		0.218	0.250	0.375	0.500	0.375	0.625	0.875	0.500	1.125	1.375	1.625	1.875	2.125	
22	558.80	22.000	4.78		5.54	6.35	9.53	12.70	9.53	15.88	22.23	12.70	28.57	34.92	41.27	47.62	53.98	
			65.31		75.58	86.50	129.01	171.01	129.01	212.52	294.14	171.01	373.57	451.13	526.70	600.28	671.88	
			0.218		0.250	0.250	0.375	0.562	0.375	0.688	0.969	0.500	1.219	1.531	1.812	2.062	2.344	
24	609.60	24.000	5.54		6.35	6.35	9.53	14.27	9.53	17.48	24.61	12.70	30.96	38.89	46.02	52.37	59.54	
			82.53		94.45	94.45	140.94	209.54	140.94	255.14	355.02	186.92	441.51	547.33	639.58	719.63	807.27	

Resistor Colour Codes

COLOUR	VALUE OF		
	(1st & 2nd bands)	(3rd band)	(4th band)
Black	0	0	± 20 %
Brown	1	1	± 2 %
Red	2	2	
Orange	3	3	
Yellow	4	4	
Green	5	5	
Blue	6	6	
Violet	7	7	
Gray	8	8	
White	9	9	
Gold		-1	± 5 %
Silver		-2	± 10 %
No colour			± 20 %

National Pipe Taper Thread Dimensions

NPT SIZE	THREADS PER INCH	DIM "A" (IN)	DIM "B" (IN)
1/16	27	.312	.261
1/8	27	.405	.264
1/4	18	.540	.402
3/8	18	.675	.408
1/2	14	.840	.534
3/4	14	1.050	.546
1	11 1/2	1.315	.683
1 1/4	11 1/2	1.660	.707



Response times (*) Temperaturesensors

acc.VDE/VDI3511

	Thermocouple mineral insulated	Thermocouple with protection tube and insert	Resistance -element mineral insulated	Resistance-element with protection tube and insert
Diameter	0,5-6 mm	9 mm	3-6 mm	9 mm
Insertion length	100-500 mm	100-400 mm	100-500 mm	100-150 mm
Response time in water (sec.)	0,06-4,0	7	0,6-4,0	30
Response time in air (sec.)	1,8-60	92	26-55	140

(*) Response times of Temperaturesensors: The time it takes to run up to 63% of final measurement value. Values are for indication only, actual process situations are determining.

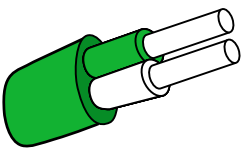
Temperature Colour Table

Colour	Celcius	Fahrenheit
Black Heat	430 - 480	810 - 900
Faint Red	480 - 570	900 - 1060
Blood Red	570 - 630	1060 - 1170
Dark Red	630 - 670	1170 - 1240
Medium Red	670 - 740	1240 - 1360
Cherry Red	740 - 840	1360 - 1540
Bright Red	840 - 900	1540 - 1650
Red/Orange	900 - 940	1650 - 1720
Orange	940 - 990	1720 - 1810
Lemon Yellow	990 - 1080	1810 - 1980
White/Yellow	1080 - 1200	1980 - 2100
White	1200 and up	2100 and up.

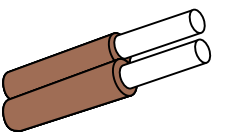
These observations where made in a relative dark room.

Thermocouple wire types

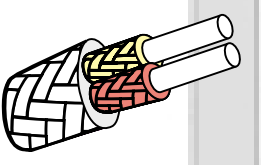
Type	Temperature	Insulation	Wiresize (mm)
T 00	- 30 + 105°C	PVC	0,5 / 0,8 / 1,0
T 01	- 30 + 105°C	PVC	0,5 / 0,8 / 1,0
T 05	- 70 + 215°C	Teflon FEP	0,12 / 0,2 / 0,5 / 0,8
T 06	- 70 + 215°C	Teflon FEP	0,12 / 0,2 / 0,5 / 0,8
T 10	- 70 + 260°C	Teflon PTFE	0,2 / 0,5 / 0,8
T 11	-265 + 315°C	Kapton	0,25 / 0,5 / 0,8
T 12	- 0 + 400°C	Glass Fibre	0,2 / 0,5 / 1,0
T 15	- 0 +1430°C	Ceramic Fibre	0,8



T01 / T06 / T10 / T11



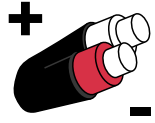
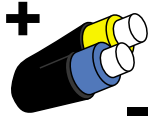
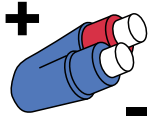
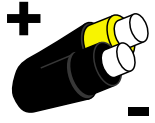
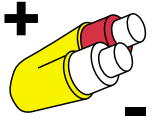
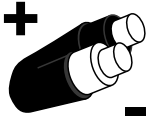
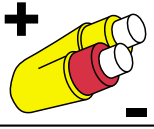
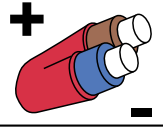
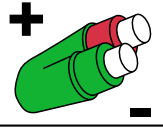
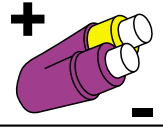
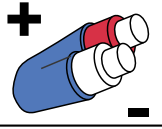
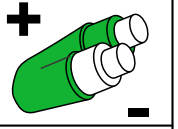
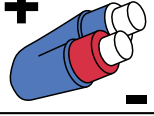
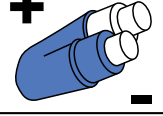
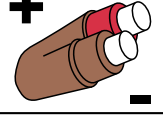
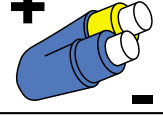
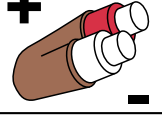
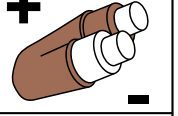
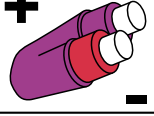
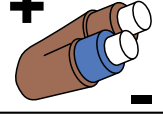
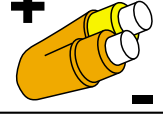
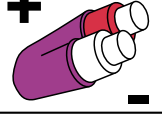
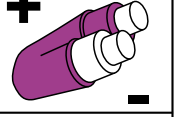
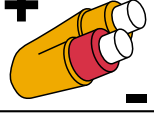
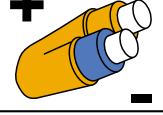
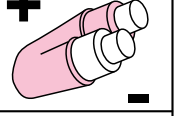
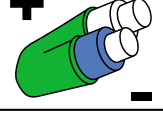
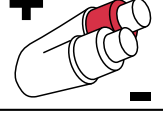
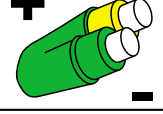
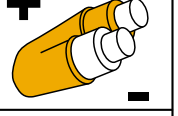
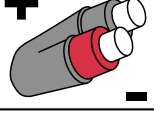
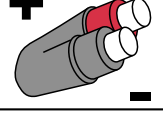
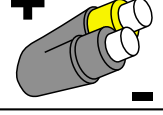
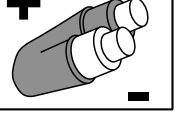
twisted
T00 / T05



T12 / T15

www.thermo-electra.com

International Thermocouple Colour Codes

Thermocouple Extension Type		ANSI	BS	DIN	NFC	JIS	IEC
JX	+ Iron - Constantan ®						
KX	+ Chromel ® - Alumel ®						
TX	+ Copper - Constantan ®						
EX	+ Chromel ® - Constantan ®						
NX	+ Nicrosil ® - Nisil ®						
SX RX	+ Copper - Alloy 11						
BX	+ Copper-S - Copper-E						

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