

# Chapter 47

## Interactive Control Charts

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# Chapter 47

## Interactive Control Charts

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### Overview

This chapter discusses the following topics:

- saving graphics coordinate data from control charts for use in creating SAS/AF applications
- associating Uniform Resource Locators (URLs) with subgroups to produce “clickable” control charts in HTML

These are two approaches for creating an interactive control chart which allows an end user to “drill down” into subgroup data points, displaying information not contained in the chart itself. The end user might want to be able to click on a subgroup to

- list the individual measurements in the subgroup,
- drill down into an out-of-control point to see a Pareto chart of the most common problems affecting the process,
- view a list of recommended corrective actions, or
- trace the raw materials used to manufacture a batch of product.

This drill-down capability can be provided using a SAS/AF application or hypertext viewed with a web browser.

The options described in this chapter can be specified in all the chart statements available in the SHEWHART procedure.

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## Details

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### Saving Control Chart Graphics Coordinates

You can use the `IMAGEMAP=` data set to save coordinate information from a control chart produced by the `SHEWHART` procedure for a graphics device. The `IMAGEMAP=` data set is an extension of the `OUTTABLE=` data set, containing the subgroup summary statistics, control limits and related information found in an `OUTTABLE=` data set in addition to coordinate data. The following additional variables are saved in an `IMAGEMAP=` data set:

**Table 47.1.** `IMAGEMAP=` Data Set

| Variable              | Description   |
|-----------------------|---|
| <code>_X1_</code>     | x-coordinate of lower left corner of primary chart subgroup bounding box    |
| <code>_Y1_</code>     | y-coordinate of lower left corner of primary chart subgroup bounding box    |
| <code>_X2_</code>     | x-coordinate of upper right corner of primary chart subgroup bounding box   |
| <code>_Y2_</code>     | y-coordinate of upper right corner of primary chart subgroup bounding box   |
| <code>_Xn_</code>     | x-coordinate for point <i>n</i> of the subgroup shape                       |
| <code>_Yn_</code>     | y-coordinate for point <i>n</i> of the subgroup shape                       |
| <code>_X1_2_</code>   | x-coordinate of lower left corner of secondary chart subgroup bounding box  |
| <code>_Y1_2_</code>   | y-coordinate of lower left corner of secondary chart subgroup bounding box  |
| <code>_X2_2_</code>   | x-coordinate of upper right corner of secondary chart subgroup bounding box |
| <code>_Y2_2_</code>   | y-coordinate of upper right corner of secondary chart subgroup bounding box |
| <code>_SHAPE_</code>  | shape of primary chart subgroup bounding area                               |
| <code>_NXY_</code>    | number of points defining primary chart subgroup bounding area              |
| <code>_GRAPH_</code>  | name of primary chart graph   |
| <code>_GRAPH2_</code> | name of secondary chart graph   |
| <code>_DXMIN_</code>  | value of lowest major tick mark on horizontal axis                          |
| <code>_DXMAX_</code>  | value of highest major tick mark on horizontal axis                         |
| <code>_XMIN_</code>   | x-coordinate of lowest major tick mark on horizontal axis                   |
| <code>_XMAX_</code>   | x-coordinate of highest major tick mark on horizontal axis                  |
| <code>_DYMIN_</code>  | value of lowest major tick mark on vertical axis                            |
| <code>_DYMAX_</code>  | value of highest major tick mark on vertical axis                           |
| <code>_YMIN_</code>   | y-coordinate of lowest major tick mark on vertical axis                     |
| <code>_YMAX_</code>   | y-coordinate of highest major tick mark on vertical axis                    |
| <code>_XMIN2_</code>  | x-coordinate of lowest major tick mark on secondary chart horizontal axis   |
| <code>_XMAX2_</code>  | x-coordinate of highest major tick mark on secondary chart horizontal axis  |
| <code>_DYMIN2_</code> | value of lowest major tick mark on secondary chart vertical axis            |
| <code>_DYMAX2_</code> | value of highest major tick mark on secondary chart vertical axis           |
| <code>_YMIN2_</code>  | y-coordinate of lowest major tick mark on secondary chart vertical axis     |
| <code>_YMAX2_</code>  | y-coordinate of highest major tick mark on secondary chart vertical axis    |

You can use the coordinate data saved in an `IMAGEMAP=` data set to create a “clickable” control chart in a SAS/AF application.

The variables `_X1_`, `_Y1_`, `_X2_` and `_Y2_` contain the coordinates of the lower left and upper right corners of a rectangular *bounding box* associated with each subgroup on the primary chart. This box defines the clickable area associated with the subgroup when the graph is incorporated into a SAS/AF application. It contains the symbol used to plot the subgroup data, or the junction of line segments representing the subgroup if no plotting symbol is used.

With the `BOXCHART` statement each subgroup is plotted using a box rather than a single symbol. The subgroup’s bounding box is defined by the sides of the plotted box and its lower and upper quartiles, regardless of the `BOXSTYLE=` value in effect.

If the `STARVERTICES=` option is specified, each subgroup is represented by a polygon or star with a vertex corresponding to each of the `STARVERTICES=` variables. The clickable area for a subgroup is the polygon with these vertices, regardless of the `STARTYPE=` value specified. In the `IMAGEMAP=` data set the value of the `_SHAPE_` variable is `POLY` and the `_NXY_` variable contains the number of vertices in the polygon. `_X1_`, `_Y1_`, `_X2_` and `_Y2_` contain the coordinates of the first two vertices of a subgroup’s polygon. The variables `_Xn_` and `_Yn_`, where  $n = 3$  to the value of `_NXY_`, contain the coordinates of the remaining vertices. When the `STARVERTICES=` option is not in effect, the value of `_SHAPE_` is always `RECT` and the value of `_NXY_` is always 2.

The variables `_X1_2_`, `_Y1_2_`, `_X2_2_` and `_Y2_2_` contain coordinates of the corners of subgroup bounding boxes for a secondary chart.

When a control chart spans multiple panels (pages), the panels reside on separate SAS graphs. The `_GRAPH_` character variable records the name of the graph containing the panel on which a given subgroup is plotted. This is the same name that appears in the `PROC GREPLAY` menu. When the `SEPARATE` option is used, primary and secondary charts are on different graphs. The `_GRAPH2_` variable records the name of the graph containing the secondary chart panel where a subgroup appears. When the `SEPARATE` option is not used, the values of `_GRAPH_` and `_GRAPH2_` will be the same for a given subgroup.

The variables `_DXMIN_`, `_DXMAX_`, `_XMIN_` and `_XMAX_` provide the data values and graph coordinates associated with the lowest and highest major tick marks on the horizontal (subgroup) axis. `_DYMIN_`, `_DYMAX_`, `_YMIN_` and `_YMAX_` contain the analogous values for the vertical axis. Through a simple linear transformation in your SAS/AF application you can use this information to convert from percent screen units to “data” units and vice versa.

`_XMIN2_` and `_XMAX2_` contain the graph coordinates associated with the lowest and highest major tick marks on a secondary chart’s horizontal axis. No variables for the corresponding data values are required, since they are always identical to those for the primary chart.

`_DYMIN2_`, `_DYMAX2_`, `_YMIN2_` and `_YMAX2_` contain the data and coordinate values for the lowest and highest tick marks on the secondary chart’s vertical

axis.

A SAS/AF program receives the (x,y) coordinates for the location of the cursor when the user clicks on a subgroup data point. The application can determine whether (x,y) lies within any of the boxes whose coordinates are saved in the IMAGEMAP= data set. If so, the program can determine which subgroup was selected on the primary or secondary chart and can check the \_TESTS\_ and \_TESTS2\_ variables included in the IMAGEMAP= data set to determine whether its value is out of control or triggers one of the tests for special causes.

**Notes:**

1. Graph coordinates are scaled in percent screen units from 0 to 100, where (0,0) represents the lower-left corner of the screen and (100,100) represents the upper-right corner of the screen. Because SAS/AF applications define the origin of the vertical axis at the top of the screen, it will be necessary to subtract the y-coordinates from 100 in your SCL program.
2. The variables \_X1\_2\_, \_Y1\_2\_, \_X2\_2\_, \_Y2\_2\_, \_GRAPH2\_, \_XMIN2\_, \_XMAX2\_, \_YMIN2\_, \_YMAX2\_, \_DYMIN2\_ and \_DYMAX2\_ appear in the IMAGEMAP= data set only when a secondary chart is produced. A secondary chart is produced by the IRCHART, MRCHART, XRCHART and XSCHART statements and by the BOXCHART, MCHART and XCHART statements when the TRENDVAR= option is specified.
3. When the subgroup variable is a character variable, the value of \_DXMIN\_ is zero and the value of \_DXMAX\_ is the number of subgroups in the input data set minus one.
4. A bounding box circumscribes a point displayed on a chart and its dimensions depend on the size of the symbol marker used to display the point. If no symbol marker is specified, a small default size is used for the box. If a large number of subgroups are displayed on a panel, the subgroup symbols may overlap, so it is possible for a user to inadvertently select more than one point.

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## Associating URLs with Subgroups in HTML

You can use the Output Delivery System (ODS) to produce an HTML file containing a control chart created by the SHEWHART procedure. The HTML= option provides a way to associate Uniform Resource Locators (URLs) with subgroups plotted on a control chart. It specifies a variable in the input data set whose values provide the URLs to be associated with different subgroups. The HTML= variable can be a character variable or a numeric variable with an associated character format.

The following statements generate an  $\bar{X}$  chart that is saved to a GIF file and included in an HTML file. The formatted values of the numeric HTML= variable WEB are URLs that link subgroups in the input data set to various web pages.

```
goptions target = gif;
```

```

ods html body = "example1.html";

proc format;
  value webfmt
    1='href="http://www.sas.com/'
    2='href="http://www.sas.com/service/techsup/faq/qc/shewproc.html"'
    3='href="http://www.sas.com/rnd/app/qc.html"'
    4='href="http://www.sas.com/rnd/app/qc/qcnew.html"'
    5='href="http://www.sas.com/software/web_enablement/'
  ;

data wafers2;
  format web webfmt.;
  input batch web @;
  do i=1 to 5;
    input diamtr @;
    output;
    end;
  drop i;
cards;
1 1 35.00 34.99 34.99 34.98 35.00
2 1 35.00 34.99 34.99 34.98 35.00
3 1 34.99 34.99 35.00 34.99 35.00
4 1 35.00 35.00 34.99 34.99 35.00
5 2 35.00 34.99 34.98 34.99 35.00
6 2 34.99 34.99 35.00 35.00 35.00
7 2 35.01 34.98 35.00 35.00 34.99
8 2 35.00 35.00 34.99 34.98 34.99
9 3 34.99 34.98 34.99 35.01 35.00
10 3 34.99 35.00 35.00 34.99 35.00
11 3 35.01 35.00 35.00 34.98 34.99
12 3 34.99 34.99 35.00 34.98 35.01
13 4 35.01 34.99 34.98 34.99 34.99
14 4 35.00 35.00 34.99 35.00 34.99
15 4 34.98 35.00 34.99 35.00 34.99
16 4 34.99 35.00 35.00 35.01 35.00
17 5 34.98 34.98 34.98 34.99 34.98
18 5 35.01 35.02 35.00 34.98 35.00
19 5 34.99 34.98 35.00 34.99 34.98
20 5 34.99 35.00 35.00 34.99 34.99
;

symbol1 v=square;
proc shewhart data=wafers2;
  xchart diamtr*batch / html = ( web );
run;

ods html close;
run;

```

In this example five different URLs are each associated with a set of four subgroup values. When you view the ODS HTML output with a browser, you can click on a subgroup data point and the browser will bring up the page specified by the sub-

group's URL. These URLs happen to point to pages at SAS Institute's web site which may be of interest to SAS/QC users.

**Note:** The value of the HTML= variable must be the same for each observation belonging to a given subgroup.

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## URLS and Tests for Special Causes

The TESTURLS= data set provides a way to associate a URL with each subgroup on a control chart for which a given test for special causes is positive:

**Table 47.2.** Variables Required in a TESTURLS= Data Set

| Variable | Description                                      |
|----------|--|
| _TEST_   | test number                                      |
| _CHART_  | primary or secondary chart (1 or 2)              |
| _URL_    | URL associated with subgroups with positive test |

\_TEST\_ is a number identifying one of the standard tests for special causes (see Chapter 45, "Tests for Special Causes," on page 1863). The value of \_CHART\_ is 1 or 2, specifying whether the test applies to the primary or secondary chart. The character variable \_URL\_ contains the URL link to be associated with subgroups for which the test is positive.

The following statements create a TESTURLS= data set and an  $\bar{X}$  chart using the same DATA= data set as the previous example:

```
ods html body = "example2.html";

data testlink;
  length _URL_ $ 75;
  input _TEST_ _CHART_ _URL_;
cards;
1 1 href="http://www.sas.com/"
2 1 href="http://www.sas.com/service/techsup/faq/qc/shewproc.html"
3 1 href="http://www.sas.com/rnd/app/qc.html"
4 1 href="http://www.sas.com/rnd/app/qc/qcnew.html"
5 1 href="http://www.sas.com/software/web_enablement/"
6 1 href="http://www.sas.com/rnd/app/qc/qcspc.html"
7 1 href="http://www.sas.com/software/components/qc.html"
8 1 href="http://www.sas.com/rnd/app/qc/qcover.html"
;

symbol1 v=dot;
proc shewhart data=wafers2 testurls=testlink;
  xchart diamtr*batch / tests = 1 to 8;
run;

ods html close;
run;
```

In this example only subgroups triggering tests for special causes have URLs associated with them.

**Note:** If a TESTURLS= data set and an HTML= variable are both specified, the URL from the TESTURLS= data set is associated with any subgroup for which the test is positive.