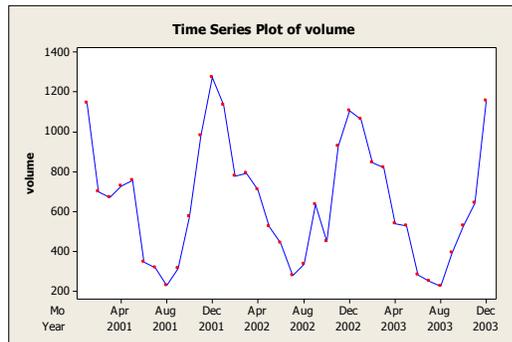


Date: March 11, 2009

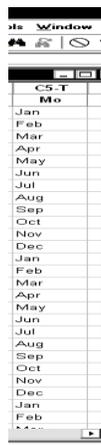
Subject: Control Charting Seasonal Data, Trending Data or Both

A. Steps to Plot Seasonal Data on a Control Chart

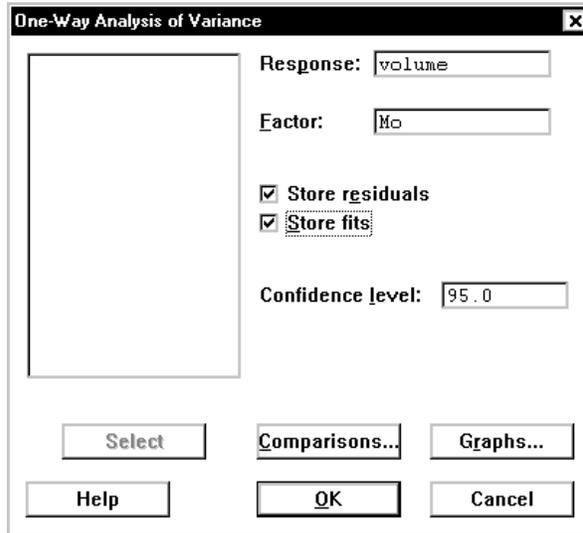
1. Have data on at least 3 repeats of the cycle. In this case the Y is Sales Volume. This data is found in the data file cycling_limits_example data.MPJ if you want to follow along in Minitab.



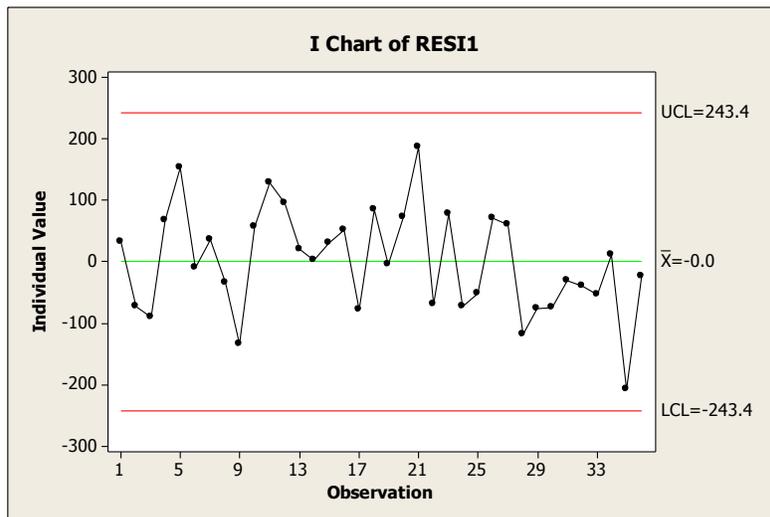
2. Make a column that identifies the week or month. In this example it is the Mo column, made with: Data > Extract from Time/Date or Calc > Make Patterned Data



- Do an ANOVA (in this case sales volume by month) and store both the fits and the residuals. The fits are the monthly averages.



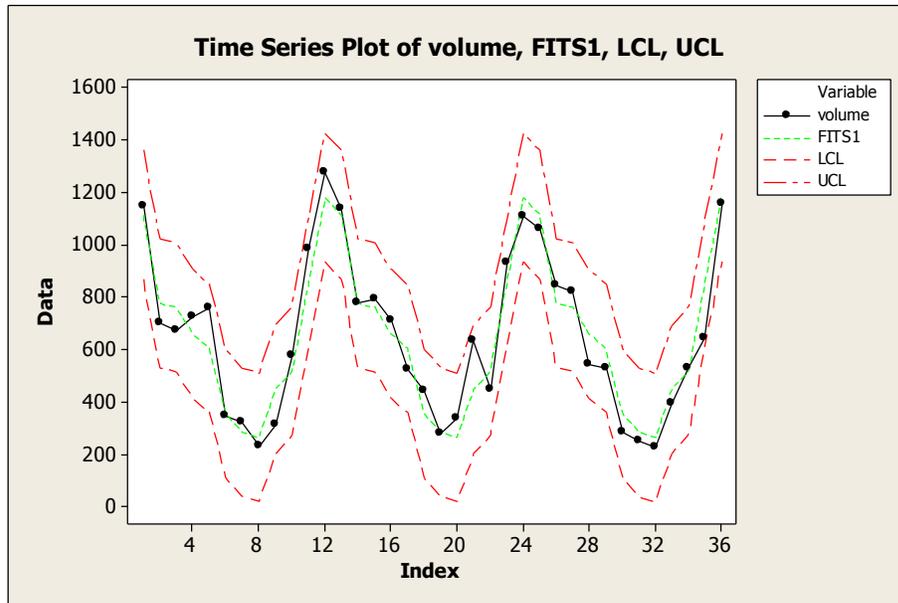
- Make an individuals control chart on the residuals from the ANOVA. All patterns of interest except that caused by the seasonal trend can be seen on this plot.



- Build UCL and LCL columns by adding and subtracting the UCL from the I chart of residuals to the stored fits. In this case:

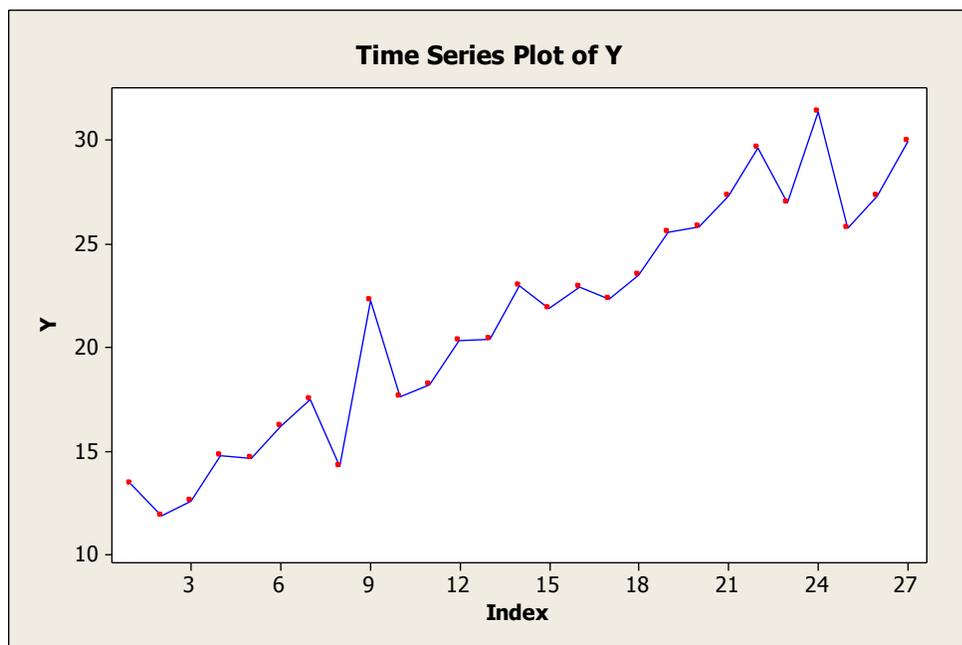
$$\begin{aligned} \text{UCL} &= \text{FITS1} + 243 \text{ and} \\ \text{LCL} &= \text{FITS1} - 243 \end{aligned}$$

- Time Series plot the data, the fits, and the UCL and LCL. Make the fitted line green, the control limits red, and remove the symbols on the lines, except for the data line.

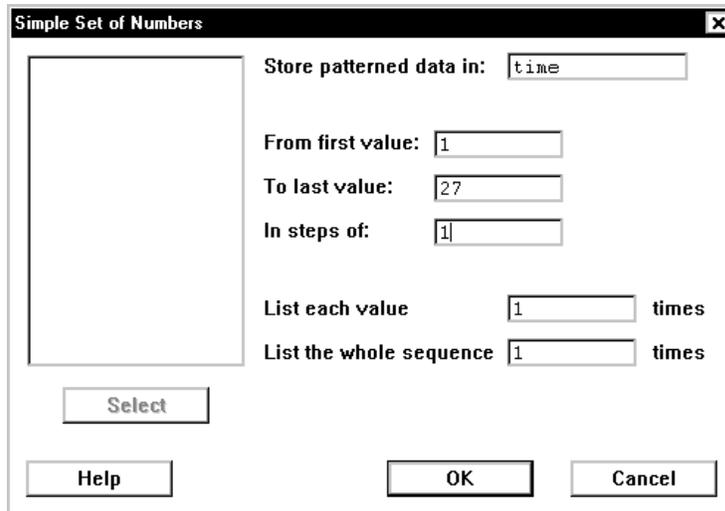


B. Steps to Plot Trending Data on a Control Chart

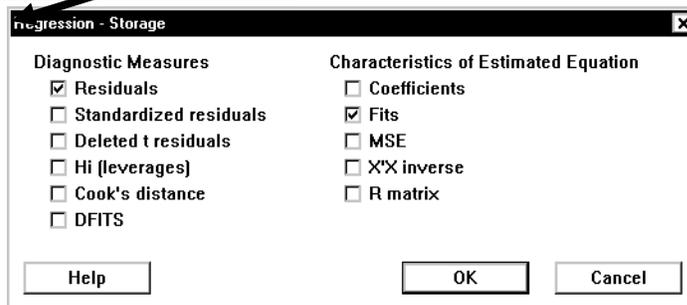
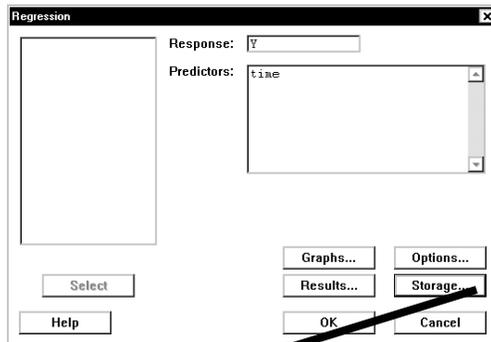
- Have enough data to visually confirm the trend on a time series plot.



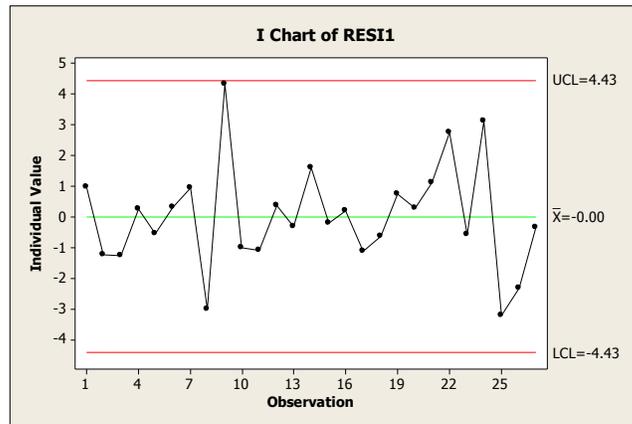
2. Make a column to represent the trend. Usually this is a column called time of 1:n, where n is the number of data points: Calc > Make Patterned Data



3. Do a regression to remove the trend (in this case regress Y on time) and store both the fits and the residuals.



4. Make an individuals chart on the residuals from the regression. All patterns of interest except that caused by the trend can be seen on this plot.

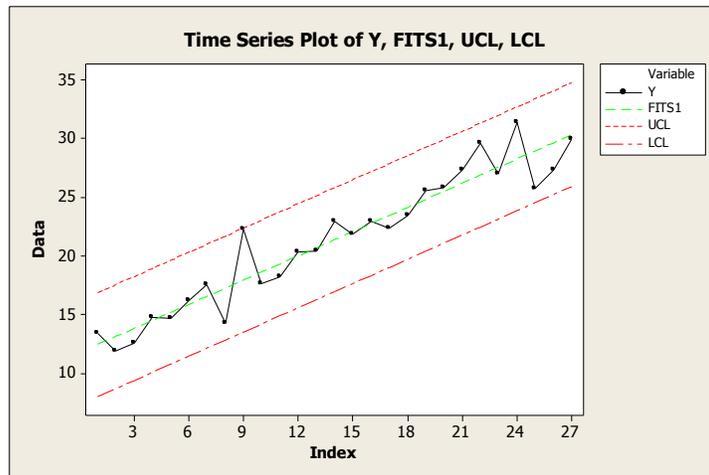


5. Build UCL and LCL columns by adding and subtracting the UCL from the I chart of residuals to the stored fits. In this case

$$UCL = FITS1 + 4.43$$

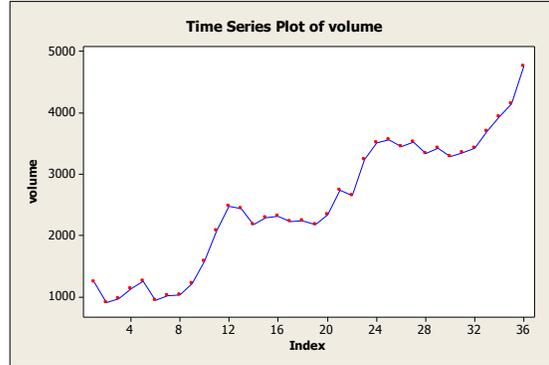
$$LCL = FITS1 - 4.43$$

6. Time Series plot the data, the fits, and the UCL and LCL. Make the fitted line green, the control limits red, and remove the symbols on the lines, except for the data line.



C. Steps to Plot Seasonal Trending Data on a Control Chart

1. Have enough data to visually confirm the trend on a time series plot. Have at least 3 seasons of data.



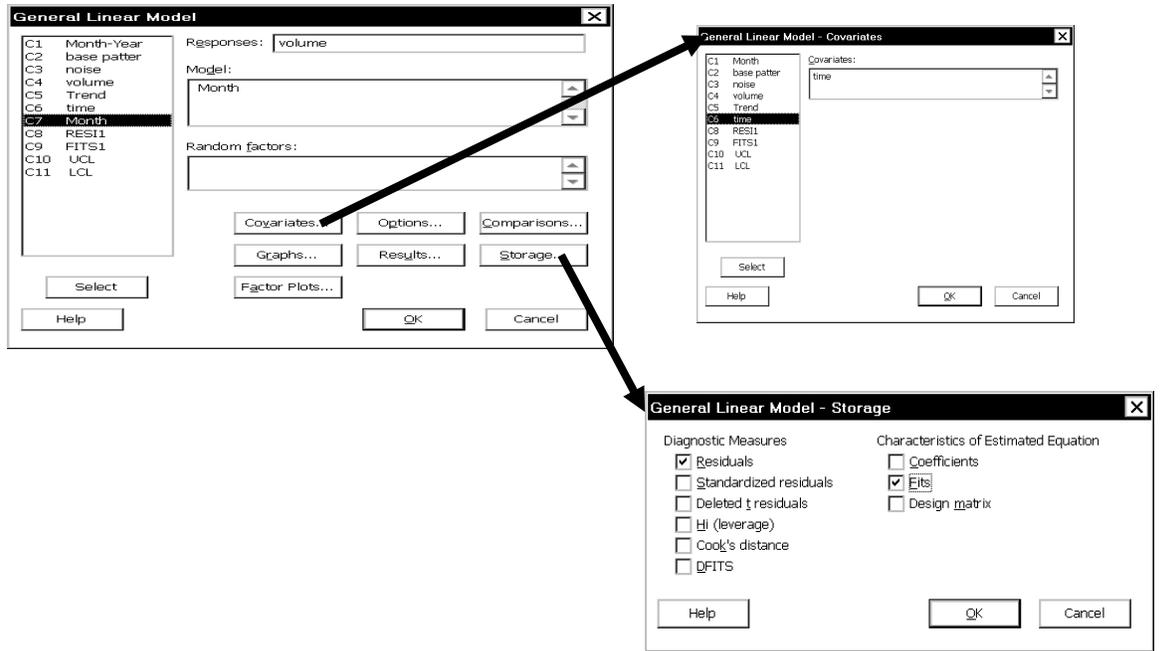
2. Make a column to represent the trend. Usually this is a column called time of 1: n, where n is the number of data points: Calc > Make Patterned Data.

Also make a column that identifies the week or month. Make with: Data > Extract from Time/Date or Calc > Make Patterned Data

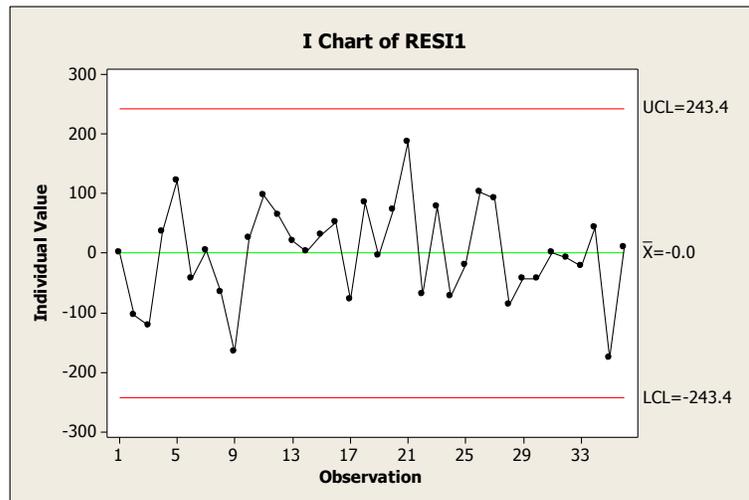
The screenshot shows a spreadsheet window titled "Seasonal and...". It displays a table with two columns: "C6" and "C7-T". The "C6" column is labeled "time" and the "C7-T" column is labeled "Mo". The data rows are numbered 1 through 14, corresponding to the indices in the time series plot. The "time" column contains dates from "1 Jan" to "14 Feb".

| | C6 | C7-T |
|----|--------|------|
| | time | Mo |
| 1 | 1 Jan | |
| 2 | 2 Feb | |
| 3 | 3 Mar | |
| 4 | 4 Apr | |
| 5 | 5 May | |
| 6 | 6 Jun | |
| 7 | 7 Jul | |
| 8 | 8 Aug | |
| 9 | 9 Sep | |
| 10 | 10 Oct | |
| 11 | 11 Nov | |
| 12 | 12 Dec | |
| 13 | 13 Jan | |
| 14 | 14 Feb | |

- Fit a general linear Model, (Stats>ANOVA> General Linear Model) with the seasonally varying column (in this case Month) as a model factor, and the trend column as a covariate. Store the fitted values and the residuals.



- Make an individuals chart on the residuals from the regression. All patterns of interest except that caused by the seasonal pattern and trend can be seen on this plot.

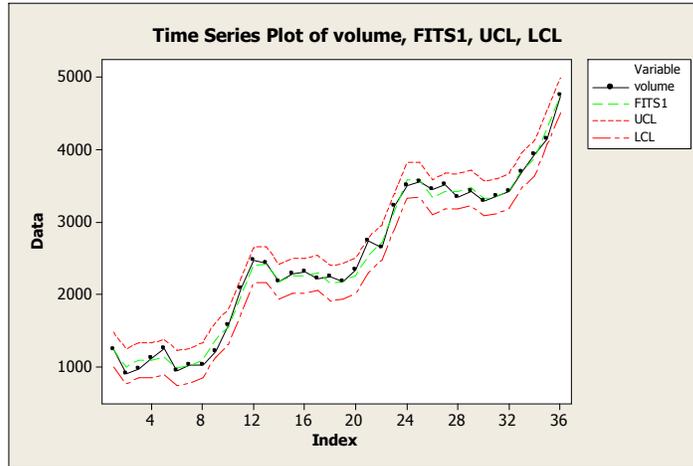


- Build UCL and LCL columns by adding and subtracting the UCL from the I chart of residuals to the stored fits. In this case:

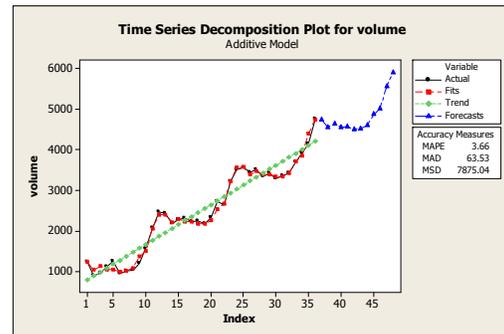
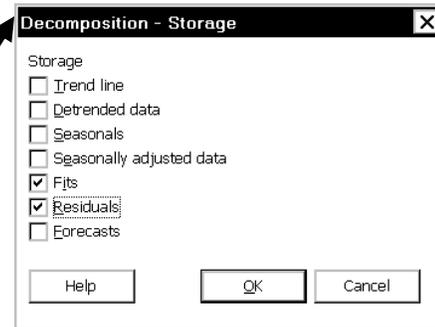
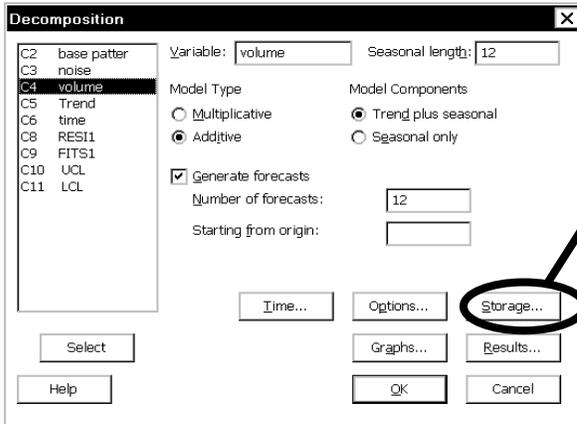
$$UCL = FITS1 + 243$$

$$LCL = FITS1 - 243$$

- Time Series plot the data, the fits, and the UCL and LCL. Make the fitted line green, the control limits red, and remove the symbols on the lines, except for the data line.



Note: an alternate approach would be to use Minitab's Time Series Decomposition. Enter the data into Stat > Time Series > Decomposition and specify the length of the seasonal pattern (in this case 12). The additive model with trend plus seasonal is equivalent to the model fit manually above. This procedure also allows for the easy generation of forecasts. If you use Storage > Residuals and Fits you can control chart the residuals and make the same plots we have constructed above.



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www.curiouscat.net/library

Control Charting Seasonal Data, Trending Data or Both

by Lynda M. Finn

www.StatisticalInsight.net

March, 2009

Address for the paper:

curiouscat.net/library/pdf/control_charting_seasonal_data.pdf

Address for the Minitab Project:

curiouscat.net/library/files/minitab_project_example_data.zip