Temperature Sensor Calibration Files

IMPORTANT NOTE:
While the accuracy of the calibration is at best on the order of several millikelvin, all test data are reported to double precision within the electronic files to allow the user to duplicate the curve fitting and numerical results performed by Lake Shore. This DOES NOT imply that the accuracy or resolution is measured to fifteen digits.

CALIBRATION FILE DESCRIPTIONS
All these files are in ASCII format, where SerialNumber is the serial number of the sensor.

The test data file
File name: *SerialNumber*.**DAT**

This file contains measurements of resistance or voltage and the corresponding temperatures.
The format for resistors is:

```
==============
Temperature (K)         Resistance (ohms)

D.DDDDDDDDDDDDDDESYY    D.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY    D.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY    D.DDDDDDDDDDDDDDESYY
       .                       .
       .                       .
       .                       .
==============
```

The format for diodes is:

```
==============
Temperature (K)         Voltage (volts)

D.DDDDDDDDDDDDDDESYY    D.DDDDDDD
D.DDDDDDDDDDDDDDESYY    D.DDDDDDD
       .                       .
       .                       .
       .                       .
==============
```

where:
"D" is a numeric digit
"." is the decimal point
"E" indicates exponential format
"S" indicates the sign of the exponent ("+" or "-") and
"YY" a two digit exponent.

There are three spaces between the two numbers.

The coefficient file
File name: *SerialNumber*.**COF**

This file contains the Chebychev polynomial coefficients for a curve fit allowing the user to transform sensor voltage or resistance measurements into their equivalent temperature. Consult the Calibration Report Description for information regarding converting resistances or voltages to temperature using the Chebychev polynomial and coefficients. The electronic file contains a label for each entry identifying it use for the fit. Standard fits are performed either as temperature versus voltage (diodes), temperature versus resistance, or temperature versus LOG10(resistance) depending upon the shape of the characteristic as a function of temperature.

The following is an example coefficient file for a platinum sensor:

```
==============
Number of fit ranges:          2
Fit range:                     1
Fit type for range:            LOG
Order of fit range 1:          9
Zlower for fit range 1:        -5.20725516305026E-01
Zupper for fit range 1:        1.61631713297016E+00
Lower limit for fit range 1:   0.4289
Upper limit for fit range 1:   32.8444
C(0) Equation 1:               5.35472104488059E+01
C(1) Equation 1:               4.84343274320430E+01
C(2) Equation 1:               1.78731249180996E+01
C(3) Equation 1:               6.71910632694103E+00
C(4) Equation 1:               2.24957224549801E+00
C(5) Equation 1:               6.83864572708680E-01
C(6) Equation 1:               1.64705729725070E-01
C(7) Equation 1:               2.77035831899347E-02
C(8) Equation 1:               8.54503010777701E-04
C(9) Equation 1:               -3.20164326544564E-03
FIT RANGE:                     2
Fit type for range 2:          LIN
Order of fit range 2:          5
Zlower for fit range 2:        2.632490364723370E+01
Zupper for fit range 2:        1.280000000000000E+02
Lower limit for fit range 2:   32.8444
Upper limit for fit range 2:   124.4599
C(0) Equation 1:               2.178061368696580E+02
C(1) Equation 1:               1.248272296845860E+02
C(2) Equation 1:               1.516717512664060E+00
C(3) Equation 1:               -0.123110200579409E-01
C(4) Equation 1:               3.970264241545280E-02
C(5) Equation 1:               -1.341884049509500E-03
==============
```

The calibration report for each sensor and the accompanying sheet "Calibration Report Description" give a complete description of these parameters and how to use them.

The interpolation table file
File name: *SerialNumber*.**TBL**

A table yielding resistance or voltage at predefined temperatures, generated from measurement values. In this file, each data record consists of a temperature in Kelvin, the corresponding resistance in Ohms (for resistors) or Voltage (for diodes) in volts, the corresponding sensitivity (dR/dT or dV/dT) in ohms/kelvin (for resistors) or millivolts/kelvin (for diodes). Additionally, the dimensionless sensitivity $Sd=(T/R)(dR/dT)=d(logR)/d(logT)$ is included for resistors.

The format for resistors is:

```
==============
Temp          Resistance              Sensitivity     Dimensionless
(K)           (ohms)                  (ohms/kelvin)   Sensitivity

DDD.DDD    SD.DDDDDDDDDDDDDDDESYY    SD.DDDDDESYY    SD.DDDDESYY
DDD.DDD    SD.DDDDDDDDDDDDDDDESYY    SD.DDDDDESYY    SD.DDDDESYY
DDD.DDD    SD.DDDDDDDDDDDDDDDESYY    SD.DDDDDESYY    SD.DDDDESYY
   .              .                       .                .
   .              .                       .                .
   .              .                       .                .
==============
```

The format for resistors is:

```
==============
Temp       Voltage     Sensitivity
(K)        (volts)     (millivolts/kelvin)

DDD.DDD    D.DDDDDDD    SDDDD.DDDDDESYY
DDD.DDD    D.DDDDDDD    SDDDD.DDDDDESYY
DDD.DDD    D.DDDDDDD    SDDDD.DDDDDESYY
   .           .              .
   .           .              .
   .           .              .
==============
```

where:
"D" is a numeric digit
"." is the decimal point
"E" indicates exponential format
"S" indicates the sign of the exponent ("-" or blank for "+") and
"YY" a two digit exponent.

There are three spaces between the numbers.

The cubic Spline file (some sensors only)
File name: *SerialNumber*.**SPL**

Each data record contains a temperature in Kelvin and the corresponding resistance in ohms or voltage (for diodes), and the curvature in the following format:

The format for resistors is:

```
==============
Temperature              Resistance              Curvature
(Kelvin)                 (Ohms)                  (Kelvin/ohm/ohm)

D.DDDDDDDDDDDDDDESYY      D.DDDDDDDDDDDDDDESYY     SD.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY      D.DDDDDDDDDDDDDDESYY     SD.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY      D.DDDDDDDDDDDDDDESYY     SD.DDDDDDDDDDDDDDESYY
         .                        .                        .
         .                        .                        .
         .                        .
==============
```

The format for diodes is:

```
==============
Temperature              Voltage      Curvature
(Kelvin)                 (Volts)      (Kelvin/Volt/Volt)

D.DDDDDDDDDDDDDDESYY      D.DDDDDDD    SD.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY      D.DDDDDDD    SD.DDDDDDDDDDDDDDESYY
D.DDDDDDDDDDDDDDESYY      D.DDDDDDD    SD.DDDDDDDDDDDDDDESYY
         .                   .                 .
         .                   .                 .
         .                   .                 .
==============
```

where:
"D" is a numeric digit
"." is the decimal point
"E" indicates exponential format
"S" indicates the sign of the exponent ("+" or "-") and
"YY" a two digit exponent.

There are three spaces between the two numbers.

CALCURVE FILE DESCRIPTIONS FOR USE WITH LAKE SHORE INSTRUMENTS

The data format designator tells the instrument what type of sensor is connected and how to interpret the data points.
Data Formats:
1   linear: milli-volts/kelvin (for thermocouples)
2   linear: volts/kelvin (for diodes)
3   linear: ohms/kelvin (for PTC sensors)
4   linear: log10(ohms)/kelvin (for NTC sensors)
5   not used
6   cubic-spline: volts/kelvin (for diodes)
7   cubic-spline: ohms/kelvin (for NTC and PTC sensors)

Temperature coefficient indicates whether the sensor has a positive or negative temperature coefficient
Temperature coefficient:
1   Negative
2   Positive

The .curve CalCurve file
File name: *SerialNumber*.**curve**

The .curve file format is based on the .340 file format, with added support for cubic-spline interpolation (data formats 6 and 7), first introduced with the Model 372 AC resistance bridge. Currently, the .curve format is used solely for cubic-spline curves for the Model 372 for applications where issues associated with linear interpolation must be eliminated.

An example of the .curve format for an NTC RTD:
```
==============
Sensor Model:    SensorModel
Serial Number:   SerialNumber
Data Format:     7      (Ohms/Kelvin)
Setpoint Limit:  40

Meas (ohms)      Temp (K)    Curvature
1.03599E+03      4.49833E+01 5.67302E-02
1.03839E+03      4.20281E+01 5.29252E-02
1.04117E+03      3.89903E+01 4.85267E-02
1.04436E+03      3.59496E+01 4.21426E-02
    .       .          .
    .       .          .
    .       .          .
==============
```
Note that data values are separated by a tab rather than spaces.

The .340 CalCurve file
File name: *SerialNumber*.**340**

The .340 file format is used with instruments with larger memory capacities for breakpoint tables, allowing interpolation errors to be greatly reduced in comparison to the .330 file format. The following instruments are compatible with the .340 file format: 211, 218, 224, 240, 331, 332, 335, 336, 340, 350, 370 and 372.

An example of the 340 format for diodes:
```
==============
Sensor Model:    SensorModel
Serial Number:   SerialNumber
Data Format:     2        (Volts/Kelvin)
SetPoint Limit: 325.       (Kelvin)
Temperature coefficient:  1 (Negative)
Number of Breakpoints:    28

No.    Units        Temperature (K)

  1  .464429         325.000
  2  .507562         307.000
  3  .552900         288.000
  4  .600367         268.000
  .      .              .
  .      .              .
  .      .              .
==============
```

An example of the 340 format for an NTC RTD:
```
==============
Sensor Model:    SensorModel
Serial Number:   SerialNumber
Data Format:     4        (Log Ohms/Kelvin)
SetPoint Limit: 325.       (Kelvin)
Temperature coefficient:  1 (Negative)
Number of Breakpoints:    28

No.    Units        Temperature (K)

  1  1.55143         330.333
  2  1.55601         325.000
  3  1.56134         319.000
  4  1.56633         313.500
  .      .              .
  .      .              .
  .      .              .
==============
```

The 330 CalCurve file
File name: *SerialNumber*.**330**

The .330 file format is compatible with older Lake Shore instruments that had limited memory for storing breakpoint tables. This includes the following instruments: 82C, 91C, 93C, 320, 321 and 330.

The following is an example of this file:

```
==============
Sensor Model:    MODEL
Serial Number:   SerialNumber
Interpolation Method:  Straight Line
SetPoint Limit: 325  (Kelvin)
Data Format:    2  (Volts/Kelvin)
Number of BreakPoints:  81

No.  Units     Temperature (K)

 1  0.82640      325.0
 2  0.85510      315.0
 3  0.92646      290.0
 4  0.95472      280.0
 .     .          .
 .     .          .
 .     .          .
==============
```

The 234 CalCurve files (SerialNumber.234):

The .234 file is a data file with resistance/temperature points formatted for the Lake Shore Cryotronics Model 234 transmitter. The first entry in the file is the sensor serial number. Each subsequent data record consists of LOG10(resistance) - temperature data pairs. An example of the 234 format:

```
==============
SerialNumber
0.00,325.000
0.02,325.000
0.04,325.000
0.60, 44.422
0.62, 43.194
 .       .
 .       .
 .       .
==============
```