ULTRALIGHT ENGINES - ENGINE INSTRUMENTS

Ultralight engines should be provided with certain instruments.

Considering its importance it is recommended to measure the following:

- engine r.p.m.
- cooling liquid temperature on liquid cooled (L/C) engines
- spark plug seat temperature of air cooled (= FAN or free-air = FA cooled) engines (also called CHT = cylinder head temperature)
- exhaust gas temperature (EGT)

Note the following in detail:

1) Engine r.p.m.

An r.p.m. counter (tachometer) m u s t be fitted because it shows before every take-off whether the engine is in order and whether the prescribed "ground test r.p.m." is reached.

NOTE: Customers' Information 5 UL 86/E - Electronic Tachometer
Service Information 5 UL 86/E - propeller/engine matching
Service Information 1 UL 87/E - Installation Instructions

An r.p.m. counter can be supplied by ROTAX, part-no. 966 070.

The accuracy of this tachometer is approx. +/- 200 r.p.m. (1/min) and should be considered as satisfactory for this application.

Perfectly accurate are digital instruments, if also the impulses are registered digitally.

If you use an analogous instrument, it is useful to compare indications occasionally with an accurate digital instrument to find out its "deviation".

2) Cooling liquid temperature

The cooling system of liquid cooled engines is more complex than that of air cooled engines, therefore the probability of malfunctions is higher.

A cooling liquid temperature gauge is an important and necessary surveying instrument and increases operational security.

"MotoMeter" offers the following suitable instrument which fits to our engines:

1 x temperature probe 642.007.1014	40° - 120° C	(1/8-27NPTF)
1 x indicating instrument 641.011.1015	40° - 120° C	(52 mm dia)

BOMBARDIER-ROTAX
GESELLSCHAFT M. B. H. MOTORENFABRIK
A-4623 GUNSKIRCHEN — AUSTRIA
Telefon: (0 72 46) 271-0*, Telefax: (0 72 46) 271286
Telex: 25546 brgk a, Telegr.: Bombrotax Gunskirchen

It, however, requires 12V direct current supply (battery or rectifier-regulator 264 870 with condensor 2000 µF/25V), see Operator's Manual.

The cylinder head is provided with the suitable thread for temperature gauge.

Further information regarding cooling system and temperature limit values - see Operator's Manual and Installation Instructions.

3) Spark plug seat temperature

3.1. A suitable and informative place to measure temperature on air cooled engines is the spark plug seat. This measuring spot responds rapidly to the thermal conditions in the cylinder and shows

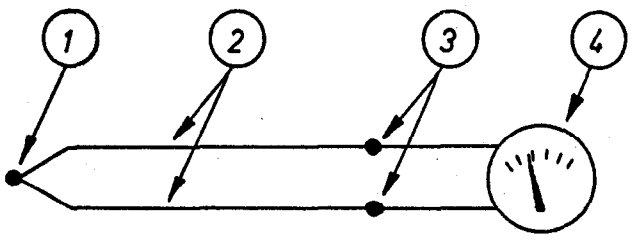
- whether cooling is functioning
- whether overheating occurs by leaning
- the temperature differences between the 2 cylinders (in case of 2-cylinder engines)

Bad fuel mixture distribution (carburettor is not fitted in a perfect rectangular position - see Operator's Manual) for example may be detected.

To get complete information, the temperature has to be measured on each cylinder.

3.2. Electronic instruments are available which work on basis of thermocouples.

System:



pos. (1) contact point of the thermocouple-wires (hot junction)
" (2) thermocouple-wires
" (3) connection to instrument (cold junction)
" (4) indicating instrument

Depending on the temperature difference between hot and cold junction the thermocouple supplies the so-called thermo voltage indicated by the instrument which is calibrated in temperature degrees.

The thermocouple wires (2) usually are
Fe-Const (iron-constantan), blue, up to 700° C
(900° C)
or
NiCr-Ni (chromel-alumel), green, up to 1000° C
(1200° C)
or
PtRh-Pt (platinum-rhodium - platinum), white, up to 1300° C (1600° C)

Each of these thermocouples supplies a different thermo voltage. It therefore is essential to know what kind of thermocouple is in use, if a measuring device is home-built.

The instrument is a millivoltmeter (mV), reading scale in °F or °C (degrees Fahrenheit or Celsius) depending on the thermocouple used.

Most instruments are calibrated for an ambient temperature of 15° or 20° C, i.e. the readings are only correct if pos. (3) is placed in an environment of 20° C.

Temperature differences at pos. (3) have to be corrected accordingly.

High-quality instruments have integrated electronic temperature compensation. In this case pos. (3) has to be on the instrument.

The commercially available instruments have to be checked for accurancy, e.g. in boiling water = 100° C at sea level (p=760 mm, Hg=1013 mbar), 97° C at 1000 m above sea level (p=674 mm, Hg=899 mbar).

Particular attention has to be paid to the ring-shaped measuring probe. This probe has to be fitted instead of the spark plug sealing ring (if of same thickness). The contact surfaces on cylinder head and measuring probe have to be metallic clean.

ATTENTION: A "screwed-down" oil carbon layer etc. isolates and reading is below the real values.

The hot junction (1) has to be the hottest spot. If the wires have a short cut away from the probe, the readings will be lower. This failure DOES NOT SHOW UP at a calibration with boiling water! It must be checked by visual inspection of the wire connection to the probe.

The pilot has the "cheating" feeling of security. False readings are always lower, never higher.

In case of home-built probes it is recommended to make a copper-ring (see illustration on page 7) with 2 bores 0,6 mm dia and to use e.g. NiCrNi thermocouple-wire 2 x 0,5 mm type G3, part no. 85 44 8501 manufactured by DEGUSSA.

ATTENTION: Some stock probes have "holding lugs" for the measuring cable. They act like a cooling fin of the probe and cause wrong readings.
Remedy: isolation of holding lugs

These few remarks already show the problematic of such measurings. Our hints may only be considered as suggestions. If your experience in this field is not sufficient and if you wish to get more information there is literature relevant to this subject.

The temperature limit values for ROTAX engines are mentioned in the Sercive Information 1 UL 87/E "Installation Instructions for ROTAX ultralight engines".

4) Exhaust gas temperature - EGT

Measuring of exhaust gas temperature gives important information about fuel mixture distribution, condition of mixture (with too lean mixture the temperature rises rapidly above the allowed value) and may also give information about ignition timing (too much ignition timing gives lower EGT-values but higher CHT-values, insufficient ignition timing reduces the CHT-values and increases the EGT-values).

Above all the EGT-indication responds very quickly to variations (much faster than CHT) and therefore represents a valuable complement to the CHT.

The EGT is measured in the exhaust manifold approx. 100 mm downstream from the piston skirt and approx. in the middle of each leg of the exhaust manifold.

Stock probes have to be installed very carefully. Avoid "cooling" of the probes due to metallic contact with the exhaust manifold or due to cooling air stream (propeller wind).

Home-built EGT-probes can be made as per enclosed drawing.

Method of measuring, checking etc. is done similarly as described under para. 3) for "CHT". Measuring errors occur even easier than at "CHT".

Temperature limit values - see "Installation Instructions".

The importance of the measuring instruments mentioned is evident as they show whether the engine works correctly and in "sound conditions".

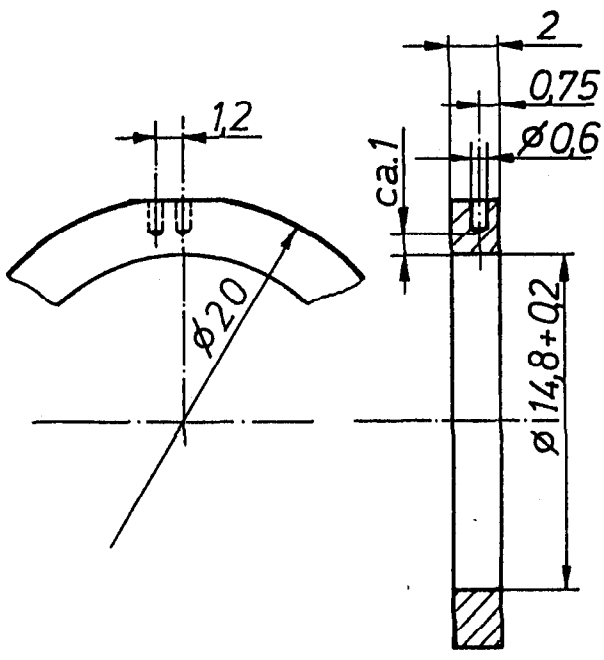
ENCLOSURES: 1 page "CHT-sensor"
1 page "EGT-sensor"
1 sheet illustration of sample probes
1 sheet "EMK" of thermocouples
1 sheet "Foreign agents of MotoMeter"
2 pages "Suppliers of thermocouple-wires"

MEMBER: MOTINSTE
VE/Ws/Wa
July 23, 87

C H T - S E N S O R

Meßsonde fuer Kerzensitztemperatur

Measuring probe for plug seat temperature

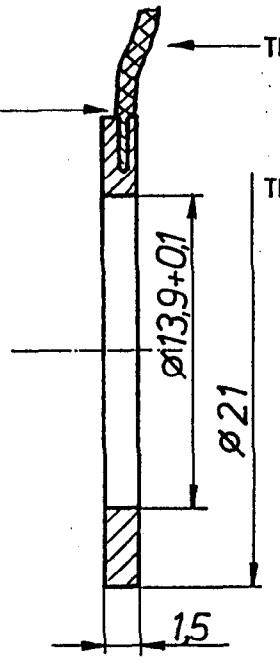


Teil mechanisch bearbeitet
vor dem Prägen.
Material: Cu-Blech 2 mm dick

Parts machined before stamping.
Material: Cu-plate 2 mm thick

Isolierung bis zur Sonde,
bzw. mit Sonde mitklemmen.

Insulation up to the probe,
respectively clamped with
the probe.

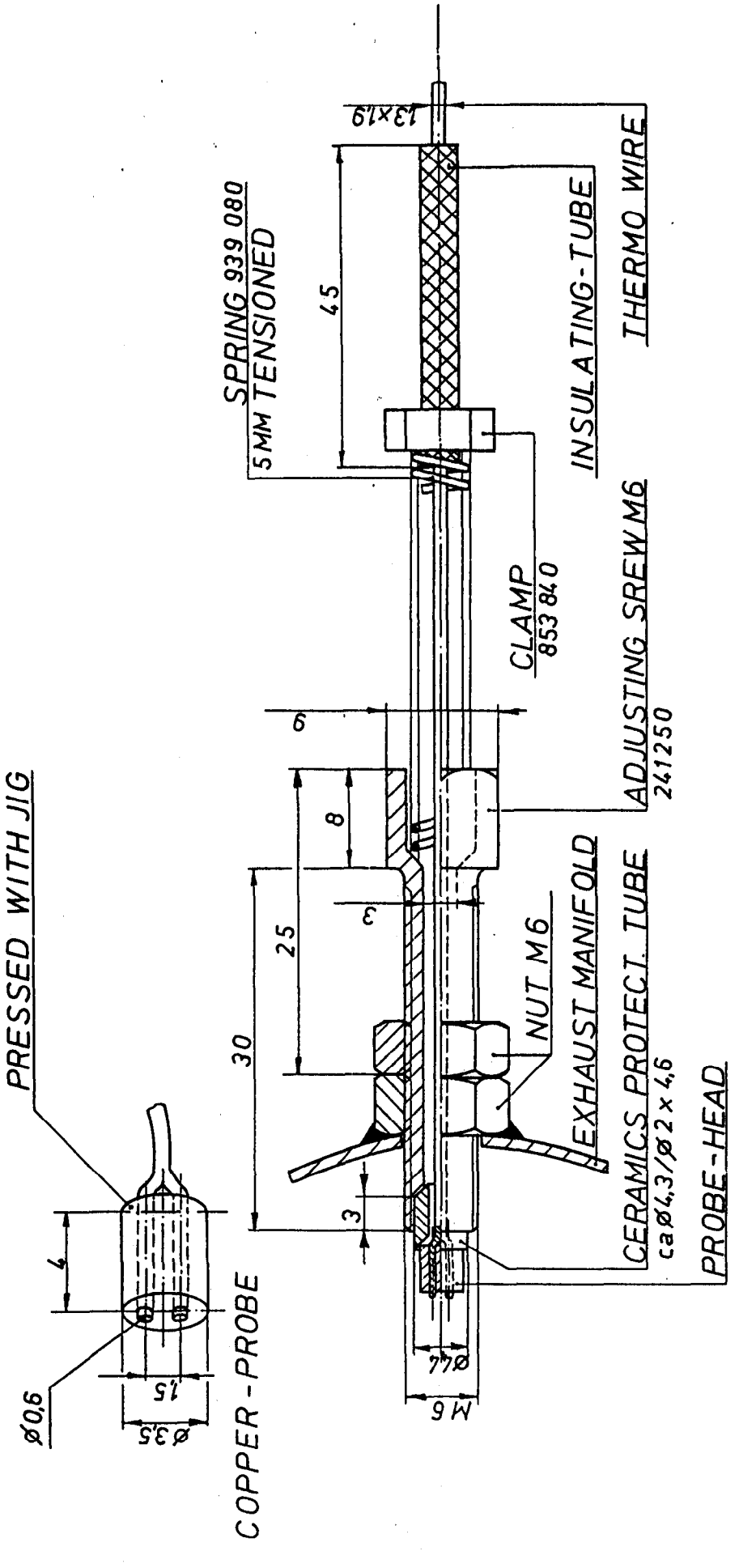


Thermodraht: z.B. Fe-Konstantan (blau)
NiCr-Ni (grün)
u.s.w. je nach Instrument

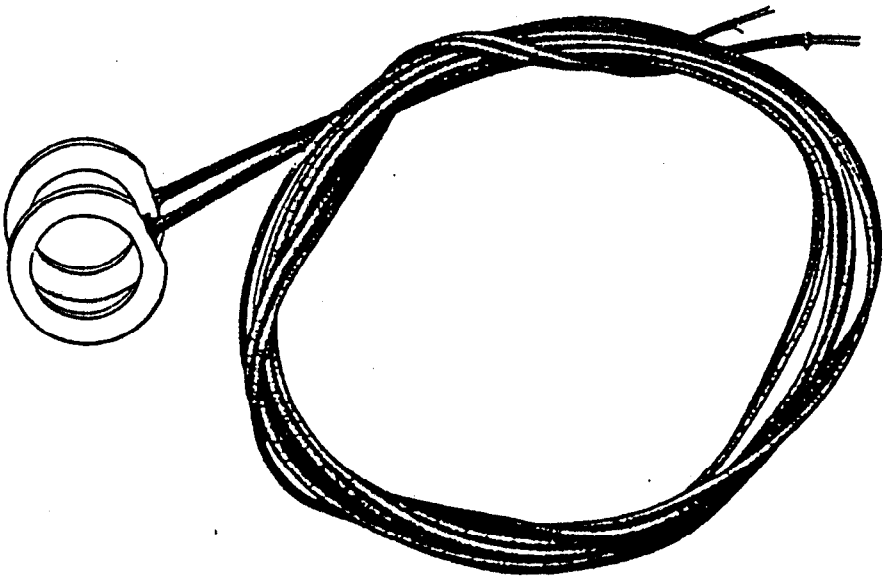
Thermowire: for example Fe-Constantan (blue)
NiCr-Ni (green)
and soon, depending
from the instruments

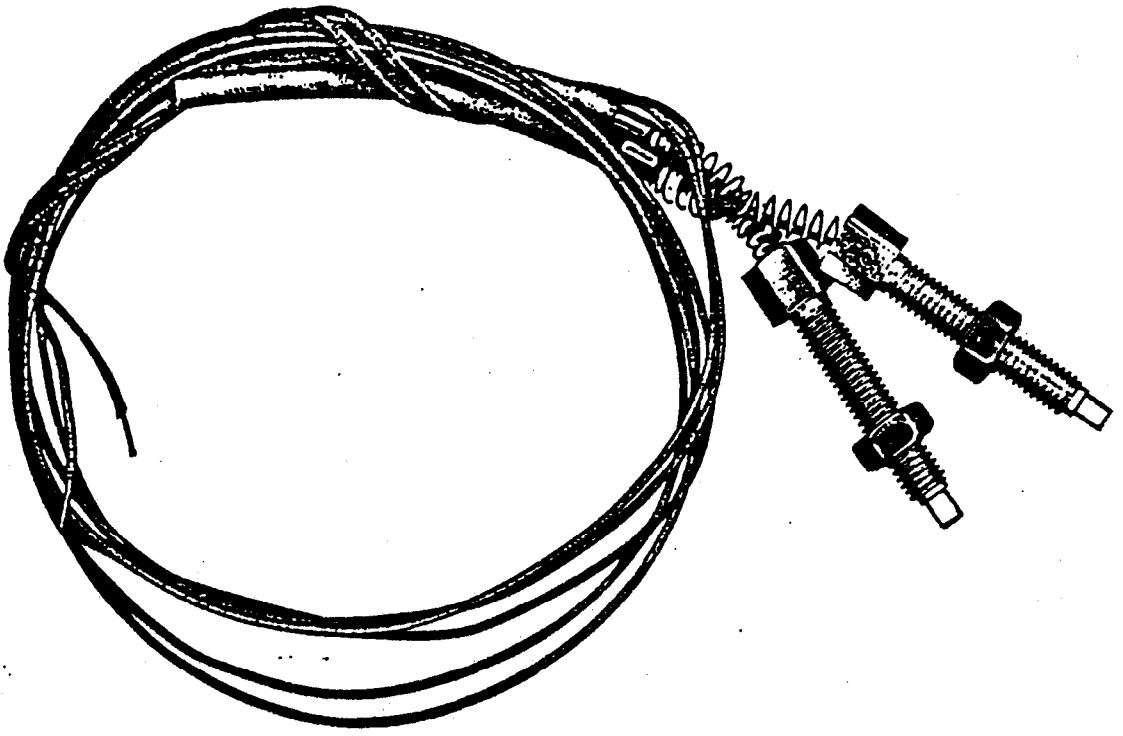
Teil nach dem Prägen bzw. Einpressen
des Thermodrahtes.

Part after stamping resp. pressing
in of the thermowire.


EGT SENSOR
SPRING 939 080
5MM TENSIONED
13x1,9
45
INSULATING-TUBE
THERMO WIRE
CLAMP
853 840
ADJUSTING SREW M6
241250
6
8
3
25
30
NUT M6
EXHAUST MANIFOLD
CERAMICS PROTECT. TUBE
ca ø4,3/ø2 x 4,6
PROBE-HEAD
3
7,7ø
M 6
PRESSED WITH JIG
4
1,5
ø3,5
ø0,6
COPPER-PROBE

Isol. Thermodraht / Isol. Thermo-Wire
NiCrNi, Type G3
2 x 0,5 mm²
P.-Nr. 8544-8501





Elektromotorische Kraft (EMK) von Thermoelementen
Electromotive force of thermocouple

Bezugstemperatur 0° Celsius
Reference temperature 0° Celsius

NiCr-Ni (Chromel-Alumel)

°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C
− 200	5,891		150	6,137	0,040	+ 500	20,640	0,043	850	35,314	0,041	+1200	48,828	0,037
190	5,730	0,016	160	6,539	0,040	510	21,066	0,043	860	35,718	0,040	1210	49,192	0,036
180	5,550	0,018	170	6,939	0,040	520	21,493	0,043	870	36,121	0,040	1220	49,555	0,036
170	5,354	0,020	180	7,338	0,040	530	21,919	0,043	880	36,524	0,040	1230	49,916	0,036
160	5,141	0,021	190	7,737	0,040	540	22,346	0,043	890	36,925	0,040	1240	50,276	0,036
150	4,912	0,023	+ 200	8,137	0,040	550	22,772	0,043	+ 900	37,325	0,040	1250	50,633	0,036
140	4,669	0,024	210	8,537	0,040	560	23,198	0,043	910	37,724	0,040	1260	50,990	0,036
130	4,410	0,026	220	8,938	0,040	570	23,624	0,043	920	38,122	0,040	1270	51,344	0,035
120	4,138	0,027	230	9,341	0,040	580	24,050	0,043	930	38,519	0,040	1280	51,697	0,035
110	3,852	0,029	240	9,745	0,040	590	24,476	0,043	940	38,915	0,040	1290	52,049	0,035
− 100	3,553	0,030	250	10,151	0,041	+ 600	24,902	0,043	950	39,310	0,040	+1300	52,398	0,035
90	3,242	0,031	260	10,560	0,041	610	25,327	0,043	960	39,703	0,039	1310	52,747	0,035
80	2,920	0,032	270	10,969	0,041	620	25,751	0,042	970	40,096	0,039	1320	53,093	0,035
70	2,586	0,033	280	11,381	0,040	630	26,176	0,043	980	40,488	0,039	1330	53,439	0,034
60	2,243	0,034	290	11,793	0,041	640	26,599	0,042	990	40,879	0,039	1340	53,782	0,034
50	1,889	0,035	+ 300	12,207	0,041	650	27,022	0,042	+1000	41,269	0,039	1350	54,125	0,034
40	1,527	0,036	310	12,623	0,042	660	27,445	0,042	1010	41,657	0,039	1360	54,466	0,034
30	1,156	0,037	320	13,039	0,042	670	27,867	0,042	1020	42,045	0,039	1370	54,807	0,034
20	0,777	0,038	330	13,456	0,042	680	28,288	0,042	1030	42,432	0,039			
10	0,392	0,039	340	13,874	0,042	690	28,709	0,042	1040	42,817	0,039			
∓ 0	0		350	14,292	0,042	+ 700	29,128	0,042	1050	43,202	0,039			
10	0,397	0,040	360	14,712	0,042	710	29,547	0,042	1060	43,585	0,038			
20	0,798	0,040	370	15,132	0,042	720	29,965	0,042	1070	43,966	0,038			
30	1,203	0,040	380	15,552	0,042	730	30,383	0,042	1080	44,349	0,038			
40	1,611	0,041	390	15,974	0,042	740	30,799	0,042	1090	44,729	0,038			
50	2,022	0,041	+ 400	16,395	0,042	750	31,214	0,042	+1100	45,108	0,038			
60	2,436	0,041	410	16,818	0,042	760	31,629	0,042	1110	45,486	0,038			
70	2,850	0,041	420	17,241	0,042	770	32,042	0,041	1120	45,863	0,038			
80	3,266	0,042	430	17,664	0,042	780	32,455	0,041	1130	46,238	0,038			
90	3,681	0,042	440	18,088	0,042	790	32,866	0,041	1140	46,612	0,037			
+ 100	4,095	0,041	450	18,513	0,043	+ 800	33,277	0,041	1150	46,985	0,037			
110	4,508	0,041	460	18,938	0,044	810	33,686	0,041	1160	47,356	0,037			
120	4,919	0,041	470	19,363	0,043	820	34,095	0,041	1170	47,726	0,037			
130	5,327	0,041	480	19,788	0,044	830	34,502	0,041	1180	48,095	0,037			
140	5,733	0,041	490	20,214	0,043	840	34,909	0,041	1190	48,462	0,037			

Fe-Const (Fe-CuNi)

°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C
−200	8,15		50	2,65	0,054	+300	16,56	0,056	550	30,75	0,058	+800	46,22	0,067
190	7,86	0,029	60	3,19	0,054	310	17,12	0,056	560	31,33	0,058	810	46,89	0,067
180	7,56	0,030	70	3,73	0,054	320	17,68	0,056	570	31,91	0,058	820	47,57	0,068
170	7,25	0,031	80	4,27	0,054	330	18,24	0,056	580	32,49	0,058	830	48,25	0,068
160	6,93	0,032	90	4,82	0,055	340	18,80	0,056	590	33,08	0,059	840	48,94	0,069
150	6,60	0,033	+100	5,37	0,055	350	19,36	0,056	+600	33,67	0,059	850	49,63	0,069
140	6,26	0,034	110	5,92	0,055	360	19,92	0,056	610	34,26	0,059	860	50,32	0,069
130	5,90	0,036	120	6,47	0,055	370	20,48	0,056	620	34,85	0,059	870	51,02	0,070
120	5,53	0,037	130	7,03	0,056	380	21,04	0,056	630	35,44	0,059	880	51,72	0,070
110	5,15	0,038	140	7,59	0,056	390	21,60	0,056	640	36,04	0,060	890	52,43	0,071
−100	4,75	0,040	150	8,15	0,056	+400	22,16	0,056	650	36,64	0,060	+900	53,14	0,071
90	4,33	0,042	160	8,71	0,056	410	22,72	0,056	660	37,25	0,061			
80	3,89	0,044	170	9,27	0,056	420	23,29	0,057	670	37,85	0,060			
70	3,44	0,045	180	9,83	0,056	430	23,86	0,057	680	38,47	0,062			
60	2,98	0,046	190	10,39	0,056	440	24,43	0,057	690	39,09	0,062			
50	2,51	0,047	+200	10,95	0,056	450	25,00	0,057	+700	39,72	0,063			
40	2,03	0,048	210	11,51	0,056	460	25,57	0,057	710	40,35	0,063			
30	1,53	0,050	220	12,07	0,056	470	26,14	0,057	720	40,98	0,063			
20	1,02	0,051	230	12,63	0,056	480	26,71	0,057	730	41,62	0,064			
10	0,51	0,051	240	13,19	0,056	490	27,28	0,057	740	42,27	0,065			
∓ 0	0		250	13,75	0,056	+500	27,85	0,057	750	42,92	0,065			
10	0,52	0,052	260	14,31	0,056	510	28,43	0,058	760	43,57	0,065			
20	1,05	0,053	270	14,88	0,057	520	29,01	0,058	770	44,23	0,066			
30	1,58	0,053	280	15,44	0,056	530	29,59	0,058	780	44,89	0,066			
40	2,11	0,053	290	16,00	0,056	540	30,17	0,058	790	45,55	0,066			

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