

# The Multipoint Calibration Extension for Chart 5

Multipoint Calibration is a Chart 5 for Windows extension that allows both linear and non-linear multiple point calibrations.

Written by staff of ADInstruments.



## Introduction

Chart software records digitized voltage signals received from the PowerLab. Normally the Units Conversion feature in Chart is used to convert the raw voltage signal into the quantity that is being studied (such as force, displacement or temperature). Units Conversion is equivalent to a two point linear calibration of the signal.

Sometimes, however, you may wish to perform a linear calibration using more than two points, or to calibrate a non-linear input from a transducer. The Multipoint Calibration Extension allows you to perform online or offline, linear and non-linear corrections on any input using up to 12 standard points. Before using the extension you should be familiar with Units Conversion, as described in the *Chart User's Guide*.

This document describes Multipoint Calibration v1.0 (or later versions of 1.0 such as 1.0.1, 1.0.2 and so on), which is compatible with Chart v5.0 for Windows or later. The description may not apply in full to other versions of Multipoint Calibration.

## Installing the extension

- Download the installer (a file called MPCalibration(5)Setup.exe) from the ADInstruments web site. The installer icon (Figure 1) will appear on your desktop (or wherever else you have saved it).
- Before running the installer, ensure that you have exited Chart.
- Double-click the installer icon.
- In the Installer window (Figure 2), choose the location of the version of Chart with which you would like to use Multipoint Calibration.

Click the Install button to begin installation. A dialog box tells you when everything is installed.



Figure 1. The Multipoint Calibration installer icon.



Figure 2. The Multipoint Calibration Installer window.

The extension will be loaded automatically when you start Chart. When loaded, Multipoint Calibration adds the MP Calibration... command to each Channel Function pop-up menu. As with the other channel calculations, a tick beside the menu command indicates which calculation is active (only one can be active at a time). Calculations apply to the entire length of the channel. The unaltered signal can be retrieved by choosing No Calculation from the pop-up menu.

Uninstalling extensions when not in use can simplify the Chart interface. To uninstall

Multipoint Calibration, move the MPCalibration(5).cfwext file from the Extensions folder to the Extensions (unused) folder, both of which are in the Chart folder.

## Using the extension

This section explains how to perform multipoint calibrations using the Multipoint Calibration Extension.

You need to decide how many points are required to accurately calibrate your signal. The calibration points should span the highest and lowest signals that you expect to encounter in your experiment. Note that some calibration functions (especially polynomials) can work poorly if subsequently used with data outside the calibration region.

You should check that Units Conversion is turned off in any channel for which you wish to use Multipoint Calibration.

1. Make a recording of the transducer response to a succession of calibration standards. For example, a force transducer might have a series of known weights attached, or a pH electrode might be immersed in a series of buffer solutions of known pH. You might find it helpful to enter Chart comments containing values for the calibration standard. The resulting recording may look similar to that shown in Figure 3.

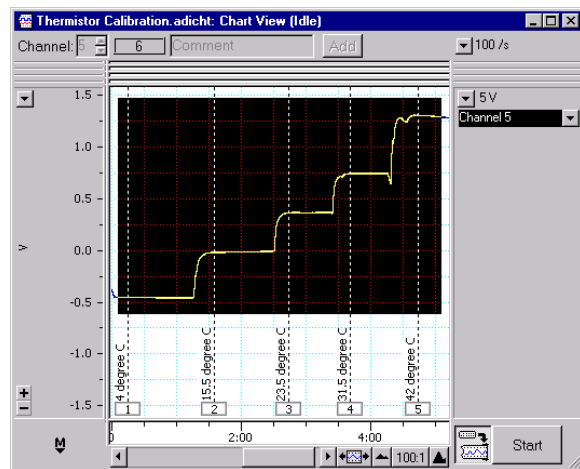


Figure 3. The transducer response to the series of calibration standards. The steps in the recording correspond to the known inputs.

2. In the Chart View, select the whole of the signal trace that includes the calibration data.
3. Choose Multipoint Calibration... from the Channel pop-up menu. The Multipoint Calibration dialog box will appear (Figure 4). Ensure that the Raw option is selected.

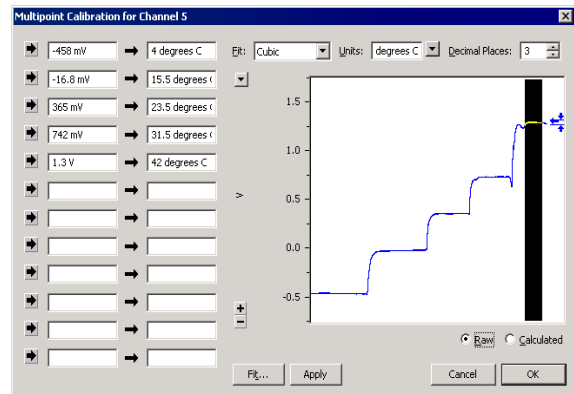


Figure 4. The Multipoint Calibration dialog box.

4. In the data display area of the dialog box, select from each calibration level in turn and enter the mean value in the left hand column by clicking the arrow button. Enter the corresponding known value in the right hand column of the Multipoint Calibration dialog box, as shown in Figure 4.
5. Select the unit name and the number of decimal places.
6. Click the Fit... button to show the Multipoint Calibration curve (Figure 5).

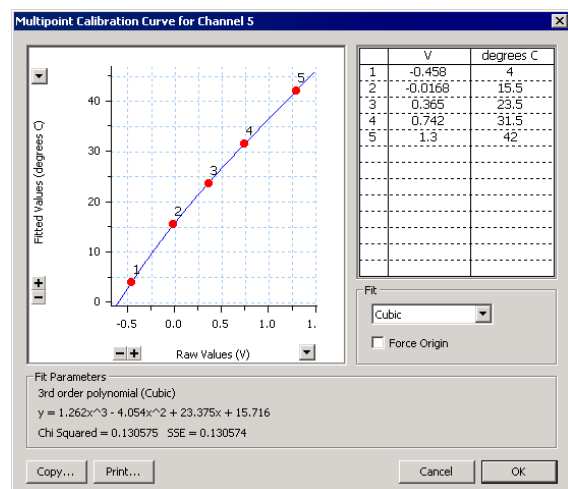


Figure 5. The Multipoint Calibration Curve.

A pop-up menu gives access to the various curve-fitting functions available. You can experiment with different functions to find the best fit to the data. Click OK to accept the fitted equation and return to the Multipoint Calibration dialog box. The calibrated values are now shown in the data display area.

- Finally, click OK to apply the calibration to the raw data. The calibrated data is displayed in the Chart View (Figure 6).

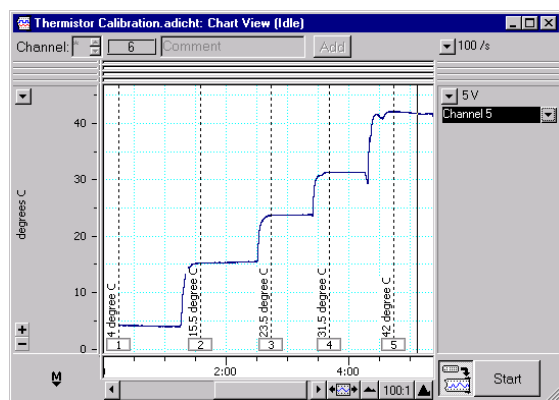


Figure 6. The Chart View showing the result of the calibration.

Different Chart channels can have different calibrations. The calibration can be altered at a later date if necessary. It can also be removed entirely by selecting No Calculation from the Channel Function pop-up menu.

Tables of calibration data are available for some transducers (such as thermocouples or thermistors). You can enter these values directly in the relevant columns in the dialog box shown in Figure 4. In this case no transducer response data needs to be recorded for the calibration process, but you should ensure that the range of a subsequently recorded signal is consistent with the range of the entered calibration points.

## Fitted functions

As each function is chosen, the corresponding equation is shown in the lower left of the Multipoint Calibration Curve dialog box (Figure 5). Chi Squared and SSE (sum of squared errors) values for the fit are also displayed. SSE is a measure of 'lack of fit'. The smaller the value the better your data is fitted by the function: a

perfect fit would produce a value of zero. Chi Squared is a measure of goodness of fit and is equal to zero for a perfect fit.

The functions (except Point to Point) are fitted by least squares to your calibration points. You can select:

- Linear:** a line  $y = ax + b$
- Quadratic:** a parabola  $y = ax^2 + bx + c$
- Cubic:** a polynomial of degree three  $y = ax^3 + bx^2 + cx + d$
- Quartic:** a polynomial of degree four  $y = ax^4 + bx^3 + cx^2 + dx + e$
- Quintic:** a polynomial of degree five  $y = ax^5 + bx^4 + cx^3 + dx^2 + ex + f$
- Logarithmic:**  $y = a \ln x + b$
- Exponential:**  $y = ae^{bx}$ . For an exponential fit, all known values (i.e. those entered in the right-hand column of the Multipoint Calibration dialog box) must be positive.
- Point to point:** linear interpolation between pairs of points. This function is used mainly for 'difficult' data, poorly fitted by other functions. The first and last line segments of the calibration graph are extrapolated to accommodate data falling outside the range of the calibration.

In addition, you can check the Force Origin checkbox (it is unchecked by default). This causes the curve of best fit to pass exactly through the origin (0,0) of the calibration graph. Force Origin should only be used if the device providing the calibration signal gives exactly a zero response when there is a zero input, otherwise it may give incorrect results.

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