OMEGA
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CY7 Series Silicon Diodes Standard Curve #10

Technical Data

M0807/0388

STANDARD CURVE #10
Measurement Current = 10µA ±0.05%

T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)
1.40	1.69812	-13.1	16.0	1.28527	-18.6	95.0	0.98564	-2.02
1.60	1.69521	-15.9	16.5	1.27607	-18.2	100.	0.97550	-2.04
1.80	1.69177	-18.4	17.0	1.26702	-18.0	110.	0.95487	-2.08
2.00	1.68786	-20.7	17.5	1.25810	-17.7	120.	0.93383	-2.12
2.20	1.68352	-22.7	18.0	1.24928	-17.6	130.	0.91243	-2.16
2.40	1.67880	-24.4	18.5	1.24053	-17.4	140.	0.89072	-2.19
2.60	1.67376	-25.9	19.0	1.23184	-17.4	150.	0.86873	-2.21
2.80	1.66845	-27.1	19.5	1.22314	-17.4	160.	0.84650	-2.24
3.00	1.66292	-28.1	20.0	1.21440	-17.6	170.	0.82404	-2.26
3.20	1.65721	-29.0	21.0	1.19645	-18.5	180.	0.80138	-2.28
3.40	1.65134	-29.8	22.0	1.17705	-20.6	190.	0.77855	-2.29
3.60	1.64529	-30.7	23.0	1.15558	-21.7	200.	0.75554	-2.31
3.80	1.63905	-31.6	24.0	1.13598	-15.9	210.	0.73238	-2.32
4.00	1.63263	-32.7	25.0	1.12463	-7.72	220.	0.70908	-2.34
4.20	1.62602	-33.6	26.0	1.11896	-4.34	230.	0.68564	-2.35
4.40	1.61920	-34.6	27.0	1.11517	-3.34	240.	0.66208	-2.36
4.60	1.61220	-35.4	28.0	1.11212	-2.82	250.	0.63841	-2.37
4.80	1.60506	-36.0	29.0	1.10945	-2.53	260.	0.61465	-2.38
5.00	1.59782	-36.5	30.0	1.10702	-2.34	270.	0.59080	-2.39
5.50	1.57928	-37.6	32.0	1.10263	-2.08	280.	0.56690	-2.39
6.00	1.56027	-38.4	34.0	1.09864	-1.92	290.	0.54294	-2.40
6.50	1.54097	-38.7	36.0	1.09490	-1.83	300.	0.51892	-2.40
7.00	1.52166	-38.4	38.0	1.09131	-1.77	310.	0.49484	-2.41
7.50	1.50272	-37.3	40.0	1.08781	-1.74	320.	0.47069	-2,42
8.00	1.48443	-35.8	42.0	1.08436	-1.72	330.	0.44647	-2.42
8.50	1.46700	-34.0	44.0	1.08093	-1.72	340.	0.42221	-2.43
9.00	1.45048	-32.1	46.0	1.07748	-1.73	350.	0.39783	-2.44
9.50	1.43488	-30.3	48.0	1.07402	-1.74	360.	0.37337	-2.45
10.0	1.42013	-28.7	50.0	1.07053	-1.75	370.	0.34881	-2.46
10.5	1.40615	-27.2	52.0	1.06700	-1.77	380.	0.32416	-2.47
11.0	1.39287	-25.9	54.0	1.06346	-1.78	390.	0.29941	-2.48
11.5	1.38021	-24.8	56.0	1.05988	-1.79	400.	0.27456	-2.49
12.0	1.36809	-23.7	58.0	1.05629	-1.80	410.	0.24963	-2.50
12.5	1.35647	-22.8	60.0	1.05267	-1.81	420.	0.22463	-2.50
13.0	1.34530	-21.9	65.0	1.04353	-1.64	430.	0.19961	-2 50
13.5	1.33453	-21.2	70.0	1.03425	-1.87	440.	0.17464	-2.49
14.0	1.32412	-20.5	75.0	1.02482	-1.91	450.	0.14985	-2.46
14.5	1.31403	-19.9	80.0	1.01525	-1.93	460.	0.12547	-2.41
15.0	1.30422	-19.4	85.0	1.00552	-1.96	470.	0.10191	-2.30
15.5	1.29464	-18.9	90.0	0.99565	-1.99	475.	0.09062	-2.22

CONFORMANCE TO STANDARD CURVE #10

Curve Band (Suffix)	Accuracy (Tolerance)		
	2K-100K	100K-305K	305K-475K
-1 (1.4K-475K)	± 0.25K	± 0.5K	± 1K
-2 (1.4K-475K)	± 0.5K	± 1.0K	± 2.0K
-3 (1.4K-475K)	± 0.5K	± 1% of T	± 1% of T
-4 (1.4K-475K)	± 1K	± 1% of T	± 1% of T
-7 (10K-425K)	± 1.5K	± 1.5% of T	± 1.5% of T

Polynomial Representation

Curve #10 can be represented by a Polynomial equation based on the Chebychev polynomials which are described below. Four separate ranges are required to accurately describe the curve, with the parameters for these ranges given in Table 1. The polynomials represent Curve #10 on the preceding page with RMS deviations on the order of 10 inK.

The Chebychev equation is of the form:

$$T(x) = \sum_{n=0} a_n t_n(x) \qquad (1)$$

where T(x) represents the temperature in Kelvin, $t_n(x)$ is a Chebychev polynomial and a_n represents the Chebychev coefficients. The parameter x is a normalized variable given by:

$$x = \frac{(V-VL)-(VU-V)}{(VU-VL)} \qquad (2)$$

where V is the voltage and VL and VU designate the lower and upper limit of the voltage over the fit range.

The Chebychev polynomials can be generated from the recursion relation:

$$t_{n+1}(x)=2xt_n(x)-t_{n-1}(x),\ t_0(x)=1,\ t_1(x)=x. \qquad (3)$$

Alternately, these polynomials are given by:

$$t_n(x)=\cos[n \cdot \arccos(x)]. \qquad (4)$$

The use of Chebychev polynomials is no more complicated than the use of the regular power series and they offer significant advantages in the actual fitting process. The first step is to transform the measured voltage into the normalized variable using equation (2). Equation (1) is then used in combination with equation (3) or (4) to calculate the temperature. Programs 1 and 2 give sample BASIC subroutines which will take the voltage and return the temperature T calculated from Chebychev fits.The subroutines assume the values VL and VU have been input along with the degree of the fit, Ndegree. The Chebychev coefficients are also assumed to be in an array A(O), A(1) . . . , A(Ndegree).

An interesting property of the Chebychev fit is evident in the form of the Chebychev polynomial given in equation (4). No term in equation (1) will be greater than the absolute value of the coefficient. This property makes it easy to determine the contribution of each term to the temperature calculation and where to truncate the series if the full accuracy is not required.

TABLE 1. Chebychev fit coefficients

2,0 to 12,0 K

A(0)	7.556358	VL =	1.32412
A(1) =	-5.917261	VU =	1.69812
A(2) =	0.237238		
A(3) =	-0.334636		
A(4) =	-0.058642		
A(5) =	-0.019929		
A(6) =	-0.020715		
A(7) =	-0.014814		
A(8) =	-0.008789		
A(9) =	-0.008554		

12.0 to 24.5 K

A(0) =	17.304227	VL=	1.11732
A(1) =	-7.894688	VU =	1.42013
A(2) =	0.453442		
A(3) =	-0.002243		
A(4) =	0.158036		
A(5) =	-0.193093		
A(6) =	0.155717		
A(7) =	-0.085185		
A(8) =	0.078550		
A(9) =	-0.018312		
A(10) =	0.039255		

24.5 to 100.0 K

A(0) =	71.818025	VL =	0.923174
A(1) =	-53.799888	VU =	1.13935
A(2) =	1.669931		
A(3) =	2.314228		
A(4) =	1.566635		
A(5) =	0.723026		
A(6) =	-0.149503		
A(7) =	0.046876		
A(8) =	-0.388555		
A(9) =	0.056889		
A(10) =	-0.116823		
A(11) =	0.058580		

100 I0 475 K

A(0) =	287.756797	VL =	0.079767
A(1) =	-194.144823	VU =	0.999614
A(2) =	-3.837903		
A(3) =	-1.318325		
A(4) =	-0.109120		
A(5) =	-0.393265		
A(6) =	0.146911		
A(7) =	-0.111192		
A(8) =	0.028877		
A(9) =	-0.029286		
A(10) =	0.015619		

PROGRAM 1. BASIC subroutine for evaluating the temperature T from the Chebychev series using equations (1) and (3). An array Tc(Ndegree) should be dimensioned.

```
100    REM Evaluation of Chebychev series
110    X=((V-VL)-(VU-V))/(VU-VL)
120    Tc(O) = 1
130    Tc(1) = X
140    T=A(0)+A(1)*X
150    FOR I = 2 to Ndegree
160    Tc(1) = 2*X*Tc(I-1)-Tc(I-2)
170    T=T+A*(1)*Tc(1)
180    NEXT I
190    RETURN
```

PROGRAM 2. BASIC subroutine for evaluating the temperature T from the Chebychev series using equations (1) end (4). ACS is used to represent the arccosine function.

```
100    REM Evaluation of Chebychev series
110    X=((V-VL)-(VU-V))/(VU-VL)
120    T = 0
130    FOR I = 0 to Ndegree
140    T=T+A(I)*COS(I*ACS(X))
150    NEXT I
160    RETURN
```

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