

# Multiple control charts

Menu: QCExpert Multiple Charts

This module is used for quick diagnostics of univariate processes simultaneously by 3 different control charts. It enables the user to assess stability, process changes and outliers and to select a suitable chart type for possible further analysis of similar processes. The module offers Shewhart x-individual chart (without special causes diagnostics), autoregression (AR) control chart and dynamic one-step-ahead prediction EWMA control chart. This module is a simplified alternative to standard control.

## Data and parameters

Data are expected in columns in the data sheet. Lengths on the data columns may be different. In the *Columns* field in the dialog window (Fig. 1) select all column that are to be analyzed. Check the required chart types (any combination from *Shewhart*, *Autoregression* and *EWMA*, at least one type must be selected) and specify their parameters: *No of data for control limits*, *Order of AR* and *Exponential weight*.

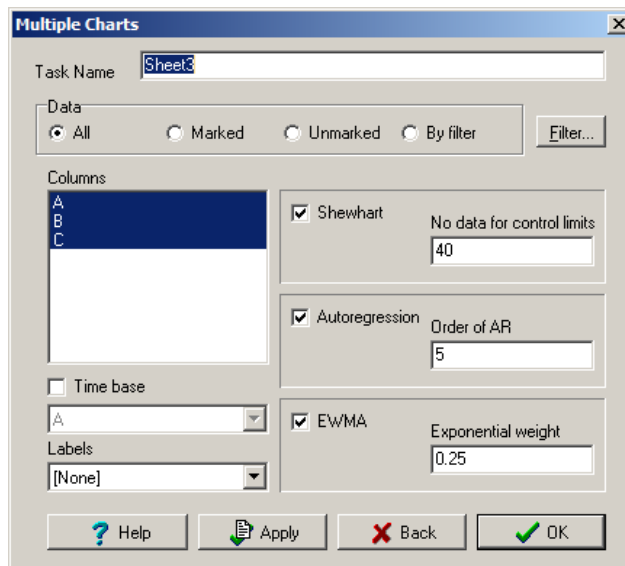


Fig. 1 Multiple Control Charts dialog window

### Chart's parameters description –

*Shewhart*: *No of data for control limits* – Number  $N_{Sh}$  of first values in a column that will be used to calculate control limits (*UCL*, *LCL*) and the central line (*CL*).

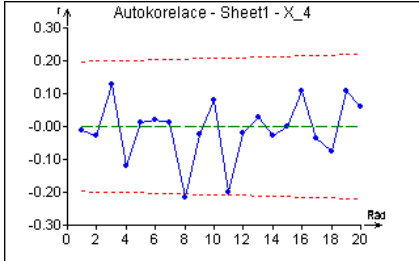
*Autoregression*: *Order of AR* – Order  $P$  of the used autoregression model  $AR(P)$ . The autoregression model coefficients are computed from all data in the respective column. Number of data rows must be at least  $P+2$ . Usual value is 2 to 10. If there is a striking significant maximum on the autocorrelation function (see the middle column on the illustration below) then the recommended value of AR order is the lag (x-value) at the first maximum.

*EWMA*: *Exponential weight* – The required value of the exponential weight  $W$ . Typical values for  $W$  are between 0.05 and 0.3.

The *Time base* checkbox allows to specify a time axis column which is then common for all columns and all plotted charts. If a column *Labels* is selected the values or test in this column is used to identify selected points in the plotted charts (as in Fig. 2).

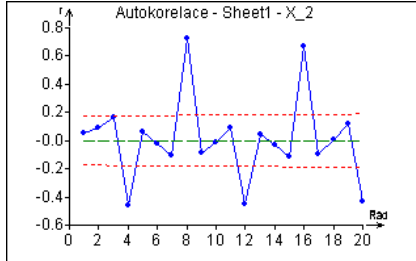
The following table is an informative guide for selecting an appropriate chart based on an autocorrelation function (ACF) available from the *Basic Statistics* module. In each column of the illustration there is a specific pattern of data possibly suitable for Shewhart, Autoregression, or EWMA control charts.

Insignificant, or slightly significant autocorrelation coefficient

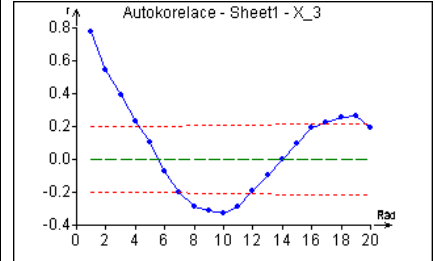


### Autocorrelation function

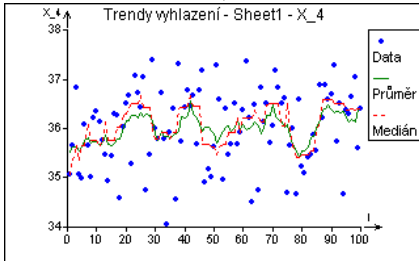
Some autocorrelation coefficients are highly significant (here, lag=8)



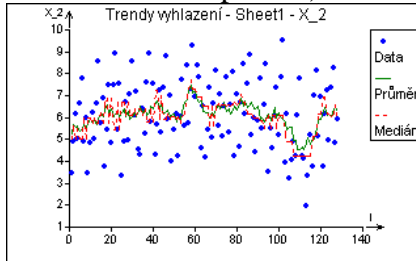
Significant first autocorrelation coefficient, slowly decreasing



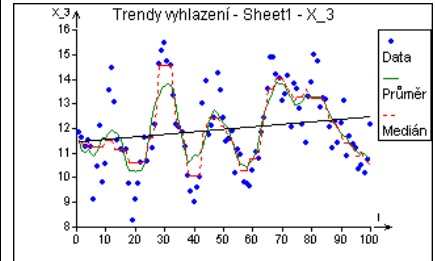
Independent randomly distributed, no trend



Regular pattern (better visible in zoomed picture)

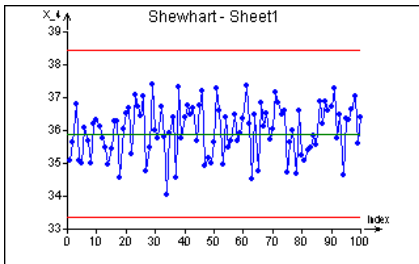


Slow, irregular oscillations and/or linear trend

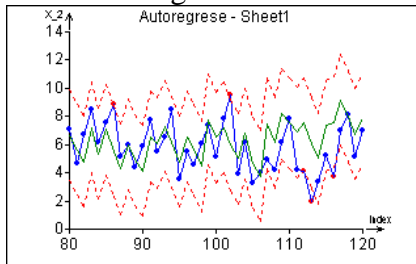


### Recommended charts

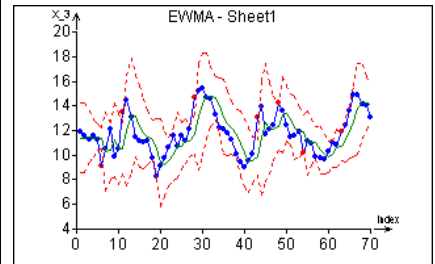
Shewhart chart

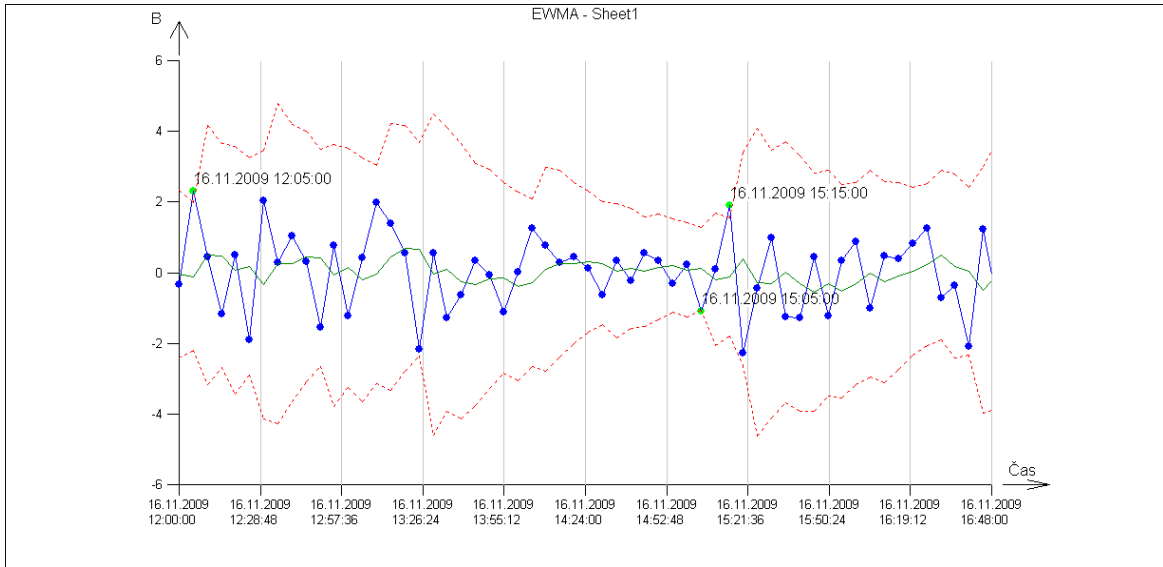


Autoregression chart



EWMA chart





**Fig. 2 Identification of selected points in the interactive plot**

***Protocol***

No text output is generated in this module.