Calculating the Steinhart – Hart coefficients for temperature measurement using thermistors.

The Steinhart- Hart equation is:

$$T(°K) = \frac{1}{a_0 + a_1 \ln(R_T) + a_2 [\ln(R_T)]^3} \quad (1)$$

Using this equation the factors a0, a1, and a2 are calculated as follows for the 10K Goldline thermister. The Goldline sensor data was provided by Goldline.
Note that in the above equation the temperature in Kelvin.

Generate three equations from the above master equation as follows:

T1	=	1/(a0 + a1*ln(R1) + a2*[ln(R1)]**3	(2)
T2	=	1/(a0 + a1*ln(R2) + a2*[ln(R2)]**3	(3)
T3	=	1/(a0 + a1*ln(R3) + a2*[ln(R3)]**3	(4)

My temperature measurement range is:

15 Degrees F to 130 Degrees F

or,

-9.4 Degrees C to 54.44 Degrees C

or,

263.6 Degrees K to 327.44 Degrees K

Choosing 110 F, 50 F and 25 F as the temperatures, I get
temperature in degrees K as:

43.33 Deg C, 10 Deg C and -3.9 Deg C.

Or,

316.33 Deg K, 283.0 Deg K and 269.1 Deg K.

Resistance for:

316.33 K	is	4,664	Ohms
283.0 K	is	19,900	Ohms
269.1 K	is	39,919	Ohms

Also	ln(R1) =	ln(4664)	=	8.447
	ln(R2) =	ln(19900)	=	9.898
	ln(R3) =	ln(39919)	=	10.594

ln(R1)**3 = 602.708
ln(R2)**3 = 969.711
ln(R3)**3 = 1188.994

re-writing equations (2) – (4) in a temperature reciprocal form

1/316.33 = a0 +a1*8.447+a2*602.708
1/283 = a0 +a1*9.898+a2*969.711
1/269.1 = a0 +a1*10.594+a2*1199.004

or transposing about the = sign,

a0 +a1*8.447+a2*602.708 = 3.161E-3 (5)
a0 +a1*9.898+a2*969.711 = 3.533E-3 (6)
a0 +a1*10.594+a2*1199.004 = 3.716E-3 (7)

From equation (5) and (6)

a1(1.451)+a2(367.003)=0.372E-3 (8)

From equation (6) and (7)

a1(0.696)+a2(229.293)=0.183E-3 (9)

From(5), (8) and (9) we get the following results:

a0 = 1.133E-3
a1 = 2.334E-4
a2 = 9.056E-8

The resistance – temperature data is shown below:

First column is temperature in Fahrenheit and the second column is the resistance at that temperature.

-50	491,142
-49	472,642
-48	454,909
-47	437,907
-46	421,602
-45	405,965
-44	390,966
-43	376,577
-42	362,770
-41	349,522
-40	336,804
-39	324,597
-38	312,876
-37	301,622
-36	290,813
-35	280,433
-34	270,460
-33	260,878
-32	251,670
-31	242,821
-30	234,316
-29	226,138
-28	218,276
-27	210,716
-26	203,445
-25	196,451
-24	189,722
-23	183,248
-22	177,019
-21	171,023
-20	165,251
-19	159,696
-18	154,347
-17	149,197
-16	144,236
-15	139,458
-14	134,855
-13	130,420
-12	126,147
-11	122,030
-10	118,061
-9	114,235
-8	110,547
-7	106,991
-6	103,561
-5	100,254
-4	97,063
-3	93,986
-2	91,017

-1	88,152
0	85,387
1	82,719
2	80,142
3	77,656
4	75,255
5	72,937
6	70,698
7	68,535
8	66,447
9	64,428
10	62,479
11	60,595
12	58,774
13	57,014
14	55,313
15	53,669
16	52,078
17	50,541
18	49,054
19	47,616
20	46,225
21	44,879
22	43,577
23	42,318
24	41,099
25	39,919
26	38,777
27	37,671
28	36,601
29	35,565
30	34,561
31	33,590
32	32,648
33	31,737
34	30,853
35	29,998
36	29,169
37	28,365
38	27,587
39	26,832
40	26,100
41	25,391
42	24,704
43	24,037
44	23,391
45	22,764
46	22,156
47	21,566
48	20,993
49	20,438
50	19,900
51	19,377
52	18,870
53	18,377
54	17,899

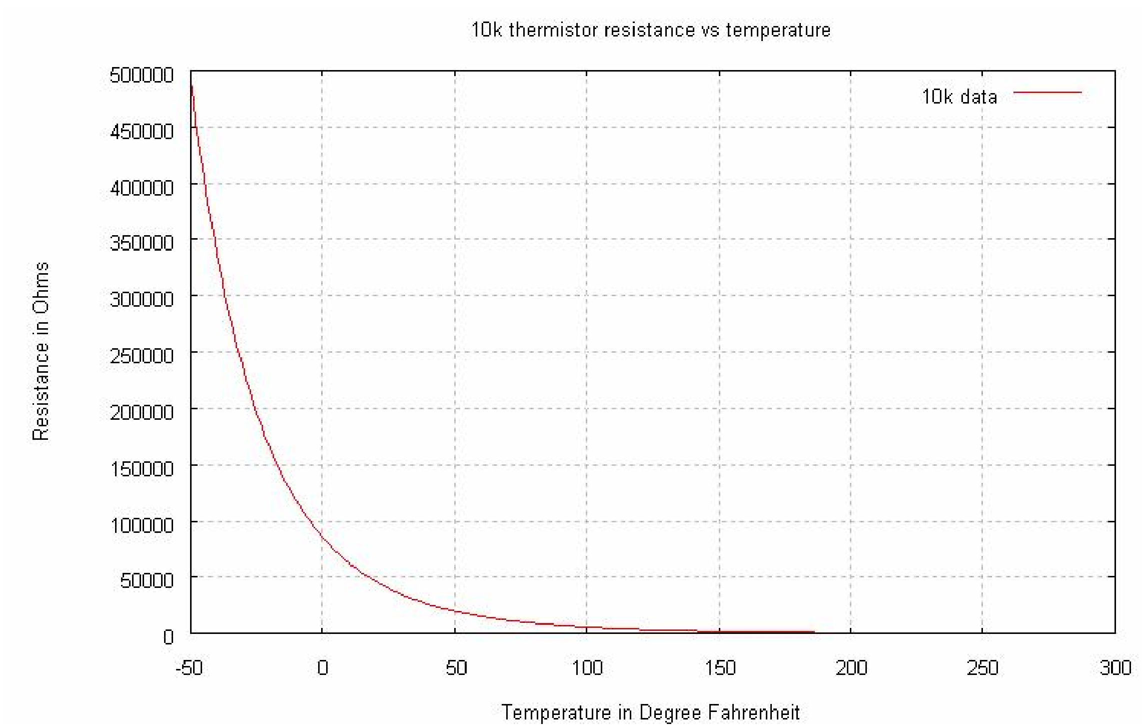
55	17,435
56	16,985
57	16,548
58	16,123
59	15,711
60	15,310
61	14,921
62	14,543
63	14,176
64	13,820
65	13,473
66	13,136
67	12,809
68	12,491
69	12,182
70	11,882
71	11,589
72	11,305
73	11,029
74	10,761
75	10,500
76	10,246
77	9,999
78	9,758
79	9,525
80	9,297
81	9,076
82	8,861
83	8,651
84	8,447
85	8,249
86	8,056
87	7,867
88	7,684
89	7,506
90	7,333
91	7,164
92	6,999
93	6,839
94	6,683
95	6,530
96	6,382
97	6,238
98	6,097
99	5,960
100	5,827
101	5,697
102	5,570
103	5,446
104	5,326
105	5,208
106	5,094
107	4,982
108	4,873
109	4,767
110	4,664
111	4,563

112	4,464
113	4,368
114	4,274
115	4,183
116	4,094
117	4,007
118	3,922
119	3,839
120	3,758
121	3,679
122	3,602
123	3,527
124	3,454
125	3,382
126	3,312
127	3,244
128	3,177
129	3,112
130	3,049
131	2,987
132	2,926
133	2,867
134	2,809
135	2,752
136	2,697
137	2,643
138	2,591
139	2,539
140	2,489
141	2,440
142	2,392
143	2,345
144	2,299
145	2,254
146	2,210
147	2,167
148	2,125
149	2,084
150	2,044
151	2,005
152	1,966
153	1,929
154	1,892
155	1,856
156	1,821
157	1,787
158	1,753
159	1,720
160	1,688
161	1,657
162	1,626
163	1,596
164	1,567
165	1,538
166	1509
167	1,482
168	1,455

169	1,428
170	1,402
171	1,377
172	1,352
173	1,328
174	1,304
175	1,281
176	1,258
177	1,235
178	1,213
179	1,192
180	1,171
181	1,150
182	1,130
183	1,110
184	1,091
185	1,072
186	1,054
187	1,035
188	1,017
189	1,000
190	983
191	966
192	950
193	933
194	918
195	902
196	887
197	872
198	857
199	843
200	829
201	815
202	802
203	788
204	775
205	763
206	750
207	738
208	726
209	714
210	702
211	691
212	680
213	669
214	658
215	648
216	637
217	627
218	617
219	607
220	598
221	588
222	579
223	570
224	561
225	553

226	544
227	536
228	527
229	519
230	511
231	503
232	496
233	488
234	481
235	473
236	466
237	459
238	452
239	445
240	439
241	432
242	426
243	420
244	413
245	407
246	401
247	395
248	390
249	384
250	378
251	373
252	367
253	362
254	357
255	352
256	347
257	342
258	337
259	332
260	327
261	323
262	318
263	314
264	309
265	305
266	301
267	296
268	292
269	288
270	284
271	280
272	276
273	273
274	269
275	265
276	262
277	258
278	255
279	251
280	248
281	244
282	241

283	238
284	235
285	232
286	229
287	225
288	223
289	220
290	217
291	214
292	211
293	208
294	206
295	203
296	200
297	198
298	195
299	193
300	190



Note this data (both tabular and graphical) is derived from a commercially available thermistor. It is also used in a Signal Processing Group Inc., system design.

Application:

Now that we know the Steinhart – Hart coefficients it is easier to measure temperature. First measure a voltage across a reference resistor (with either a reference current source or a voltage reference source with the thermistor as one part of a divider), Then use these coefficients in a calculating loop using an ADC and a microprocessor. The accuracy of the fit to the data is very, very good (much less than 1 degree). Of course some signal processing circuitry is required at the front end, such as filters and amplifiers. But the fundamental principle is as described here.