Hall Effect

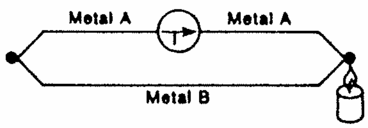
Appendix B

Thermocouples and the Hall Probe

Source: “Omega Temperature Measurements Handbook and Encyclopedia”

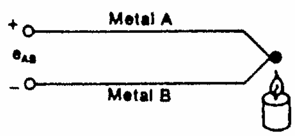
THE THERMOCOUPLE

When two wires composed of dissimilar metals are joined at both ends and one of the ends is heated, there is a continuous current which flows in the *thermoelectric* circuit. Thomas Seebeck made this discovery in 1821.



THE SEEBECK EFFECT
Figure 2

If this circuit is broken at the center, the net open circuit voltage (the Seebeck voltage) is a function of the junction temperature and the composition of the two metals.



e_{AB} = SEEBECK VOLTAGE
Figure 3

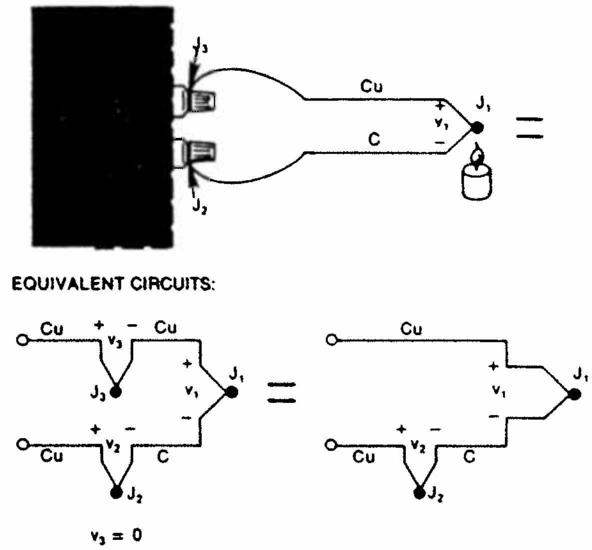
All dissimilar metals exhibit this effect. The most common combinations of two metals are listed in Appendix B of this application note, along with their important characteristics. For small changes in temperature the Seebeck voltage is linearly proportional to temperature:

$$\Delta e_{AB} = \alpha \Delta T$$

Where α, the Seebeck coefficient, is the constant of proportionality.

Measuring Thermocouple Voltage – We can't measure the Seebeck voltage directly because we must first connect a voltmeter to the thermocouple, and the voltmeter leads themselves create a new thermoelectric circuit.

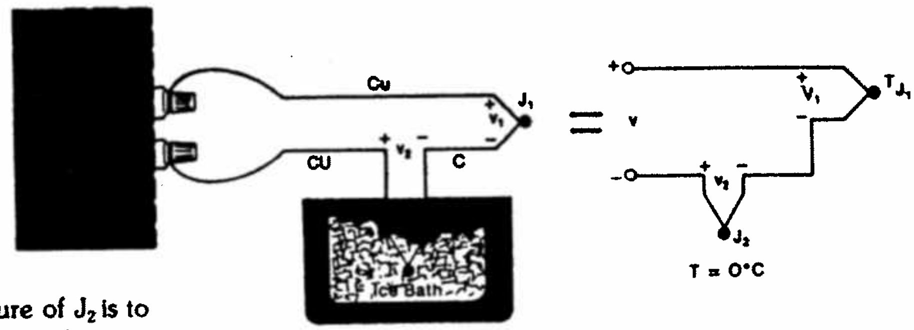
Let's connect a voltmeter across a copper-constantan (Type T) thermocouple and look at the voltage output:



MEASURING JUNCTION VOLTAGE WITH A DVM
Figure 4

We would like the voltmeter to read only V_1, but by connecting the voltmeter in an attempt to measure the output of Junction J_1, we have created two more metallic junctions: J_2 and J_3. Since J_3 is a copper-to-copper junction, it creates no thermal EMF ($V_3 = 0$) but J_2 is a copper-to-constantan junction which will add an EMF (V_2) in opposition to V_1. The resultant voltmeter reading V will be proportional to the temperature *difference* between J_1 and J_2. This says that we can't find the temperature at J_1 unless we first find the temperature of J_2.

The Reference Junction



EXTERNAL REFERENCE JUNCTION
Figure 5

One way to determine the temperature of J_2 is to physically put the junction into an ice bath, forcing its temperature to be 0°C and establishing J_2 as the *Reference Junction*. Since both voltmeter terminal junctions are now copper-copper, they create no thermal emf and the reading V on the voltmeter is proportional to the temperature difference between J_1 and J_2.

Now the voltmeter reading is (See Figure 5):

$$V = (V_1 - V_2) \cong \alpha\,(t_{J_1} - t_{J_2})$$

If we specify T_{J_1} in degrees Celsius:

$$T_{J_1}\,(°C) + 273.15 = t_{J_1}$$

then V becomes:

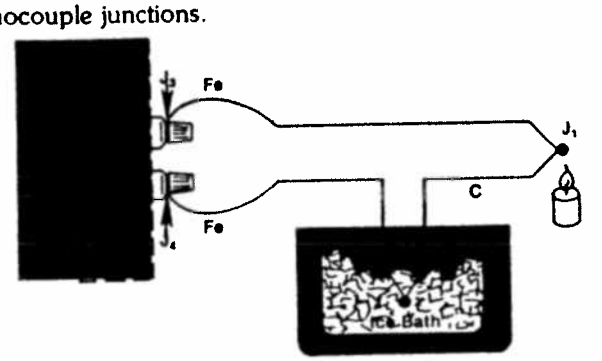
$$V = V_1 - V_2 = \alpha\left[(T_{J_1} + 273.15) - (T_{J_2} + 273.15)\right] = \alpha\,(T_{J_1} - T_{J_2}) = \alpha(T_{J_1} - 0)$$

$$V = \alpha T_{J_1}$$

We use this protracted derivation to emphasize that the ice bath junction output, V_2, is *not* zero volts. It is a function of absolute temperature.

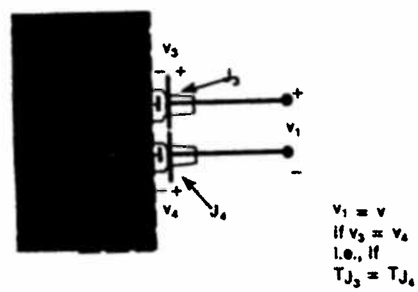
By adding the voltage of the ice point reference junction we have now referenced the reading V to 0°C. This method is very accurate because the ice point temperature can be precisely controlled. The ice point is used by the National Bureau of Standards (NBS) as the fundamental reference point for their thermocouple tables, so we can now look at the NBS tables and directly convert from voltage V to Temperature T_{J_1}.

The copper-constantan thermocouple shown in Figure 5 is a unique example because the copper wire is the same metal as the voltmeter terminals. Let's use an iron-constantan (Type J) thermocouple instead of the copper-constantan. The iron wire (Figure 6) increases the number of dissimilar metal junctions in the circuit, as both voltmeter terminals become Cu-Fe thermocouple junctions.



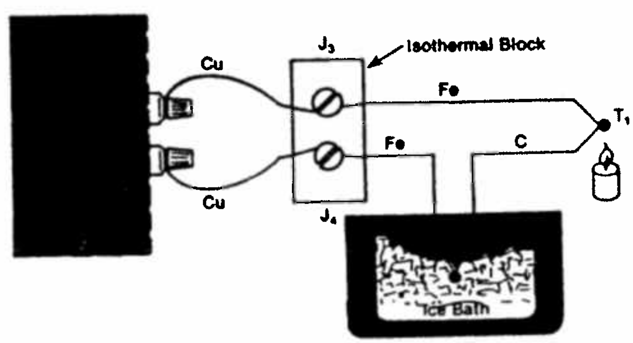
IRON-CONSTANTAN COUPLE
Figure 6

This circuit will still provide moderately accurate measurements as long as the voltmeter *high* and *low* terminals (J_3 & J_4) in opposition (Fig. 7):



JUNCTION VOLTAGE CANCELLATION
Figure 7

If both front panel terminals are not at the same temperature, there will be an error. For a more precise measurement the copper voltmeter leads should be extended so the copper-to-iron junctions are made on an *isothermal* (same temperature) block:

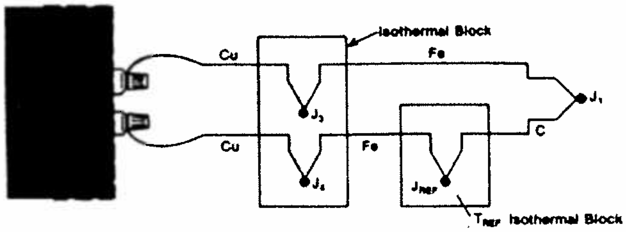


REMOVING JUNCTIONS FROM DVM TERMINALS
Figure 8

The isothermal block is an electrical insulator but a good heat conductor and it serves to hold J_3 and J_4 at the same temperature. The absolute block temperature is unimportant because the two Cu-Fe junctions act in opposition. We still have

$$V = \alpha(T_1 - T_{REF})$$

Let's replace the ice bath with another isothermal block:



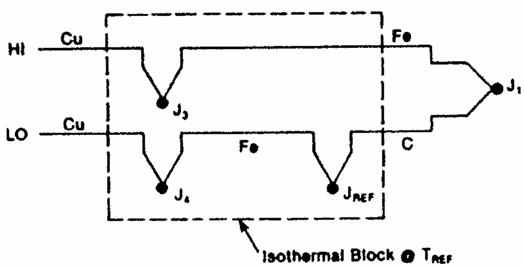
ELIMINATING THE ICE BATH
Figure 9

The new block is at Reference Temperature T_{REF}, and because J_3 and J_4 are still at the same temperature we can again show that

$$V = \alpha (T_1 - T_{REF})$$

This is still a rather inconvenient circuit because we have to connect two thermocouples. Let's eliminate the extra Fe wire in the negative (Lo) lead by combining the Cu-Fe junction (J_4) and the Fe-C junction (J_{REF}).

We can do this by first joining the two isothermal blocks (Figure 9b).

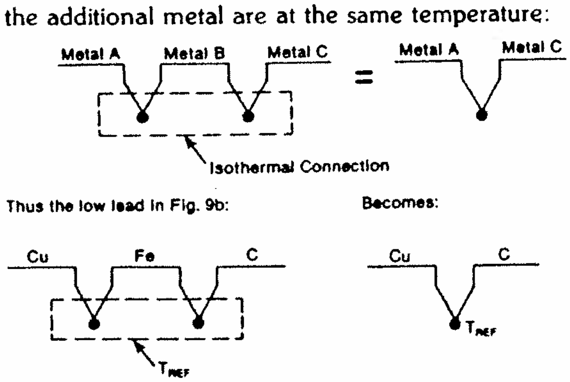


JOINING THE ISOTHERMAL BLOCKS
Figure 9b

We haven't changed the output voltage V. It is still

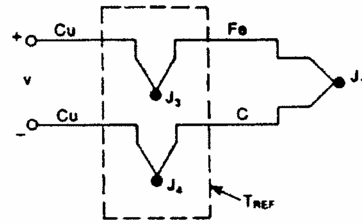
$$V = \alpha (T_{J_1} - T_{J_{REF}})$$

Now we call upon the law of intermediate metals (see Appendix A) to eliminate the extra junction. This empirical "*law*" states that a third metal (in this case, iron) inserted between the two dissimilar metals of a thermocouple junction will have no effect upon the output voltage as long as the two junctions formed by the additional metal are at the same temperature:



LAW OF INTERMEDIATE METALS
Figure 10

This is a useful conclusion, as it completely eliminates the need for the iron (Fe) wire in the *LO* lead:

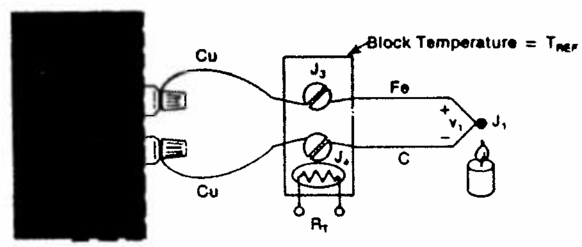


EQUIVALENT CIRCUIT
Figure 11

Again, $V = \alpha (T_{J_1} - T_{REF})$, where α is the Seebeck coefficient for an Fe-C thermocouple.

Junctions J_3 and J_4 take the place of the ice bath. These two junctions now become the *Reference Junction*.

Now we can proceed to the next logical step: Directly measure the temperature of the isothermal block (the *Reference Junction*) and use that information to compute the unknown temperature, T_{J_1}).



EXTERNAL REFERENCE JUNCTION-NO ICE BATH
Figure 12

A thermistor, whose resistance R_T is a function of temperature, provides us with a way to measure the absolute temperature of the reference junction. Junctions J_3 and J_4 and the thermistor are all assumed to be at the same temperature, due to the design of the isothermal block. Using a digital multimeter under computer control, we simply:

1) Measure R_T to find T_{REF} and convert T_{REF} to its equivalent reference junction voltage. V_{REF}

2) Measure V and subtract V_{REF} to find V_1, and convert V_1 to temperature T_{J_1}

This procedure is known as *Software Compensation* because it relies upon the software of a computer to compensate for the effect of the reference junction. The isothermal terminal block temperature sensor can be any device which has a characteristic proportional to absolute temperature: an RTD, a Thermistor, or an integrated circuit sensor.

It seems logical to ask: If we already have a device that will measure absolute temperature, (like an RTD or thermistor) why do we even bother with a thermocouple that requires reference junction compensation? The single most important answer to this question is that the thermistor, the RTD, and the integrated circuit transducer are only useful over a certain temperature range. Thermocouples, on the other hand, can be used over a range of temperatures, and optimized for various atmospheres. They are much more rugged than thermistors, as evidenced by the fact that thermocouples are often welded to a metal part or clamped under a screw. They can be manufactured on the spot, either by soldering or welding. In short, thermocouples are the most versatile temperature transducer available and since the measurement system performs the entire task of reference compensation and software voltage-to-temperature conversion, using a thermocouple becomes as easy as connecting a pair of wires.

Thermocouple measurement becomes especially convenient when we are required to monitor a large number of data points. This is accomplished by using the isothermal reference junction for more than one thermocouple element (see Figure 13).

A reed relay scanner connects the voltmeter to the various thermocouples in sequence. All of the voltmeter and scanner wires are copper, independent of the type of thermocouple chosen. In fact, as long as we know what each thermocouple is, we can mix thermocouple types on the same isothermal junction block (often called a *zone box*) and make the appropriate modifications in software. The junction block temperature sensor, R_T is located at the center of the block to minimize errors due to thermal gradients.

Software compensation is the most versatile technique we have for measuring thermocouples. Many thermocouples are connected on the same block, copper leads are used throughout the scanner, and the technique is independent of the types of thermocouples chosen. In addition, when using a data acquisition system with a built-in zone box, we simply connect the thermocouple as we would a pair of test leads. All of the conversions are performed by the computer. The one disadvantage is that the computer requires a small amount of additional time to calculate the reference junction temperature. For maximum speed we can use hardware compensation.

ZONE BOX SWITCHING
Figure 13

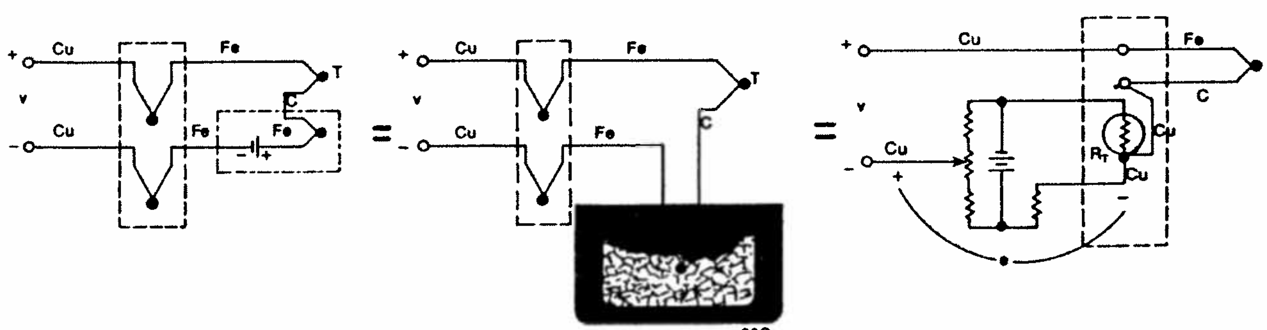
Hardware Compensation

Rather than measuring the temperature of the reference junction and computing its equivalent voltage as we did with software compensation, we could insert a battery to cancel the offset voltage of the reference junction. The combination of this *hardware compensation* voltage and the reference junction voltage is equal to that of a 0°C junction.

The compensation voltage, e, is a function of the temperature sensing resistor, R_T. The voltage V is now referenced to 0°C, and may be read directly and converted to temperature by using the NBS tables.

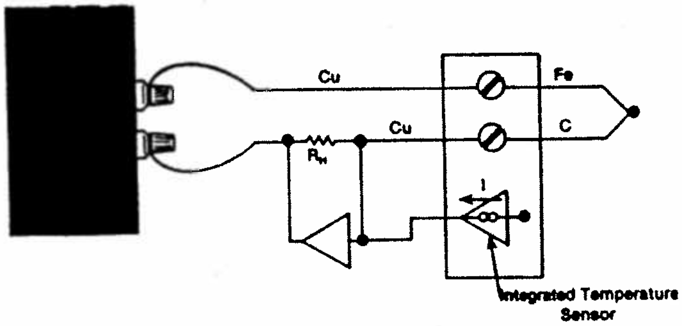
Another name for this circuit is the *electronic ice point reference*.[6] These circuits are commercially available for use with any voltmeter and with a wide variety of thermocouples. The major drawback is that a unique ice point reference circuit is usually needed for each individual thermocouple type.

Figure 15 shows a practical ice point reference circuit that can be used in conjunction with a reed relay scanner to compensate an entire block of thermocouple inputs. All the thermocouples in the block must be of the same type, but each block of inputs can accommodate a different thermocouple type by simply changing gain resistors.



HARDWARE COMPENSATION CIRCUIT
Figure 14

[6] Refer to Bibliography 6.



PRACTICAL HARDWARE COMPENSATION
Figure 15

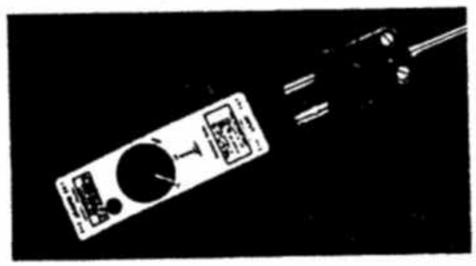
The advantage of the hardware compensation circuit or *electronic ice point reference* is that we eliminate the need to compute the reference temperature. This saves us two computation steps and makes a hardware compensation temperature measurement somewhat faster than a software compensation measurement.

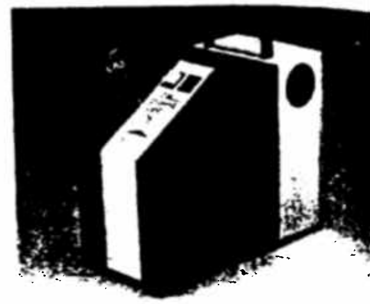
HARDWARE COMPENSATION	SOFTWARE COMPENSATION
Fast	Requires more computer manipulation time
Restricted to one thermocouple type per card	Versatile – accepts any thermocouple

Table 2

OMEGA TAC—Electronic Ice Point and Thermocouple Preamplifier/Linearizer Plugs into Standard Connector.

OMEGA Electronic Ice Point Built into Thermocouple Connector—"MCJ"





OMEGA Ice Point Reference Chamber. Electronic Refrigeration Eliminates Ice Bath.

Voltage-To-Temperature Conversion

We have used hardware and software compensation to synthesize an ice-point reference. Now all we have to do is to read the digital voltmeter and convert the voltage reading to a temperature. Unfortunately, the temperature-versus-voltage relationship of a thermocouple is not linear. Output voltages for the more common thermocouples are plotted as a function of temperature in Figure 16. If the slope of the curve (the Seebeck coefficient) is plotted vs. temperature, as in Figure 17, it becomes quite obvious that the thermocouple is a non-linear device.

A horizontal line in Figure 17 would indicate a constant α, in other words, a linear device. We notice that the slope of the type K thermocouple approaches a constant over a temperature range from 0°C to 1000 °C. Consequently, the type K can be used with a multiplying voltmeter and an external ice point reference to obtain a moderately accurate direct readout of temperature. That is, the temperature display involves only a scale factor. This procedure works with voltmeters.*

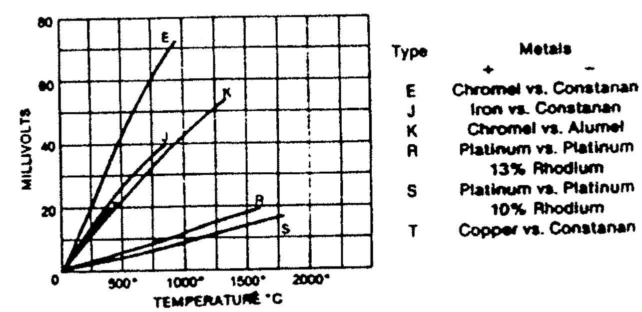
By examining the variations in Seebeck coefficient, we can easily see that using one constant scale factor would limit the temperature range of the system and restrict the system accuracy. Better conversion accuracy can be obtained by reading the voltmeter and consulting the National Bureau of Standards Thermocouple Tables[4] in Section T of the *OMEGA TEMPERATURE MEASUREMENT HANDBOOK* – see Table 3.
We could store these *look-up* table values in a computer, but they would consume an inordinate amount of memory. A more viable approach is to approximate the table values using a power series polynomial:

$$T = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots + a_n x^n$$

where
T = Temperature
x = Thermocouple Voltage
a = Polynomial coefficients unique to each thermocouple
n = Maximum order of the polynomial

As n increases, the accuracy of the polynomial improves. A representative number is n = 9 for ±1°C accuracy. Lower order polynomials may be used over a narrow temperature range to obtain higher system speed.

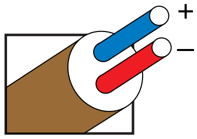
Table 4 is an example of the polynomials used in conjunction with system software compensation packages for a data acquisition system. Rather than directly calculating the exponentials, the computer is programmed to use the *nested polynomial* form to save execution time. The polynomial *fit* rapidly degrades outside the temperature range shown in Table 4 and should not be extrapolated outside those limits.



THERMOCOUPLE TEMPERATURE
vs.
VOLTAGE GRAPH
Figure 16

* Some recommended voltmeters that can be used are: *HEWLETT PACKARD* models 3455A, 3456B and 3467A.
[4] Refer to Bibliography 4.

Revised Thermocouple Reference Tables

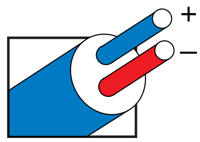


Thermocouple Grade

TYPE T

Reference Tables N.I.S.T. Monograph 175 Revised to ITS-90

Copper vs. Copper-Nickel



Extension Grade

MAXIMUM TEMPERATURE RANGE
Thermocouple Grade
– 328 to 662°F
– 200 to 350°C
Extension Grade
– 76 to 212°F
– 60 to 100°C

LIMITS OF ERROR
(whichever is greater)
Standard: 1.0°C or 0.75% Above 0°C
1.0°C or 1.5% Below 0°C
Special: 0.5°C or 0.4%

COMMENTS, BARE WIRE ENVIRONMENT:
Mild Oxidizing, Reducing Vacuum or Inert; Good Where Moisture Is Present; Low Temperature and Cryogenic Applications

TEMPERATURE IN DEGREES °C
REFERENCE JUNCTION AT 0°C

Thermoelectric Voltage in Millivolts

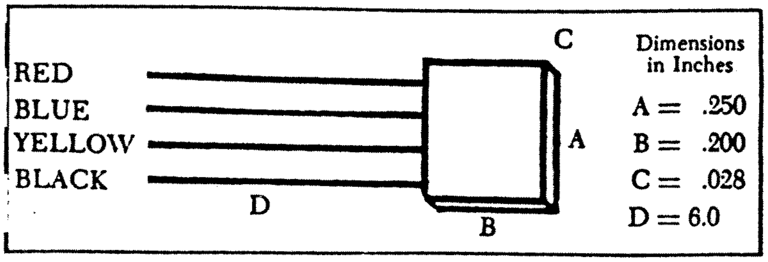
°C	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	°C
-260	-6.258	-6.256	-6.255	-6.253	-6.251	-6.248	-6.245	-6.242	-6.239	-6.236	-6.232	-260
-250	-6.232	-6.228	-6.223	-6.219	-6.214	-6.209	-6.204	-6.198	-6.193	-6.187	-6.180	-250
-240	-6.180	-6.174	-6.167	-6.160	-6.153	-6.146	-6.138	-6.130	-6.122	-6.114	-6.105	-240
-230	-6.105	-6.096	-6.087	-6.078	-6.068	-6.059	-6.049	-6.038	-6.028	-6.017	-6.007	-230
-220	-6.007	-5.996	-5.985	-5.973	-5.962	-5.950	-5.938	-5.926	-5.914	-5.901	-5.888	-220
-210	-5.888	-5.876	-5.863	-5.850	-5.836	-5.823	-5.809	-5.795	-5.782	-5.767	-5.753	-210
-200	-5.753	-5.739	-5.724	-5.710	-5.695	-5.680	-5.665	-5.650	-5.634	-5.619	-5.603	-200
-190	-5.603	-5.587	-5.571	-5.555	-5.539	-5.523	-5.506	-5.489	-5.473	-5.456	-5.439	-190
-180	-5.439	-5.421	-5.404	-5.387	-5.369	-5.351	-5.334	-5.316	-5.297	-5.279	-5.261	-180
-170	-5.261	-5.242	-5.224	-5.205	-5.186	-5.167	-5.148	-5.128	-5.109	-5.089	-5.070	-170
-160	-5.070	-5.050	-5.030	-5.010	-4.989	-4.969	-4.949	-4.928	-4.907	-4.886	-4.865	-160
-150	-4.865	-4.844	-4.823	-4.802	-4.780	-4.759	-4.737	-4.715	-4.693	-4.671	-4.648	-150
-140	-4.648	-4.626	-4.604	-4.581	-4.558	-4.535	-4.512	-4.489	-4.466	-4.443	-4.419	-140
-130	-4.419	-4.395	-4.372	-4.348	-4.324	-4.300	-4.275	-4.251	-4.226	-4.202	-4.177	-130
-120	-4.177	-4.152	-4.127	-4.102	-4.077	-4.052	-4.026	-4.000	-3.975	-3.949	-3.923	-120
-110	-3.923	-3.897	-3.871	-3.844	-3.818	-3.791	-3.765	-3.738	-3.711	-3.684	-3.657	-110
-100	-3.657	-3.629	-3.602	-3.574	-3.547	-3.519	-3.491	-3.463	-3.435	-3.407	-3.379	-100
-90	-3.379	-3.350	-3.322	-3.293	-3.264	-3.235	-3.206	-3.177	-3.148	-3.118	-3.089	-90
-80	-3.089	-3.059	-3.030	-3.000	-2.970	-2.940	-2.910	-2.879	-2.849	-2.818	-2.788	-80
-70	-2.788	-2.757	-2.726	-2.695	-2.664	-2.633	-2.602	-2.571	-2.539	-2.507	-2.476	-70
-60	-2.476	-2.444	-2.412	-2.380	-2.348	-2.316	-2.283	-2.251	-2.218	-2.186	-2.153	-60
-50	-2.153	-2.120	-2.087	-2.054	-2.021	-1.987	-1.954	-1.920	-1.887	-1.853	-1.819	-50
-40	-1.819	-1.785	-1.751	-1.717	-1.683	-1.648	-1.614	-1.579	-1.545	-1.510	-1.475	-40
-30	-1.475	-1.440	-1.405	-1.370	-1.335	-1.299	-1.264	-1.228	-1.192	-1.157	-1.121	-30
-20	-1.121	-1.085	-1.049	-1.013	-0.976	-0.940	-0.904	-0.867	-0.830	-0.794	-0.757	-20
-10	-0.757	-0.720	-0.683	-0.646	-0.608	-0.571	-0.534	-0.496	-0.459	-0.421	-0.383	-10
0	-0.383	-0.345	-0.307	-0.269	-0.231	-0.193	-0.154	-0.116	-0.077	-0.039	0.000	0
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352	0.391	0
10	0.391	0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.790	10
20	0.790	0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155	1.196	20
30	1.196	1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570	1.612	30
40	1.612	1.654	1.696	1.738	1.780	1.823	1.865	1.908	1.950	1.993	2.036	40
°C	0	1	2	3	4	5	6	7	8	9	10	°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
50	2.036	2.079	2.122	2.165	2.208	2.251	2.294	2.338	2.381	2.425	2.468	50
60	2.468	2.512	2.556	2.600	2.643	2.687	2.732	2.776	2.820	2.864	2.909	60
70	2.909	2.953	2.998	3.043	3.087	3.132	3.177	3.222	3.267	3.312	3.358	70
80	3.358	3.403	3.448	3.494	3.539	3.585	3.631	3.677	3.722	3.768	3.814	80
90	3.814	3.860	3.907	3.953	3.999	4.046	4.092	4.138	4.185	4.232	4.279	90
100	4.279	4.325	4.372	4.419	4.466	4.513	4.561	4.608	4.655	4.702	4.750	100
110	4.750	4.798	4.845	4.893	4.941	4.988	5.036	5.084	5.132	5.180	5.228	110
120	5.228	5.277	5.325	5.373	5.422	5.470	5.519	5.567	5.616	5.665	5.714	120
130	5.714	5.763	5.812	5.861	5.910	5.959	6.008	6.057	6.107	6.156	6.206	130
140	6.206	6.255	6.305	6.355	6.404	6.454	6.504	6.554	6.604	6.654	6.704	140
150	6.704	6.754	6.805	6.855	6.905	6.956	7.006	7.057	7.107	7.158	7.209	150
160	7.209	7.260	7.310	7.361	7.412	7.463	7.515	7.566	7.617	7.668	7.720	160
170	7.720	7.771	7.823	7.874	7.926	7.977	8.029	8.081	8.133	8.185	8.237	170
180	8.237	8.289	8.341	8.393	8.445	8.497	8.550	8.602	8.654	8.707	8.759	180
190	8.759	8.812	8.865	8.917	8.970	9.023	9.076	9.129	9.182	9.235	9.288	190
200	9.288	9.341	9.395	9.448	9.501	9.555	9.608	9.662	9.715	9.769	9.822	200
210	9.822	9.876	9.930	9.984	10.038	10.092	10.146	10.200	10.254	10.308	10.362	210
220	10.362	10.417	10.471	10.525	10.580	10.634	10.689	10.743	10.798	10.853	10.907	220
230	10.907	10.962	11.017	11.072	11.127	11.182	11.237	11.292	11.347	11.403	11.458	230
240	11.458	11.513	11.569	11.624	11.680	11.735	11.791	11.846	11.902	11.958	12.013	240
250	12.013	12.069	12.125	12.181	12.237	12.293	12.349	12.405	12.461	12.518	12.574	250
260	12.574	12.630	12.687	12.743	12.799	12.856	12.912	12.969	13.026	13.082	13.139	260
270	13.139	13.196	13.253	13.310	13.366	13.423	13.480	13.537	13.595	13.652	13.709	270
280	13.709	13.766	13.823	13.881	13.938	13.995	14.053	14.110	14.168	14.226	14.283	280
290	14.283	14.341	14.399	14.456	14.514	14.572	14.630	14.688	14.746	14.804	14.862	290
300	14.862	14.920	14.978	15.036	15.095	15.153	15.211	15.270	15.328	15.386	15.445	300
310	15.445	15.503	15.562	15.621	15.679	15.738	15.797	15.856	15.914	15.973	16.032	310
320	16.032	16.091	16.150	16.209	16.268	16.327	16.387	16.446	16.505	16.564	16.624	320
330	16.624	16.683	16.742	16.802	16.861	16.921	16.980	17.040	17.100	17.159	17.219	330
340	17.219	17.279	17.339	17.399	17.458	17.518	17.578	17.638	17.698	17.759	17.819	340
350	17.819	17.879	17.939	17.999	18.060	18.120	18.180	18.241	18.301	18.362	18.422	350
360	18.422	18.483	18.543	18.604	18.665	18.725	18.786	18.847	18.908	18.969	19.030	360
370	19.030	19.091	19.152	19.213	19.274	19.335	19.396	19.457	19.518	19.579	19.641	370
380	19.641	19.702	19.763	19.825	19.886	19.947	20.009	20.070	20.132	20.193	20.255	380
390	20.255	20.317	20.378	20.440	20.502	20.563	20.625	20.687	20.748	20.810	20.872	390
°C	0	1	2	3	4	5	6	7	8	9	10	°C

HALLTRON HALL EFFECT PROBES

MODEL HR-66

SPECIFICATIONS



HALL OUTPUT (V_h), open circuit
B = 10 Kilogauss
I_c = 200 Milliamperes .... 500 millivolts ±25%

CONTROL CURRENT (I_c) .... 200 milliamperes, nominal

OHMIC RESIDUAL (V_{ro})
B = 0
I_c = 100 Milliamperes .... <0.5 millivolts, typical

INPUT RESISTANCE (R_{in}) .... approx. 5.0 ohms

OUTPUT RESISTANCE (R_{out}) .... approx. 4.0 ohms

TEMPERATURE COEFFICIENT OF V_h .... −0.2%/°C

LOAD RESISTANCE (R_L) for
OPTIMUM LINEARITY .... 15 ohms, typical

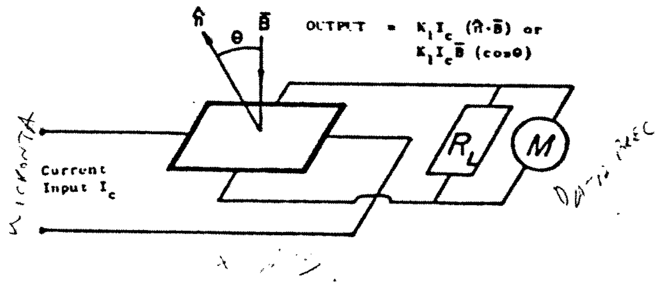
LINEARITY ERROR, PERCENT OF
FULL SCALE WITH OPTIMUM R_L .... ±1%

LEAD COLOR CODE: Input .... RED-BLACK
Output .... YELLOW-BLUE

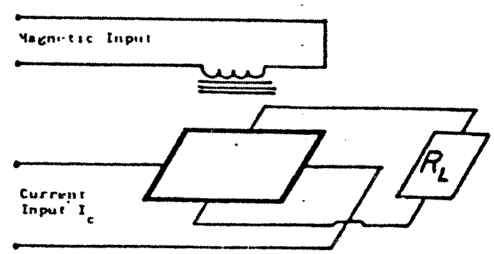
LEAD INSULATION .... Teflon

POLARITY: With positive voltage applied to the RED lead and the Halltron positioned as shown in the above illustration, a positive output will be observed on the YELLOW lead.

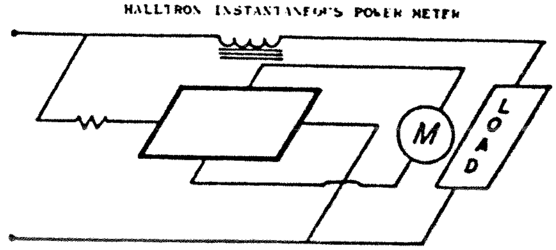
HALLTRON MAGNETIC FIELD MEASUREMENT



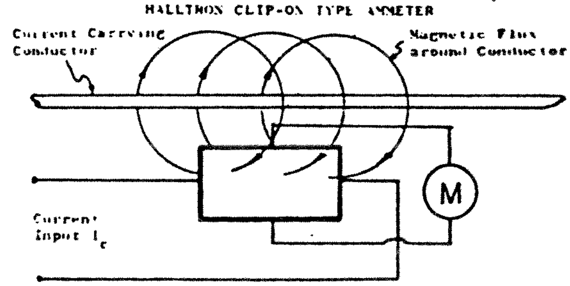
HALLTRON ELECTRONIC MULTIPLIER



HALLTRON INSTANTANEOUS POWER METER



HALLTRON CLIP-ON TYPE AMMETER



OHIO SEMITRONICS, INC.
1205 Chesapeake Avenue • Columbus, Ohio 43212 / Phone 614-486-9561

Pioneer in solid state energy conversion materials, devices and systems.

Printed in U.S.A.

PRECISION HALL-EFFECT PROBES — *MODEL* HR

HALLTRON MAGNETIC FIELD PROBE

FEATURES
- High accuracy, low noise.

APPLICATIONS
- Magnetic field sensing applications.

MODEL SELECTION

HALL OUTPUT* ±25% (mV)	NOMINAL CONTROL CURRENT Ic (mA)	MAX. OHMIC RESIDUAL (mV)		NOMINAL INPUT RESISTANCE approx. (Ω)	NOMINAL OUTPUT RESISTANCE approx. (Ω)	DIMENSIONS (INCHES)					LEAD INSULATION MATERIAL	AWG	TEMP. COEFF. % OUTPUT PER ºC (typical)	MODEL NUMBER
		FIELD=0 Ic=10mA	FIELD=0 Ic=100mA			A	B	C	D	E				
350	350		0.15	1.5	1.5	0.625	0.375	0.035	6	0.250	PVC	32	-0.10	**HR36**
200	25	0.15		10.0	10.0	0.625	0.375	0.035	6	0.250	PVC	32	-0.25	**HR38**
500	200		0.50	5.0	4.0	0.200	0.250	0.028	6	0.250	Enamel**	34	-0.15	**HR66**
340	200		0.50	2.0	2.0	0.200	0.250	0.028	6	0.250	PVC	32	-0.10	**HR70**
700	100		2.00	9.0	6.0	0.200	0.250	0.028	6	0.250	Enamel**	34	-0.25	**HR72**
550	100	0.20		10.0	10.0	0.200	0.250	0.035	6	0.250	Enamel**	34	-0.25	**HR77**
75	100		0.50	1.5	1.5	0.200	0.250	0.028	6	0.250	Enamel**	34	-0.05	**HR120**
100	100		0.50	2.5	2.0	0.200	0.250	0.028	6	0.250	Enamel**	34	-0.15	**HR125A**
10	200		0.03	1.0	1.0	0.200	0.250	0.028	6	0.250	Enamel**	34	-0.005	**HR170**

* Output specified with field strength of 10kGauss and control current as listed in table.
** Magnet wire with enamel and/or polyurethane insulation may be used.
Other sizes and configurations are available. Contact factory for details.

SPECIFICATIONS

INPUT
Magnetic Field 10kGauss

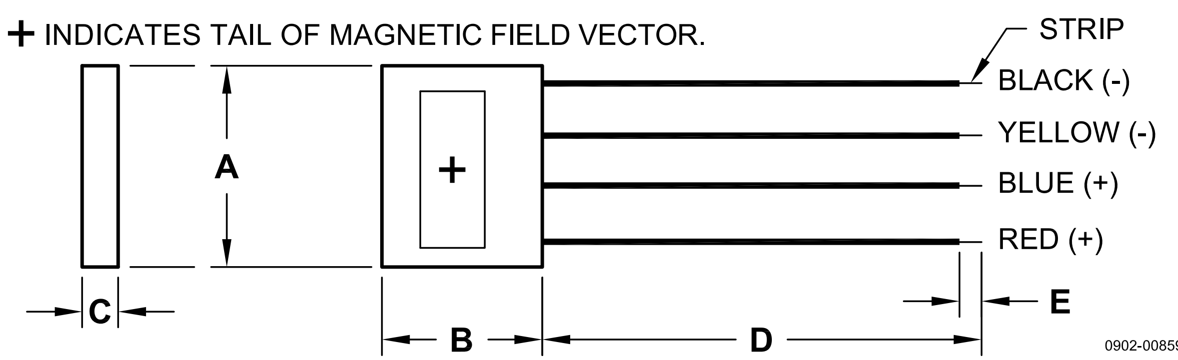
INSTRUMENT POWER
Control Current .... See Table

OUTPUT
Voltage .... See Table

TEMPERATURE
Operating Range .... -65 to 85ºC
Coefficient .... See Table

PHYSICAL
Input Leads .... Red (+), Black (-)
Output Leads .... Blue (+), Yellow (-)

DIMENSIONS



See table for length, width, and thickness dimensions.

NOTE: For HR36 and HR38 probes, the wire color order is (top to bottom) Blue, Red, Yellow, Black, where Red (+) and Black (-) are the input leads and Blue (+) and Yellow (-) are the output leads.

OHIO SEMITRONICS, INC.
4242 REYNOLDS DRIVE * HILLIARD, OHIO * 43026-1264
PHONE: (614) 777-1005 * FAX: (614) 777-4511
WWW.OHIOSEMITRONICS.COM * 1-800-537-6732