

MASsoft *Professional* Manual Addendum: The IMP-EPD

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Welcome

The purpose of this manual is to describe certain features of the MASsoft *Professional* application when it is used with a Hidden Ion Milling Probe configured for End Point Detection.

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1 IMP-EPD software

The Hiden Ion Milling Probe End Point Detector (IMP-EPD) is controlled by MASsoft. MASsoft is a general purpose programme that can be used to control any instrument in Hiden Analytical's range of mass spectrometers.

This manual will cover those aspects of the MASsoft software relevant to its use as an endpoint detector. For information on other capabilities of MASsoft please refer to the MASsoft *Professional* User Manual reference HA-085-067.

MASsoft performs the following functions:

- Endpoint detection in conjunction with a "Template" file.
- Tuning - adjustment of the mass spectrometer electrode voltages.
- Maintenance and diagnostic functions.

This section considers the software with regard to its use as an Endpoint Detector. The other functions are described elsewhere in this manual.

1.1 Experiment files

MASsoft holds data, and the settings used to acquire the data, in files called "Experiment" files.

MASsoft Experiment files are actually sets of five files:

- The .EXP file - this is the master index file
- The .SCN file - this holds the scan structure
- The .ENV file - this holds the environment values
- The .ANN file - this holds information about view.
- The .DAT file - this holds data.

Note

ANN is an abbreviation for annotation.

MASsoft treats all five constituent files as if they were a single entity. To view data all five files are required (though the .ANN file can be re-created). When moving or copying data (e.g. for backup purposes) all five files must be moved or copied.

MASsoft does not distinguish between settings and data files. Experiment files are initially created empty, without data. Empty experiment files just contain settings but still require a .DAT file, albeit a very small one (5 bytes). Data files are Experiment files that contain data.

Any experiment file may be run, empty or with data. When the file is run the settings are sent to the control unit. The option is given to over-write the existing file or to create a new file; if a new file is created the settings are copied from the existing file.

The most convenient way to manage experiment files is to use MASsoft's File Explorer tab.

Note

The control unit used in IMP-EPD systems is a 2U high RC Interface unit. Other instruments in the Hiden range used use this or a 7U high Mass Spectrometer Interface Unit (MSIU).

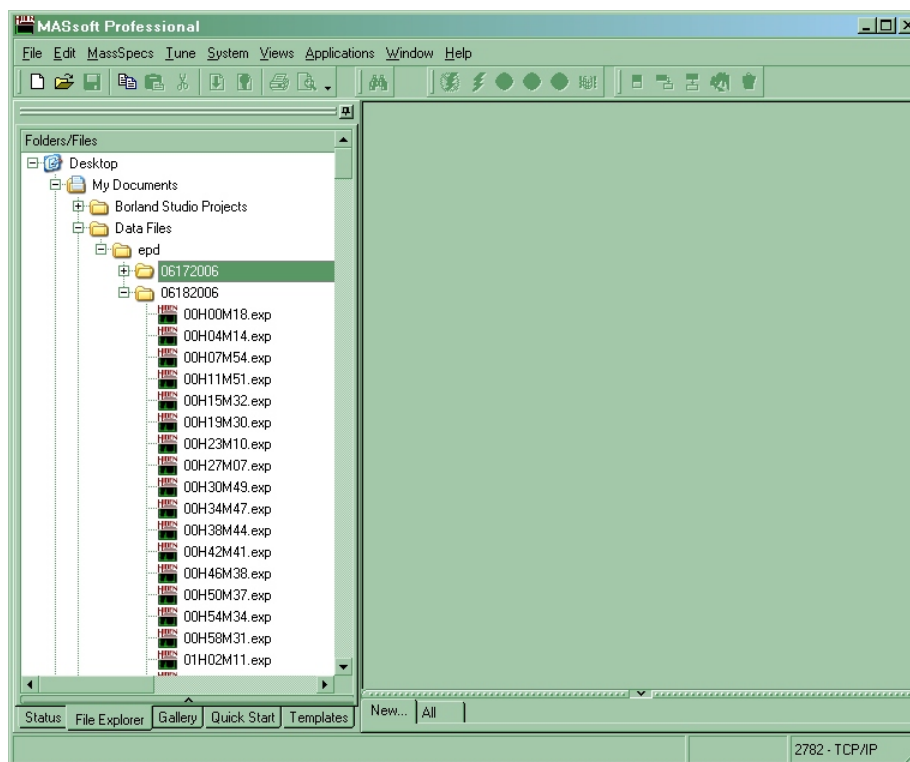


Figure 1 Typical MASsoft Professional window

MASsoft's File Explorer tab only shows the main .EXP file. Moving, copying or deleting the .EXP file also moves, copies or deletes the other constituent files. In addition the File Explorer tab treats .LOG and .CSV files with the same name as the .EXP file in the same way.

The .EXP file itself is only an index to the other files. The .EXP file (or the .DAT file) on its own is not sufficient to view the data. If data are sent all five files must be sent. If the files are to be sent by e-mail they should be compressed (into a .zip file) because some e-mail clients may embed one or more of the constituent files as a text file.

CAUTION

When sending data to Hiden please send zipped experiment files not screen shots.

Sending the zipped experiment file is preferable to sending a captured screen shot because the experiment file contains the environment settings used to acquire the data and because the full capabilities of MASsoft may be used to view the data, for example to zoom in on part of the data. Experiment files are also usually much smaller than screen shots.

1.2 Template files

An Experiment File that contains the settings required for a particular analysis is called a Template File; usually the file is saved without data.

The **Save as template** command on the File menu allows a file to be saved as a template.

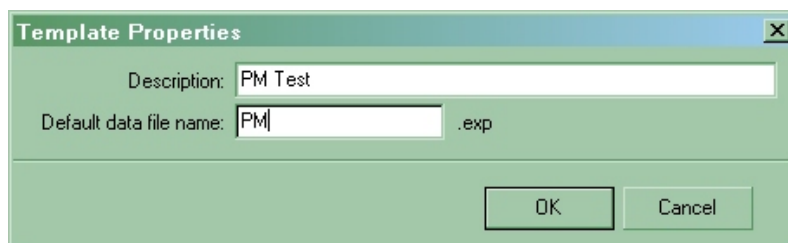


Figure 2 Template Properties dialog box

Standard template files are saved to a template folder as a combination of description and data file name.

When a template has been saved it can be run from the Template Tab.

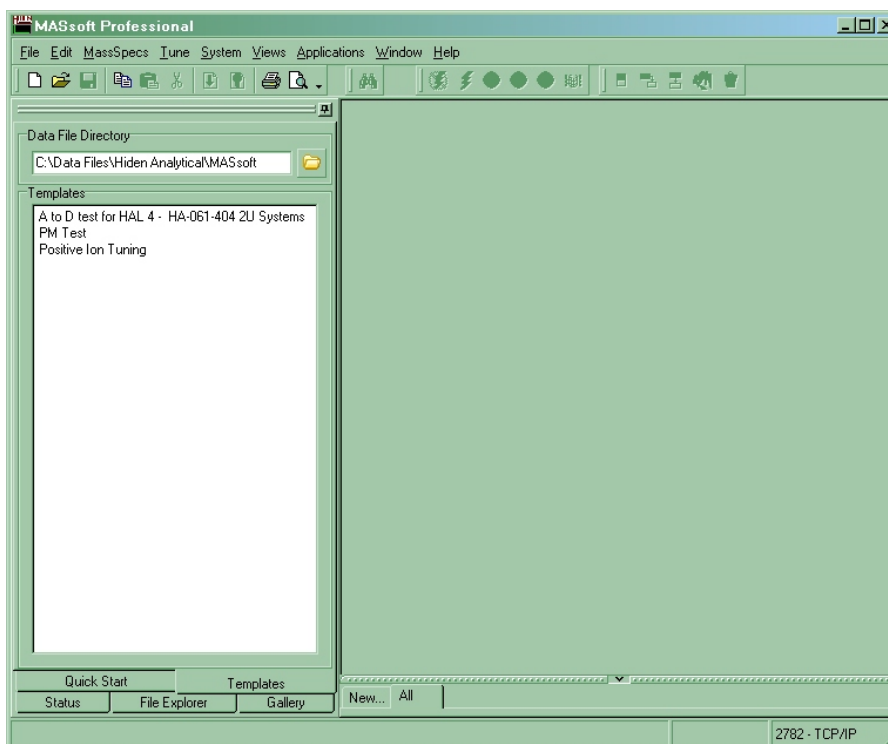


Figure 3 Template tab

Double click on the template's description to run it. A data file will be saved in the **Data File Directory**. Each run will generate a sequentially numbered file based on the **Default data file name** in the Template's properties.

1.3 EPD Template Files

An EPD Template file is an Experiment file that contains the settings, scan and control sequence needed to detect the endpoint of an etch step.

EPD Template files should be saved in a different folder from standard Template files so that they do not appear in the Templates Tab. EPD Template files are not associated with a data file name in the same way as the templates in the Templates tab.

The folder for used EPD Templates is specified by the Script Interpreter in its Experiment Parameters dialog accessed from the Preferences menu.

Do not use the **Save As Template** command to save EPD Templates. EPD Templates should be saved using the standard **Save** or **Save As** commands.

1.3.1 Overview of an EPD Template File

The Scan Tree – The Scan tree specifies the masses of the ions that are to be measured. These correspond to the materials in the wafer stack.

The Instrument Environment – Holds settings that are to be used in common by all endpoint templates (Not strictly part of the Template file).– The Instrument Environment holds the current multiplier voltage. The “tuned” values for the mass spectrometer electrode voltages are saved to the Instrument Environment after the “Autotune” procedure.

The Global Environment – Holds the settings for the endpoint method, determines when the endpoint is found. Holds any mass spectrometer electrode voltages that have been optimised for the particular wafer stack.

The Local Environment – Holds mass spectrometer electrode voltages that have been optimised for a particular ion. Use to adjust the instrument's sensitivity to a specific layer in the wafer stack.

The Event Sequence – Contains the control sequence that implements endpoint detection. The event sequence is responsible for starting and stopping the scan in response to signals from the PM. It monitors the data and signals to the PM when endpoint is found.

1.4 The Scan Tree

The IMP-EPD determines the endpoint of the etch by monitoring the secondary ions produced by the ion milling process.

The mass spectrometer monitors several secondary ions by rapidly scanning the mass filter. The display is usually set up to show an ion that characterises each layer. However, only one ion is used to determine the endpoint; a second ion is sometimes used as a reference peak.

The sequence of masses to be measured is defined in a “Scan Tree”.

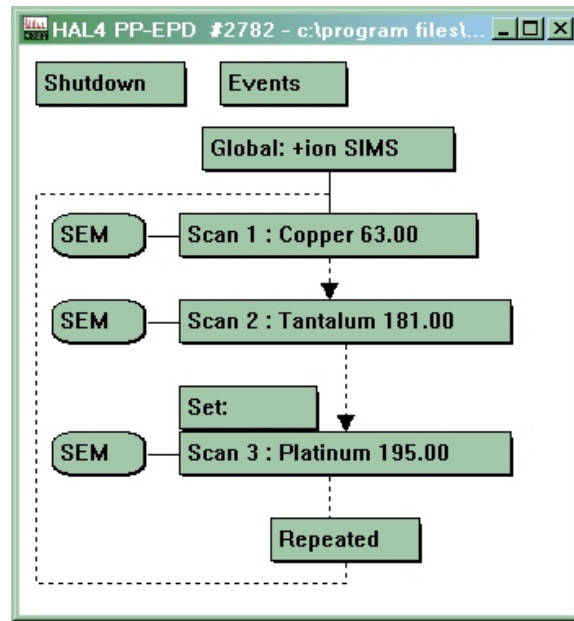


Figure 4 A scan tree

The scan in Figure 4 measures three ions, Copper at 63 amu, Tantalum at 181 amu and Platinum at 195 amu. The scan measures the three ions in sequence. First the mass filter is set to 63 amu and a measurement taken using the Pulse Ion Counting (PIC) SEM detector, then the filter is set to 181 amu and another measurement is taken using the PIC SEM detector; finally the filter is set to 195 amu and a measurement taken.

The quadrupole mass filter can only pass one mass at a time, so readings are consecutive. By default each reading takes 110ms; this value can be adjusted to take longer readings to reduce the noise on small signals, or shorter readings when monitoring ions from layers above the endpoint layer.

The Platinum scan is shown with a “Local environment” attached. This allows mass spectrometer electrode voltages that have been optimised for the measurement of platinum to be used, or for the resolution to be reduced to increase the instrument sensitivity.

When all the ions have been measured the cycle repeats itself.

As many masses as required may be added to the scan tree.

1.5 Environments

An environment is a collection of variables and device settings. These can broadly be split into two categories:

1. Analyser control variables.
 - Hardware device settings, mainly associated with power supplies that drive the electrodes of the lenses that comprise the ion optics of the analyser.
2. Endpoint detection variables.

1.5.1 Analyser control variables

The analyser control variables are grouped according to their function into five groups; Filter, Source, Quad and Detector and Other.

These are best understood in relation to the configuration of the Parallel Plate Ion Milling Probe.

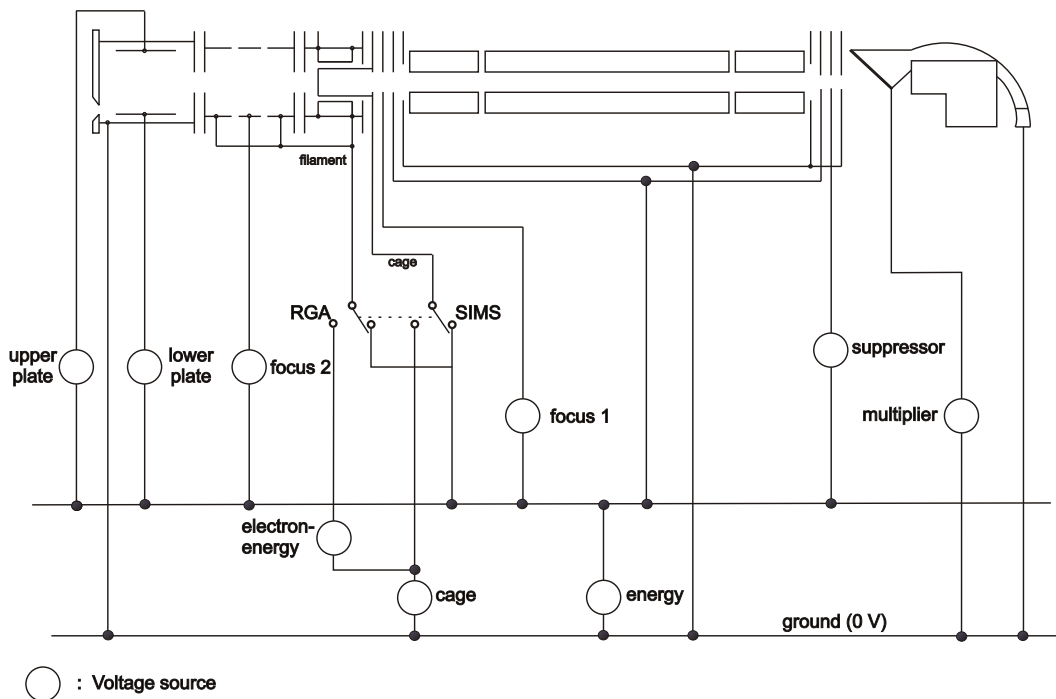


Figure 5 Voltage references

Note

Voltage references for the Bessel Box IMP are given in the Ion Milling Probes manual reference HA-085-019.

1.5.1.1 Filter group variables

- focus1** Focuses the ion source output into the quadrupole mass filter entrance aperture.
- suppressor** The main function is to stop electrons reaching the detector; it also acts as a lens, helping to focus the ion beam into the detector. The suppressor should always be set to -100V.
- focus2** Focuses the beam from the parallel plate energy filter into the ion source. A negative bias is normally applied.
- energy** Sets the axial potential of the quadrupole mass filter and defines the energy of the ion which are analysed.

upper plate
lower plate

The voltage difference between the **upper plate** and **lower plate** determines the transmission level of the probe. The lower this voltage difference the greater the energy resolution but the lower the signal level. The **upper plate** is normally positively biased with respect to **energy** in order to deflect ions towards the probe axis.

Note

*As they are positioned in front of the ionisation source, the **upper plate**, **lower plate** and **focus 2** have no effect in RGA mode.*

1.5.1.2 Source group variables

The source group contains all the parameters associated with operation in RGA mode, i.e. filament **emission**, **cage** potential and **electron-energy**.

Note

These controls have no function in SIMS mode. In SIMS mode the cage and filament are connected to the energy supply by a relay.

electron-energy Sets the energy of the electrons emitted by the ion source filament. The normal operating voltage in RGA mode is 70 V. **electron-energy** should not be set below 5 V in order to avoid filament damage.

emission The current due to electrons emitted from the filament and collected on the ion source cage mesh is set by **emission** (not shown in Figure 5). The normal operating **emission** current in RGA mode is 20uA. The filament current is controlled to ensure that this electron current is maintained.

cage During scanning, the **cage** voltage is set to the value of this variable. It determines the energy at which ions, created in the ion source (normally RGA ions), transit the mass filter.

1.5.1.3 Quad group variables

resolution Sets the analyser's high mass resolution; it is displayed on an arbitrary $\pm 100\%$ scale.

delta M Is displayed on an arbitrary $\pm 100\%$ scale; it sets the low mass resolution.

1.5.1.4 Detector group variables

CAUTION

To avoid detector damage voltages applied to the SEM detector must be selected with care.

The detector is a continuous dynode SEM.

multiplier	Sets the voltage across the SEM and consequently determines the gain of the device. multiplier should be set very carefully. If the voltage is set too high permanent damage to the SEM may result.
discriminator	Sets a voltage level on a comparator connected to the pulse amplifier. If the pulse height is more negative than the discriminator level then the pulse is counted. The discriminator level should be set below the most negative level of the background noise to prevent false counts. During normal operation it is set at -10%.

1.5.1.5 Other group variables

mass	Sets the quadrupole mass filter to allow the specified mass to be measured. Only used when the scan tree is scanning a lens other than mass. For example when auto-tuning mass is set to 63 to tune on copper.
mode-change-delay	Is the delay when switching to the current mode. In RGA mode the mode-change-delay allows the filament's emission to stabilise before starting measurements.

1.5.2 Endpoint detection variables

Endpoint detection variables are all in the endpoint group.

- %fall
- %over-etch
- falling
- initial-delay
- slope
- RPM
- Average
- Endpoint scan
- Method
- Reference scan
- Step
- Symmetry
- Warning level

- Endpoint Layer
- Limit
- Max Over Etch
- Over Etch Time

Note

The **falling** variable is retained for backward compatibility with older templates. In new templates the **method** variable is used in instead.

1.5.2.1 Endpoint group variables

Group	Use	Name	Value	Units
endpoint				
	<input checked="" type="checkbox"/>	%fall	50	%
	<input checked="" type="checkbox"/>	%over-etch	0	%
	<input checked="" type="checkbox"/>	RPM	60	RPM
	<input checked="" type="checkbox"/>	average	2	
	<input checked="" type="checkbox"/>	endpoint-layer	2	
	<input checked="" type="checkbox"/>	endpoint-scan	2	
	<input checked="" type="checkbox"/>	falling	1	(1 = on, 0 =
	<input checked="" type="checkbox"/>	initial-delay	20	s
	<input checked="" type="checkbox"/>	slope	0	
	<input checked="" type="checkbox"/>	step	3	
	<input checked="" type="checkbox"/>	symmetry	4	
	<input checked="" type="checkbox"/>	warning-level	0	c/s

Figure 6 Endpoint group variables

Rising edge variables

- initial-delay** The delay, in seconds, after the start of the run until endpoint detection is enabled. This may be used to ensure endpoint detection ignores any layers above the endpoint layer.
- slope** Minimum 'slope' value for the rising edge of the endpoint layer. This value is the minimum difference required between the signals read in the current and previous (normally 5 cycles earlier) scan cycles before a trace maximum (and, therefore, an endpoint) will be detected. A suitable value for this parameter can compensate for noise or sample rotation.
- limit** A minimum intensity limit for the endpoint layer. Signals below this level are regarded as noise or background and are not used for endpoint detection.

Falling edge variables

falling	Set true (1) if the endpoint is to be a falling edge, otherwise set false (0). Falling edge detection is recommended as it allows a level relative to the layer maximum to be used (see %fall).
%fall	Determines how far below the maximum the signal must fall before the endpoint is signalled.

Over-etch variables

over-etch-time	The time, in seconds, after the endpoint is detected before the endpoint signal is set true. Determines how long the etch continues after the endpoint.
%over-etch	Over-etch time as a percentage of the run time. This is the delay after the endpoint is detected before the endpoint signal is set true. It can compensate for varying etch rates.
max_over-etch	The maximum time, in seconds, that a percentage over-etch may take. This time will not be exceeded even if a calculated percentage over-etch time is longer.

Method variables

endpoint-scan	The mass to endpoint on.
reference-scan	The mass to use as the 100% level or calculate ratios relative to, depending on the method.
endpoint-layer	Used when there is more than one layer of an element. Specifies the layer to endpoint on.
method	Allows one template to handle multiple methods of endpointing: e.g. ratio, %fall relative to another peak

Noise reduction variables

average	Set the number of cycles of data averaged for the endpoint and reference scans.
RPM	These can be used to calculate the time required for one revolution.
symmetry	This can be used to prevent endpointing on oscillations caused by rotation and to set the dwell time to minimise the oscillations.

Other variables

warning-level	The minimum peak height for the reference and endpoint masses.
step	Used by the Script Interpreter to tell the EPD what PM Recipe step is running.

1.5.3 Modes

The IMP-EPD has three modes. Each mode has its own set of environment variables. Different values may be assigned to the analyser control variables in each mode of operation.

Shutdown	<p>In shutdown mode the lens power supplies are left in a safe state. The multiplier should be set to 0V to protect the SEM. The mass should be set to a low mass. The RGA ion-source is disabled.</p> <p>The analyser and SEM will not be damaged if the system vents in Shutdown mode.</p>
RGA	<p>Residual Gas Analysis mode is used for diagnostics and maintenance. It analyses gases in the chamber. It should not be used when the Ion Beam is on. In RGA mode the ion-source is enabled. The multiplier should be set to the present operating voltage.</p> <p>energy should be set between 0V and 0.5V. The energy may be adjusted to improve the peak shape in RGA mode. electron-energy should be set to 70V and emission to 20uA. focus1 should be set to -30V.</p>
SIMS	<p>Secondary Ion Mass Spectrometry mode is used for endpoint detection. It analyses externally produced ions. It requires the ion beam to be on, no signal will be obtained in the absence of the ion beam. The RGA ion-source is disabled.</p> <p>The multiplier operating voltage in SIMS mode should be set to the same value as in RGA mode.</p> <p>energy, upper-plate, lower-plate, focus1 and focus2 should be “tuned” for maximum signal.</p>

The endpoint detection variables are only used in SIMS mode, during endpoint detection. They only need to be defined in SIMS mode in EPD Template files.

1.5.4 The environment hierarchy

Environments exist in a hierarchy:

Instrument Environment < Global Environment < Local Environment

A value in the Global Environment takes precedence over the corresponding value in the Instrument Environment if its “Use” check box is checked in the Global Environment.

Likewise if a scan has a Local Environment then the value in the Local Environment takes precedence of the corresponding value in the Global Environment if its “Use” check box is checked in the Local Environment.

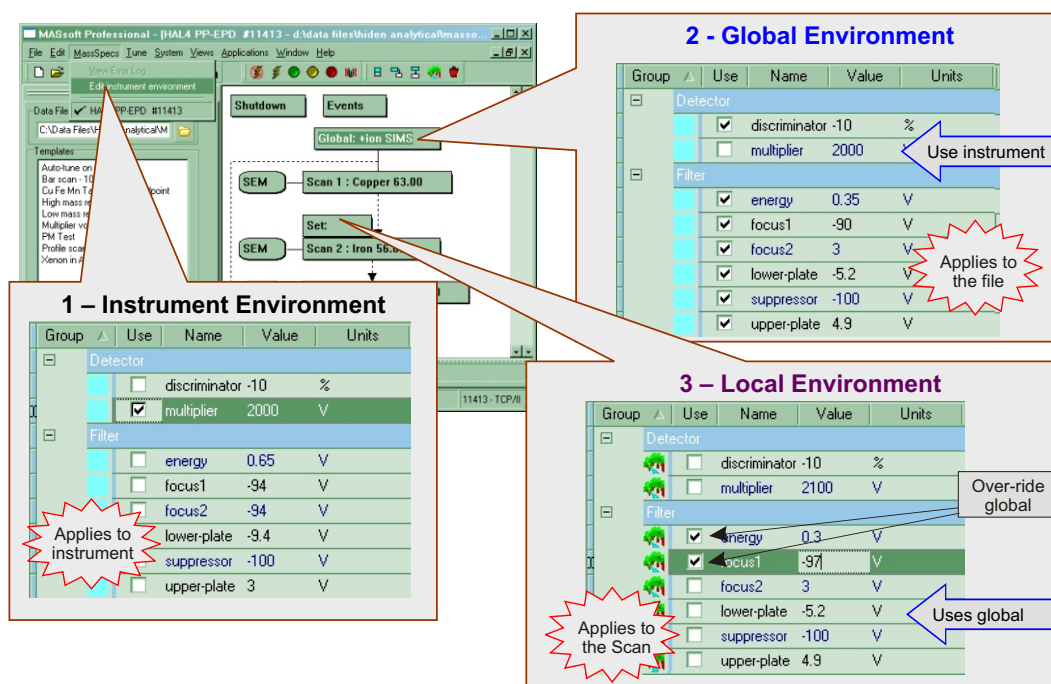


Figure 7 Environment hierarchy

The Instrument Environment

- Has values for Shutdown, RGA and SIMS modes.
- Holds settings that are specific to the instrument.
- Holds settings that are to be used in common by all endpoint templates.
- Most of the Analyser Control variables should take their values from here.
- Holds the current multiplier voltage.
- Values for Analyser Control variables are saved in the Instrument Environment after auto-tuning.

The Shutdown Environment

- Has values for Shutdown mode only.
- Settings are specific to the file.

- Will usually default to same values as in Shutdown mode in the Instrument Environment, so all “Use” checkboxes may be left unchecked.

The Global Environment

- Has values for RGA and SIMS modes.
- Settings are specific to the file.
- Default mode is defined here – should be **+ion SIMS** in an EPD Template file.
- Holds the settings for the endpoint method, determines when the endpoint is found.
- All endpoint detection variables should have their “Use” checkbox checked.
- Holds any analyser control variables that have been optimised for the particular wafer stack.
- All other analyser control variables should have their “Use” checkbox unchecked.

The Local Environment

- Settings are specific to the scan to which it is attached.
- Has values for one mode only, RGA or SIMS, depends on mode of scan – should be **+ion SIMS** in an EPD Template file.
- Holds analyser control variables that have been optimised for a particular ion.
- Must not contain any endpoint detection values. All variables in the endpoint group must have their “Use” checkbox unchecked.

2 Endpoint methods

2.1 Methods

Standard Methods	Layer Counting Methods	Layer Counting (1st layer precedes Reference Peak)	Rotation Proof Methods
1 Rising edge	11 Rising edge *	21 Rising edge#	
2	12	22	
3 Rise relative to reference	13 Rise relative to reference +	23 Rise relative to reference #	
4 Below %fall or limit	14 Below %fall or limit *	24 Below %fall or limit #	104 114 124
5 Below %fall	15 Below %fall+	25 Below %fall #	105 115 125

Method used to determine end of layer when layer counting:

* Less than % fall or limit

+ Less than %fall

less than limit

Table 1 Methods summary

The **method** endpoint variables control the way endpoints are found.

There are two basic ways of finding the endpoint:

- 1 Looking for the rising edge of a peak and finding endpoint when the signal rises above a reference level.
- 2 Looking for the falling edge of the peak and finding endpoint when the signal drops by a specified amount or below a reference level.

To these basic methods may be added.

- 1 Use of a separate reference peak to measure a reference level
- 2 Layer counting to end on the second (or later) occurrence of a layer.
- 3 Methods that are less susceptible to variation in the signal due to rotation of the wafer.

The material to endpoint on is specified by the **endpoint-scan** variable, this specifies a scan in the scan tree; the mass specified in this scan determines the ion measured.

In addition a **reference-scan** may be specified.

2.2 Rising edge methods

Method 1

Method 1 is the simplest rising edge method. Endpoint is found when the signal from the endpoint-scan exceeds the **limit** variable and the gradient exceeds the **slope** variable.

Endpoint is found when the present level – minimum level is greater than the limit value.

The minimum level is the lowest signal level of the endpoint-scan occurring after the **initial-delay** but before the peak.

The disadvantage of this method is that endpoint is set by an absolute level. It will also be susceptible to changes in peak height due to changes in etch rate or other conditions. Different levels will have to be used for unmasked qualification wafers and masked production wafers.

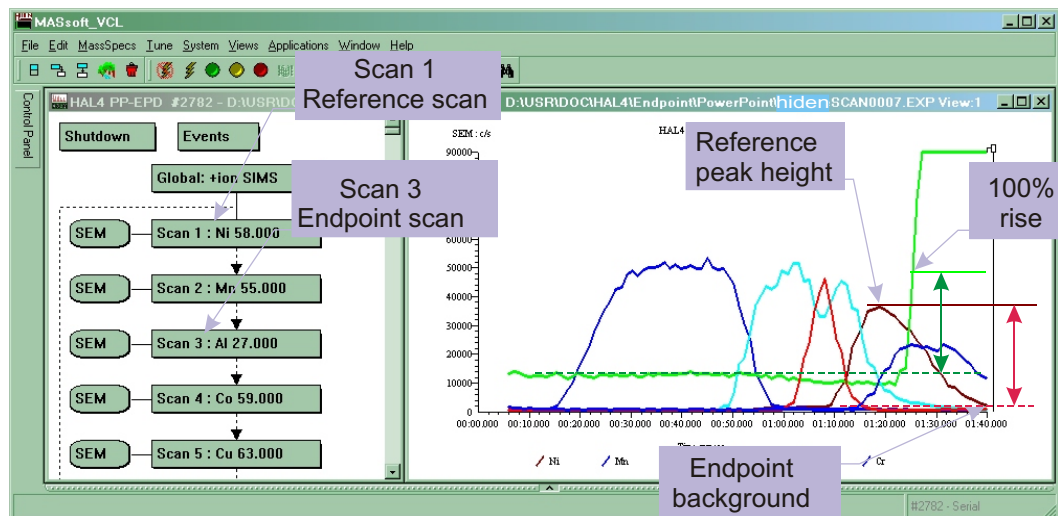
Method 2

Not implemented.

Method 3

Method 3, rising edge relative to a reference, overcomes the disadvantages of method 1.

Endpoint is found when the signal from the endpoint-scan exceeds a limit value calculated as a percentage of the height of a reference peak specified by the **reference-scan** variable.



The improved rising-edge method uses %rise above background with respect to the reference peak height.

Figure 8 Improved rising edge endpoint

The reference peak must precede the endpoint peak. The reference level is calculated as the difference between the lowest signal before the peak and the highest signal during the peak; the value may be revised upward if a later reference peak is encountered.

The **%fall** variable is applied to the reference level to calculate the endpoint level using the expression:

$$\text{Endpoint level} = \text{Reference Level} * \% \text{fall} / 100$$

Endpoint is found when the current level – minimum level is greater than the endpoint level.

2.3 Falling edge methods

Before the falling edge of a peak can be found the rising edge must be found, that is the current signal must exceed the **limit** variable and the gradient must exceed the **slope** variable.

Method 5

Method 5 is the simplest falling edge method. Endpoint is found on the falling edge of the peak when the signal from the endpoint-scan drops by the percentage specified in the **%fall** variable from its maximum value.

If no reference scan is specified the maximum level is calculated from the endpoint-scan as the difference between the lowest signal before the peak (the minimum level) and the highest signal during the peak.

The **%fall** variable is applied to the maximum level to calculate the endpoint level using the expression:

$$\text{Endpoint level} = \text{Maximum Level} * (100 - \% \text{fall}) / 100$$

Endpoint is found when the current level – minimum level is less than the endpoint level.

Thus for a 25% fall the signal has to fall below 75% of the maximum level.

Method 5 may also be used with a reference peak. In this case the endpoint level will be calculated from the reference level as defined in method 3.

$$\text{Endpoint level} = \text{Reference Level} * (100 - \% \text{fall}) / 100$$

Note

Endpoint is defined as a percentage fall from the height of the reference peak.

Method 4

Method 4 is similar to method 5, but will also find endpoint if the present level – minimum level falls below the limit.

Method 4 might be used if the %fall required is large, say 90%. If the peak does not reach this it will still endpoint if and when it falls below the limit.

Note that in methods 3, 13 and 23 the %fall is used as straight percentage of the reference level. Values greater than 100% may be used to set the endpoint level to a value higher than the reference peak.

2.4 Layer Counting

It is not uncommon for a wafer stack to have two or more layers of a material. Layer counting allows the layer to endpoint on to be specified. Methods 11 – 15 enable layer counting. The number of layers is specified by the **endpoint-layer** variable.

Each method, 1 to 5, has an equivalent layer counting method, 11 to 15.

A layer is counted when it falls back below the %fall or limit value, for exact details for each method see the method summary table.

A problem arises when using reference peaks if one or more layers precede the reference peak. In this case the reference level will be zero and the criterion of falling below the reference level will never be met. In this situation methods 21 – 25 should be used. These methods determine the end of the layer by comparing the present level with the **limit** variable instead.

Another common situation is where the endpoint material is used for both the first and last layer of the stack (e.g. Ta caps). In this case the **initial-delay** should be used to skip the first layer instead of using layer counting.

The reason for this is because the signal for the first layer begins high as soon as the shutter opens. No minimum level can be evaluated. The signal begins high and may not meet the slope criterion for a rising edge so the start of the peak is not detected.

If the scan ends without finding the expected number of layers this is recorded in the log. In this case this occurred because the second peak was too small.

2.5 Endpointing in the presence of rotational variation

Rotation of the wafer may cause the signal to vary as different areas of the mask enter the cone of acceptance; variation is also caused by rotating source magnets. Rotational variation can be minimised by ensuring that the probe is correctly aligned and that the upper and lower plate voltages are tuned to the centre of the wafer.

Use of the **RPM** and **symmetry** variables can also reduce rotational variation.

However, it may not be possible to remove the effects of rotation completely and this may affect the determination of the endpoint.

Methods 105, 115 and 125 prevent endpoint being found too soon on a falling edge by re-setting the endpoint if the signal rises back above the endpoint level during the over-etch period. The over-etch period is re-started when the signal falls below the endpoint level again; for this method to work correctly the over-etch time must be longer than the rotational period.

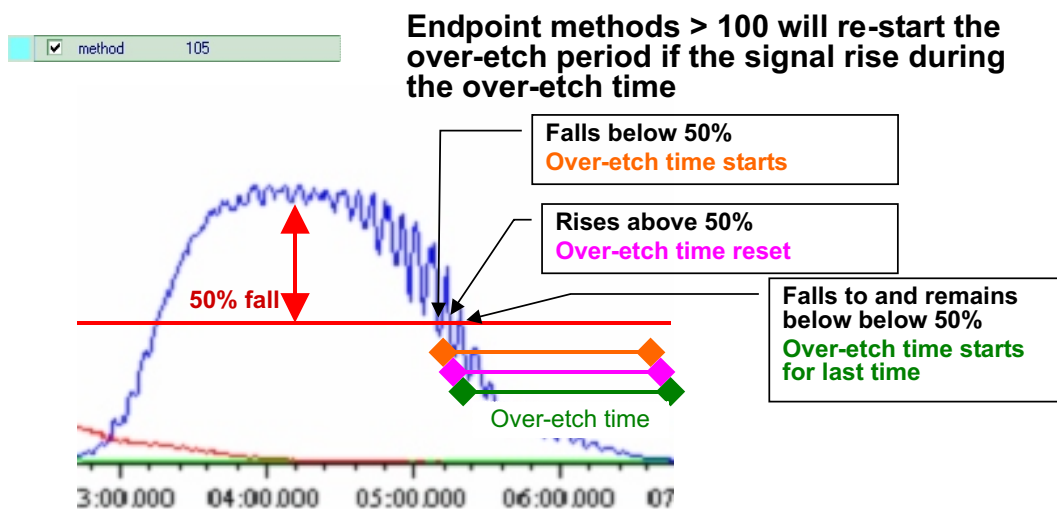


Figure 9 Reducing the effect of rotation

2.6 The chart marker

A chart marker may be added to the scan. The chart marker will indicate the point at which endpoint was detected.

The chart marker will also indicate the initial delay period, layers when layer counting and the over-etch period; the chart marker does this by using different levels.

During the initial delay the chart mark has the value 10.

At the end of the initial delay the chart mark goes to zero.

When the endpoint-scan goes above the slope and limit the chart mark goes to the value 1.

This will change to 2 or 3 immediately. Values between 2 and 7 indicate the progress of peak detection until endpoint is found.

When endpoint is found the chart mark goes to the value 15 for the duration of the over-etch period. At the end of the over-etch period the chart mark goes to the value 20, until the scan is stopped by the PM.

Chart Mark Value	Description
10	Initial delay
0	No peak
1	Signal is above limit and slope exceeded
2	Above limit
3	Above %fall and above limit
4	Below limit, above %fall
5	Below %fall and limit
6	Below %fall, above limit
7	Below limit and %fall
15	Endpoint found - overetch period started
20	Endpoint found - overetch period complete

Table 2 Chart marker descriptions

The values between 1 and 7 are best understood by reference to this sequence diagram. The branch taken depends on whether the signal level equivalent to the %fall value is above or below the limit. If the %fall level is less than the limit then the sequence will go immediately to 3 as soon as the condition for 1 is met. It will then follow the sequence 3 - 4 - 5. However usually the level for %fall will be above the limit, so the normal sequence is 2 - 3 - 6 - 7.

Peak Found States

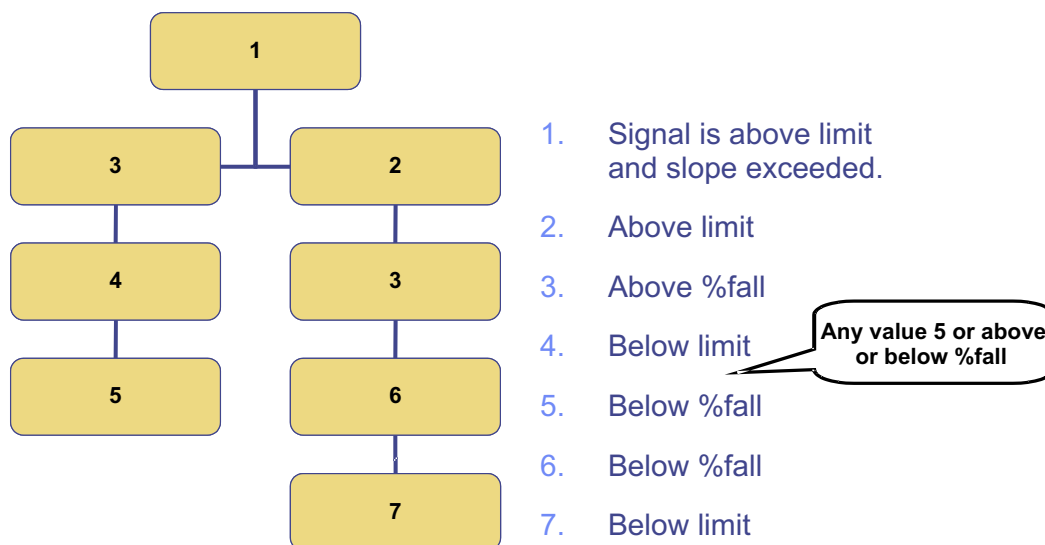
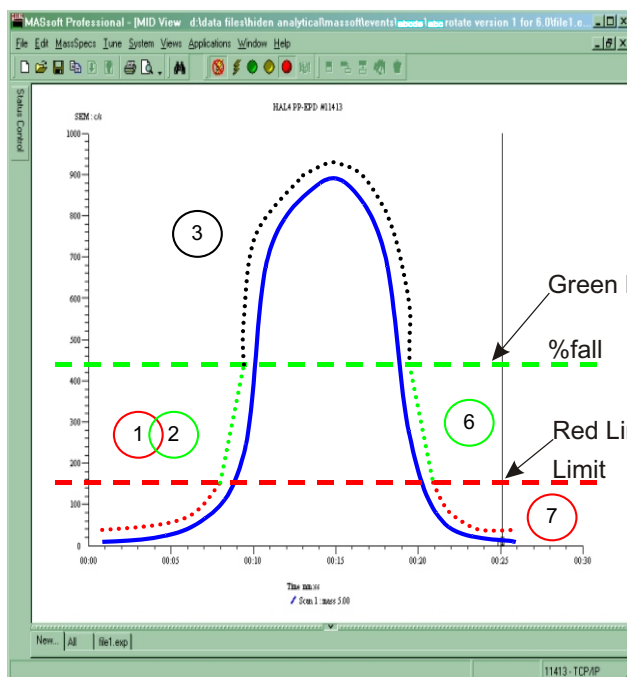


Figure 10 Peak found states

These values also correspond to the endpoint methods, because endpoint is found when the value is greater than or equal to the basic method number. For instance method 4 (or 14, 24, 104 etc.) will end when the signal drops below either the limit or the %fall level, whichever comes first. Method 5 ends when the signal drops below the %fall. Methods 6 and 7 would require the %fall level to be above the limit.

Normal sequence if the level equivalent to %fall (green line) is above the limit (red line) :

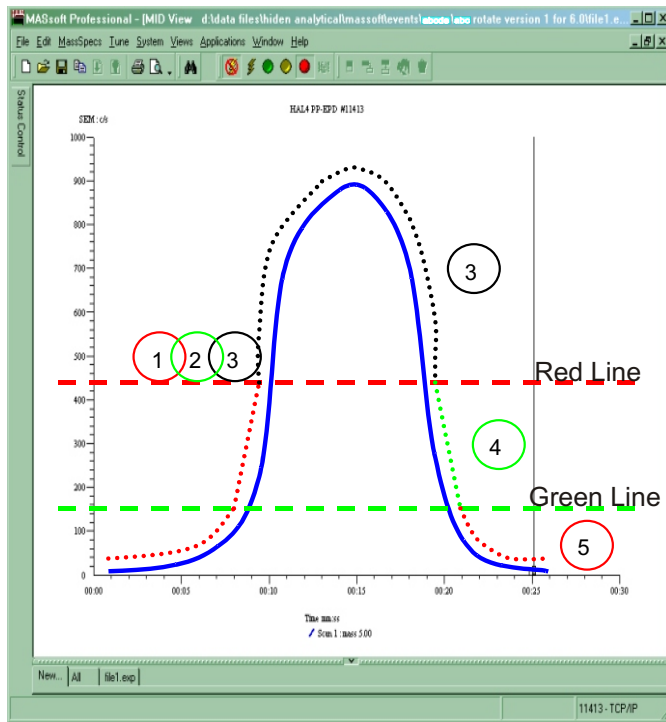


- ① Above limit, gradient above slope.
- ② Above limit
- ③ Above %fall
- ⑥ Below %fall
- ⑦ Below limit

Figure 11 %fall above limit

- 1 and 2 Above limit
- 3 Above %fall
- 6 Below %fall
- 7 Below %fall and limit

Sequence if level equivalent to %fall (green line) is below the limit (red line):



- ① Above limit, gradient above slope.
- ② Above limit
- ③ Above limit
- ④ Below limit
- ⑤ Below %fall

Figure 12 %fall below limit

- 1 and 2 Above limit
- 3 Above %fall
- 4 Below limit, Above %fall
- 5 Below limit and below %fall

2.7 Method Summary

Standard Methods	Layer Counting Methods	Layer Counting (1st layer precedes Reference Peak)	Rotation Proof Methods
1 Rising edge	11 Rising edge *	21 Rising edge#	
2	12	22	
3 Rise relative to reference	13 Rise relative to reference +	23 Rise relative to reference #	
4 Below %fall or limit	14 Below %fall or limit *	24 Below %fall or limit #	104 114 124
5 Below %fall	15 Below %fall+	25 Below %fall #	105 115 125

Table 3 Method summary

Method used to determine end of layer when layer counting:

* Less than % fall or limit

+ Less than %fall

less than limit

Method 1 – Rising edge

Endpoint found as soon a signal of endpoint-scan exceeds limit.

Method 2

Effectively identical to method 1.

Method 3 – Rising edge (Above %fall)

With no reference peak this behaves the same as method 1 (until the maximum is reached the signal is bound to be above %fall).

If a reference-scan is specified endpoint is found when the signal from the endpoint-scan exceeds the %fall percentage of the signal of the reference-scan.

Method 4 – Falling edge (Below limit or %fall)

Endpoint found when the signal from the endpoint-scan is less than limit or the endpoint-scan signal has fallen by %fall percent from its maximum.

Method 4 might be used if the %fall required is large, say 90%. If the peak does not reach this it will still endpoint if and when it falls below limit.

Method 5 – below %fall

Endpoint not found until the signal from the endpoint-scan has fallen by the %fall percentage from its maximum, even if this is below limit.

Method 5 with reference

Endpoint not found until the signal from the endpoint-scan has fallen below a level equal to %fall percent from the maximum of the signal specified by the reference-scan, even if this is below limit

Method 15 with reference and layer counting

Method 15 uses the endpoint-layer variable to specify the layer of a material to endpoint on.

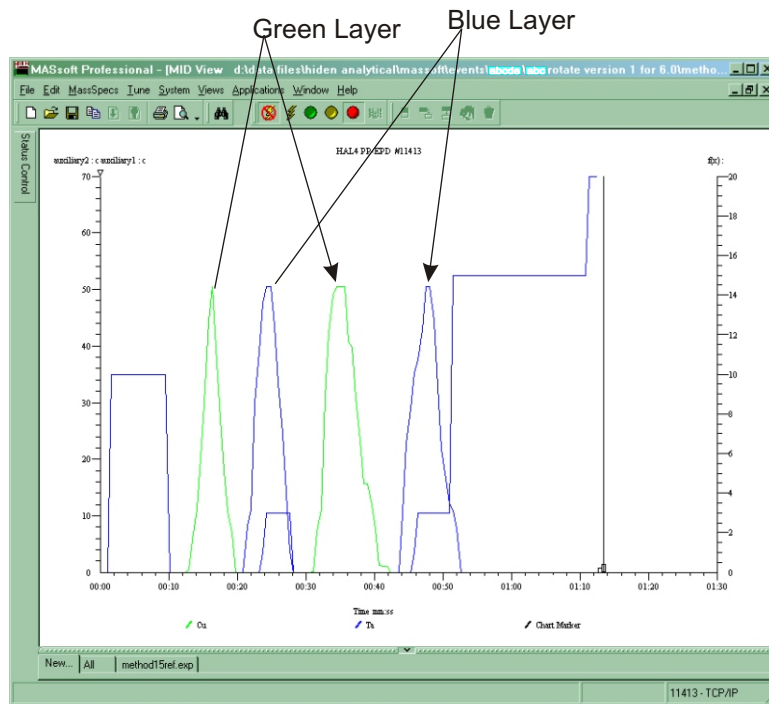


Figure 13 Method 15 endpoint

The green layer is measured by the reference-scan.

The layer counting is counting layers of the blue material so the green layers are not counted. endpoint-layer is set to 2 so the endpoint is found on the second blue peak

Note that the reference-scan layer must precede the first endpoint-scan layer for the layers to be counted correctly using method 15.

In this example the chart marker shows that the end of the first two blue peaks was not found until the green reference peak starts. As a result the two blue layers were counted as a single layer.

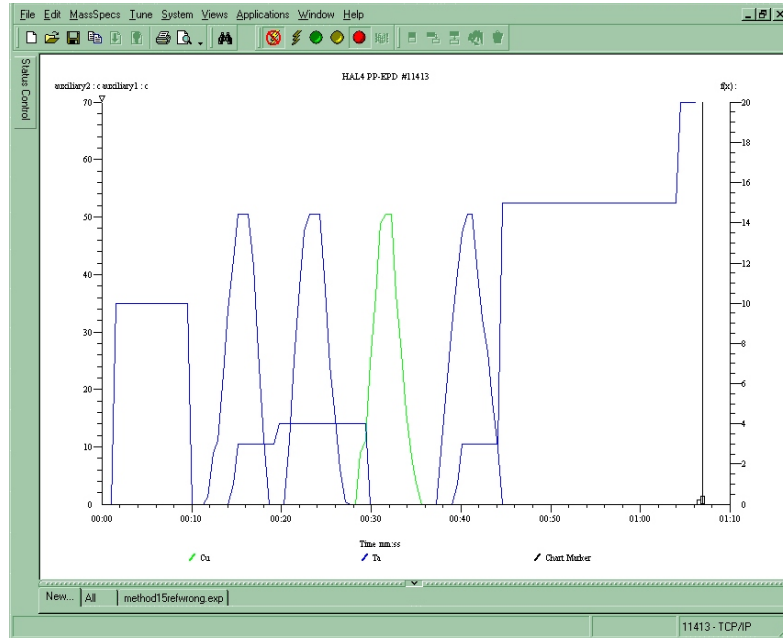


Figure 14 Using the chart marker

Using method 15 it is not possible to end the first layer using %fall if the first endpoint layer is before the reference peak; in this case method 25 should be used which finds the end of the layer using the limit value.

Method 15 with reference and layer counting

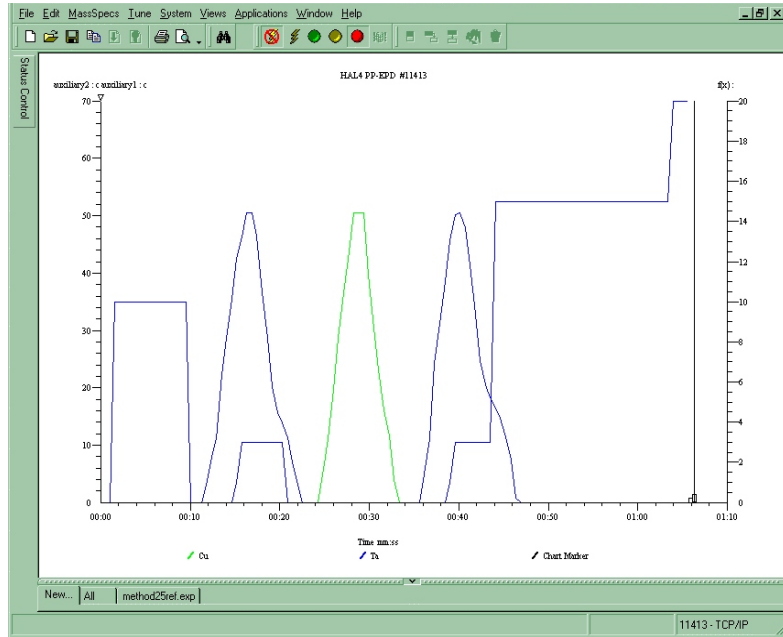


Figure 15 Method 25

In the above example using method 25 the chart mark shows that the end of the first blue layer is found when the signal drops below the limit value.

3 IMP-EPD endpoint variables

End point detection is performed by the Event Sequence.

The Event Sequence is copied from the original EPD Template file – it should not need editing.

The sequence is controlled by variables in the Global Environment.

This section covers the endpoint variables in the Global Environment and how to determine their correct values.

The correct values will be determined from data acquired by a manual etch of the wafer.

Endpoint variables are found in the endpoint group in the Global Environment.

Group	Use	Name	Value	Units
endpoint				
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	%fall	50	%
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	%over-etch	0	%
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RPM	60	RPM
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	average	2	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	endpoint-layer	2	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	endpoint-scan	2	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	falling	1	(1 = on, 0 =
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	initial-delay	20	s
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	slope	0	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	step	3	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	symmetry	4	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	warning-level	0	c/s

Figure 16 Endpoint group variables

Values for endpoint variables should be set in +ion SIMS mode only, values for other modes and Shutdown are not used.

Do not set endpoint values in Local Environments. All the values in the endpoint group in a Local Environment must have their “Use” checkbox un-checked.

3.1 Determining the endpoint variables

To generate the Endpoint variables, run a template file manually, (see Section 4.5), on a test wafer etch. If an unmasked qualification wafer is run then the values for the limit, slope and warning-level variables will have to be adjusted to those expected for a masked production wafer.

Open the test wafer etch file using the File, Open command. Use MASsoft’s data manipulation facilities to examine the data and derive values described in the following sections.

3.2 Method variables

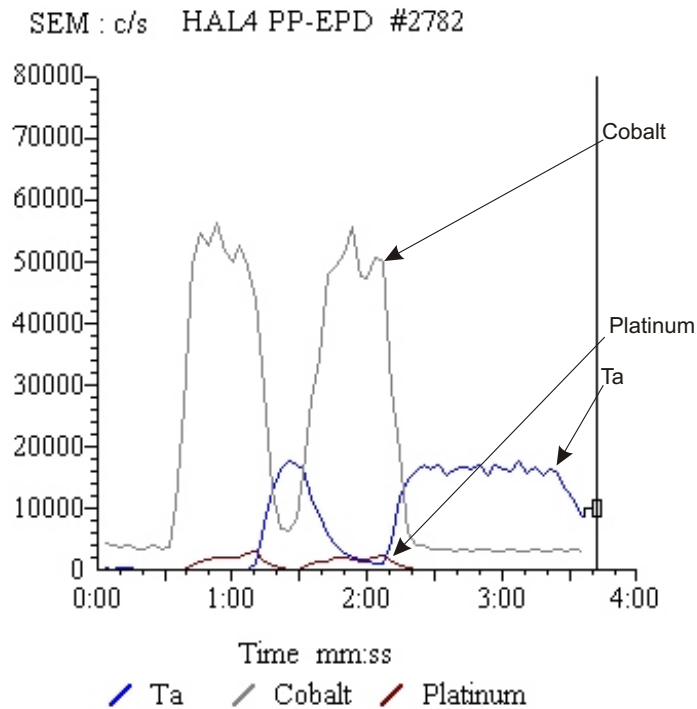


Figure 17 Method variables

- Examine the data to determine the desired endpoint. In the scan shown in Figure 17 it might be at the second Co / Ta interface.
- Decide whether to use a rising or falling edge as the endpoint. In the above example this would be the falling edge of Co or the rising edge of Ta. The advantage of the falling edge is that it is relative to the maximum peak height so does not change as the system sensitivity changes.
- Choose the basic endpoint method, 1 for rising edge, 5 for falling edge.
- With reference to the scan tree, the endpoint-scan will depend on the layer being endpointed on. In the above example it would be scan 2 if ending on the rising edge of Ta or scan 3 if ending on the falling edge of Co (Scan 1 is used for the chart mark).
- If using the rising edge consider using a reference scan so that the endpoint does not vary with system sensitivity. In the above example Co or Pt could be the reference scan. Using the larger signal would mean ending on 15% of the Co peak (55,000 c/s) to stop half way up the Ta peak (17,000 c/s).
- If there is more than one layer of the endpoint material then use the endpoint-layer to specify which layer to end on. In the above example the endpoint-layer should be set to 2 to end on the second Co or Ta layer. If ending on the rising edge of Pt and using Co as the reference peak then use method 11, because the first Pt layer is preceded by a Co layer and so can use the same end criteria as the endpoint. If the first Co layer were absent method 21 would be used so that the end of the first peak was determined by the **limit** variable.

method

Set this to the desired endpoint method. See Section 2.

endpoint-scan

Set this to the scan number of the scan that measures the endpoint material.

reference-scan

Set **reference-scan** to 0 if no reference peak is required.

Set this to the scan number of the scan that measures the reference peak.

endpoint-layer

Used with methods 11-15 and 21-25. Specifies which layer to endpoint on when there is more than one layer of the material specified by the endpoint-scan.

Notes

1. *Only layers of the material specified by the endpoint-scan are counted.*
2. *Use the initial-delay to skip the layer if the material specified by the endpoint-scan is the first layer in the stack.*

falling

Retained to support older template files.

Only used by method 0.

For a rising edge endpoint use method 0 with falling set to 0, this is equivalent to method 1.

For a falling edge endpoint use method 0 with falling set to 1, this is equivalent to method 5.

3.3 Rising edge variables

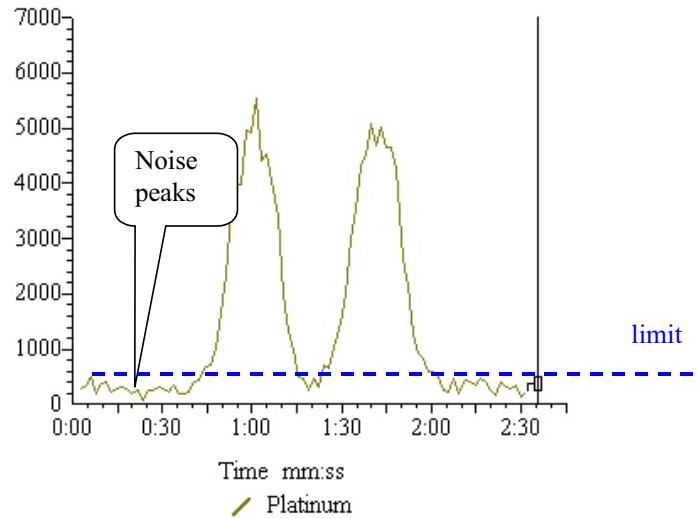
The rising edge variables are used to detect endpoint on a rising edge endpoint and to detect the beginning of a peak on a falling edge endpoint.

Endpoint will not be found if the peak does not meet these endpoint criteria.

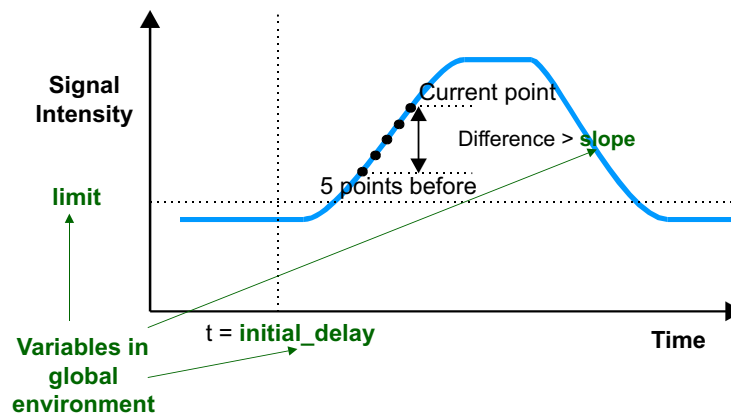
initial-delay

Set this to avoid the burst of signal that occurs after the shutter has opened.

If the first layer of the wafer is of the same material as the endpoint layer use the initial delay to avoiding finding endpoint on this layer.

limit**Figure 18 Limit variable**

The slope and limit variables must be set so that the endpoint is not found on small noise peaks on the background signal at the start of the scan. The limit should be set just above the amplitude of the noise.

slope**Figure 19 Endpoint control, rising edge**

This parameter may be set to avoid noise or signal variation causing a false endpoint. In most cases this variable may be set to zero.

If the slope is set to zero endpoint may be found after any rising edge. When slope is zero the actual measured slope at the point where the limit is exceeded is written to the log at the end of the scan.

Alternatively, the test etch file may be examined to establish an average slope per cycle on the rising edge of the endpoint layer.

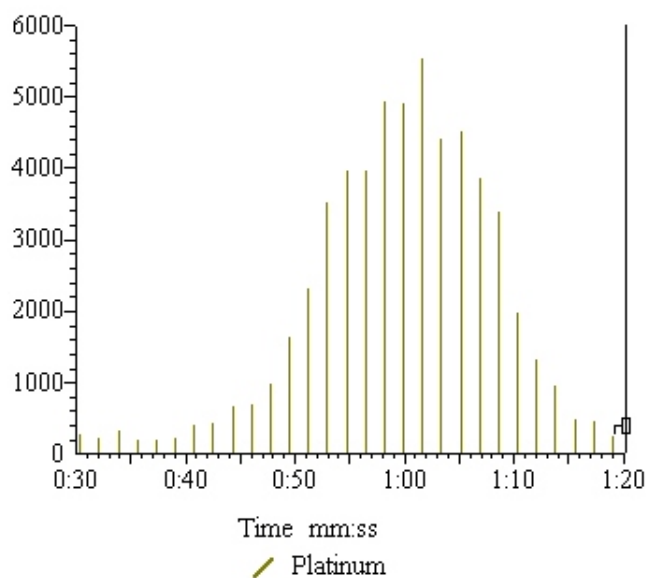


Figure 20 Individual data points

To allow the individual points of the data to be seen create a view of a single ion and select **Views, Properties, Type**, and select **Histogram graph**. Measure the difference in count rate over a set of 5 cycles on the rising edge of the peak close to the limit value, and set **slope** to 25 % of this value.

In the above example if the limit was 500 then the slope would be $(1662 - 445) / 4 = \sim 300$.

3.4 Falling edge variables

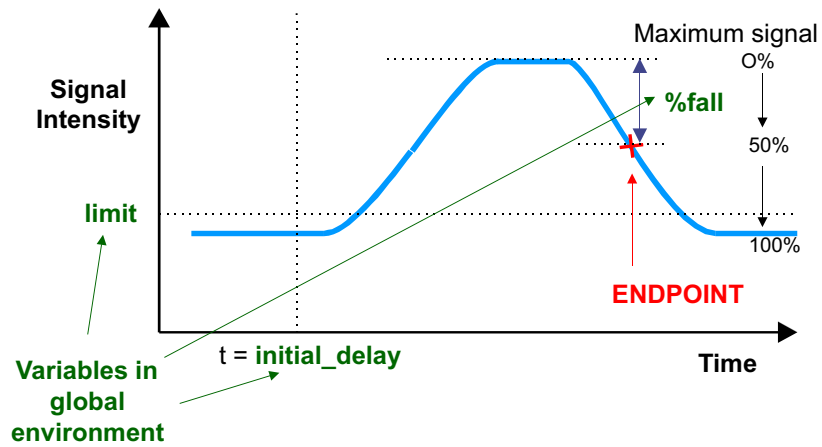


Figure 21 Falling edge endpoint control

%fall

After the initial-delay has expired, the maximum signal level detected during the etch will be assumed to be 100 %. Set this value to be the percentage fall of this signal at which the endpoint should occur.

%fall (and %rise) calculations are with respect to the endpoint signal baseline (the lowest signal preceding the maximum but after the initial delay).

The %fall may be calculated relative to a reference peak maximum (specified by reference-scan) instead of the endpoint peak itself (specified by endpoint-scan).

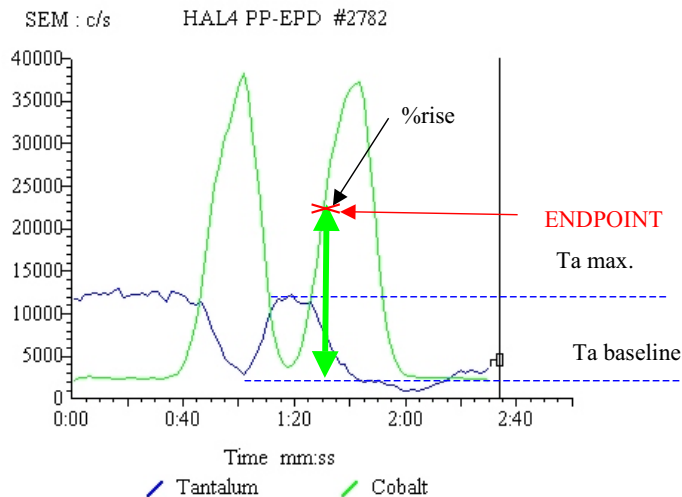


Figure 22 %fall variable

The %fall variable is also used on rising edge endpoints with a reference peak to hold the %rise value. The height of Ta peak is the maximum Ta signal minus the Ta baseline (the lowest Ta signal preceding the maximum but after the initial delay).

3.5 Over-etch variables

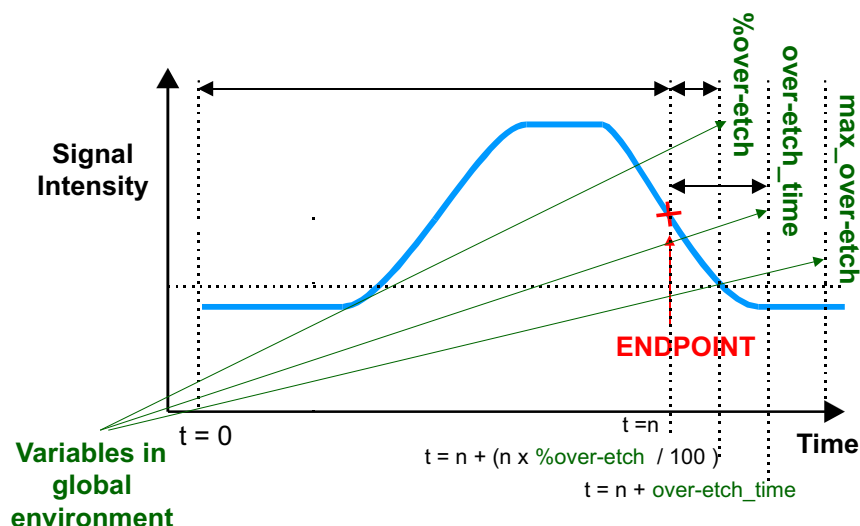


Figure 23 Endpoint control over-etch

over-etch_time

If an absolute over-etch-time (i.e. a fixed number of seconds) is to be allowed before the endpoint signal goes true, set this parameter to this time. Fractional values can be used in this parameter.

If a percentage over-etch time is to be used, set this variable to **0**.

%over-etch

If an over-etch-time which is a percentage of the measured time from the start signal to the time at which the endpoint is detected, is to be allowed before the endpoint signal goes true, set this parameter to this percentage. If an absolute over-etch time is to be used, set this variable to **0**.

max_over-etch

Set this to the maximum allowable over-etch-time that should be needed. Avoids a percentage over-etch-time being too large.

3.6 Data averaging variables

Variations due to rotation can cause the endpoint to be found too soon.

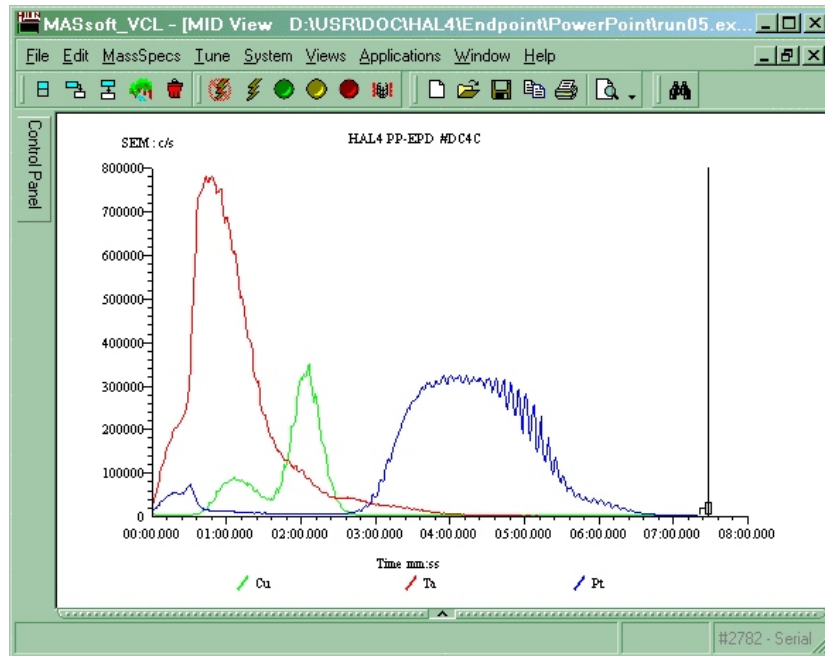


Figure 24 Data averaging variables

average

The average variable can be used to reduce the effect of noise by averaging the readings from several cycles.

It will have less effect than RPM and period on rotation.

It only affects the values used by the endpoint event sequence so its effects are not seen in the display.

RPM

symmetry

The RPM and symmetry variables can be used to reduce the effect of rotation.

The period of rotation in ms is calculated by the formula

$$\text{Period} = 60000 / \text{RPM}$$

This is divided by the repetition due to symmetry to calculate the dwell in ms

$$\text{Dwell} = \text{period} / \text{symmetry}$$

By setting the endpoint scan's dwell time to this value the data is averaged over one cycle of variation.

RPM and symmetry change the dwell, their affect will be seen in the displayed data.

3.7 Error checking variables

warning-level

Set the warning-level to the minimum acceptable peak height for the endpoint layer.

3.8 Other variables

step

The step variable must be set to zero. The step variable is set by the Script Interpreter script.

4 Creating a template file

4.1 General

At this point, the mass spectrometer has been set up to acquire the strongest signal from the wafer, and a template file may now be created.

A template contains information which tells the EPD which ions to monitor and how to detect the endpoint. MASsoft files do not normally contain endpoint detection sequences, so to create a new template it is necessary to copy and modify an existing template. A new system will always contain at least one template provided by Hidden Analytical Limited.

- Copy an existing MASsoft Template file in order to copy the Event Sequence.
- Ensure the present multiplier voltage is used.
- Check the tuned lens values in the Global Environment
- Edit the Scan Tree to include the ions to monitor.
- Add Views to the Scan to be able to see the data
- Run a wafer and determine the endpoint settings.
- Select an endpoint method.
- Specify the ion to endpoint on.
- Enter the Endpoint settings into the Global Environment.

4.2 Copying an existing template

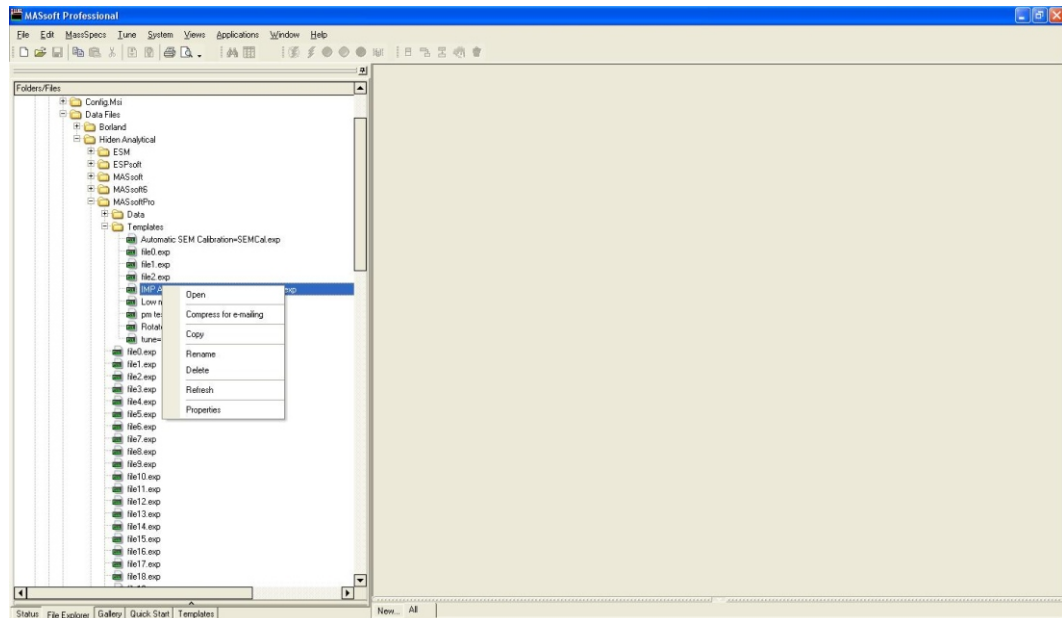


Figure 25 File Explorer tab

To copy an existing template file to a new template file:

1. Select the **File Explorer** tab in the Control Tabs.
2. Navigate to the EPD Template folder. Hidden supplied templates are stored in
C:\Data Files\Hiden
Analytical\MASsoftPro\EPDTemplates
3. Select the template to be copied. e.g MethodsPro.exp
4. Using the right mouse button bring up the pop-up menu and select Copy.
5. Select the template folder itself.
6. Using the right mouse button bring up the pop-up menu and select Paste
7. The file MethodsPro.exp will be copied to Copy of MethodsPro.exp.
8. Select Copy of MethodsPro.exp.
9. Using the right mouse button bring up the pop-up menu and select Rename.
10. Enter the new name for the template file. Give the template a meaningful name
for ease of use later.

Note:

Using the File Explorer tab in MASsoft ensures that all 5 files that constitute a MASsoft Experiment file are copied.

Alternatively the file may be opened using File, Open from the Menu Bar, and then saved under a new name using File, Save As.

Note:

Do not use File, Save as Template to save EPD Templates.

4.3 Checking the new template

The new template file must now be checked to ensure that the optimum environment values are used.


This is especially important when using older Templates from previous versions of MASsoft. Previous versions of MASsoft held the present multiplier voltage and tuned SIMS variables in the Global Environment, MASsoft *Professional* normally holds these

values in the instrument environment. Steps 7 and 8 must be followed to ensure that these variables are taken from the Instrument Environment.

If the new template has been created by copying a Hiden supplied file, the file will need to be “Converted” to the user's instrument (see step 2) and the Global Environment values may need modification.

1. Open the template file by double-clicking on it in the File Explorer.

Alternatively, on the **File** menu click **Open**.
2. If the file was created on a different instrument then convert the file by clicking the Convert tool  on the tool bar.

Alternatively on the **File** menu click **Convert File**.
3. If the file is locked, unlock the file by clicking the Unlock tool  on the tool bar.

Alternatively, on the **File** menu click **Unlock**.
4. In the Scan Tree window double-click on the **Global:** box.

The **Global Environment Editor** dialog box is opened.
5. Select the **+ion SIMS** tab.

To change mode select the **+ion SIMS** tab and then click on the **Default mode** checkbox.
6. Ensure the **Default mode** is set to **+ion SIMS**. The default mode is marked by a tick in the tab,

+ion SIMS
7. Ensure the present multiplier voltage is being used.

The **multiplier** variable in the **Detector** group should have its “Use” check box unchecked so that it is using the value from the Instrument Environment; this will be necessary when using files from an earlier version of MASsoft.
8. Ensure the global SIMS environment variables are set to the latest tuned values.

The tuned values are all in the **Filter** group.

Where the new template has been created from one already in use on the tool, the environment values should already be optimum.

Usually the tuned values will be stored in the Instrument Environment, to use these values the SIMS environment variables should have their “Use” check boxes unchecked; this will be necessary when using files from an earlier version of MASsoft.

If the Template requires values that have been tuned for the particular stack then these may be imported from the .tun tune file saved at the end of the autotune procedure.

To do this exit the Global Environment Editor by clicking on the **OK** button to save the new settings. Select the Global Environment in the Scan Tree, then use the **File, Import, Environment, Tuned values** command from the Menu Bar. After importing the values repeat steps 6 and 7 to ensure the values are correct. Imported tuned values will have their “Use” checkbox checked; these values will take precedence over the values in the Instrument Environment.

9. Set the **initial-delay endpoint** variable to 36000 s. This ensures that the EPD will not find an endpoint and cause the etch module to end the run prematurely. This variable must be changed to the correct value when the endpoint criteria have been determined.

10. Click **OK**. The **Environment Editor** dialog box is closed.

4.4 Editing the new template

To fully define MASsoft’s automatic endpoint detection event sequence, a wafer stack needs to be milled completely through in order to determine the parameter values to use. Test wafers should ideally contain similar materials and levels of masking as production wafers. In the template file, although it is not necessary to create a scan tree to monitor all the masses present in the wafer, it is advisable to select one element’s mass to represent each layer; the scan tree should contain one mass scan for each layer. Table 4 shows the masses of some typical etch products. The masses of the ions of other elements may be obtained from the pop-up periodic table in the Scan Editor. Usually the mass of the most abundant isotope should be used. Other masses may be obtained from Hiden Analytical Limited if the required ion is not shown.

Layer	Substance to monitor	Mass (amu)
AlTiC	Ti	48
CoFe	Co	59
Al ₂ O ₃	Al/AIO	27/43
Ta	Ta	181
NiFe	Ni	58
Cu	Cu	63
FeMn	Mn	55
Co	Co	59
Ca	Ca	40
Ti	Ti	48
Cr	Cr	52
Ag	Ag	107
Au	Au	197
Pt	Pt	195
Si	Si	28/44

Table 4 Typical layer materials

Although auto endpoint criteria evaluate the trend of only one mass, monitoring each layer provides a real-time display of which layer the primary beam is currently etching through; this can often be used to help determine better endpoint criteria. For example, at a layer interface, it would be better to use the falling signal of the upper layer in preference to the rising signal of the lower layer, as this allows a percentage fall to be specified, which cannot be done with a rising signal.

1. Double-click on the chosen **Scan** box. The **Scan Editor** dialog box is opened.
2. Select the MID (Multiple Ion Detection) tab.

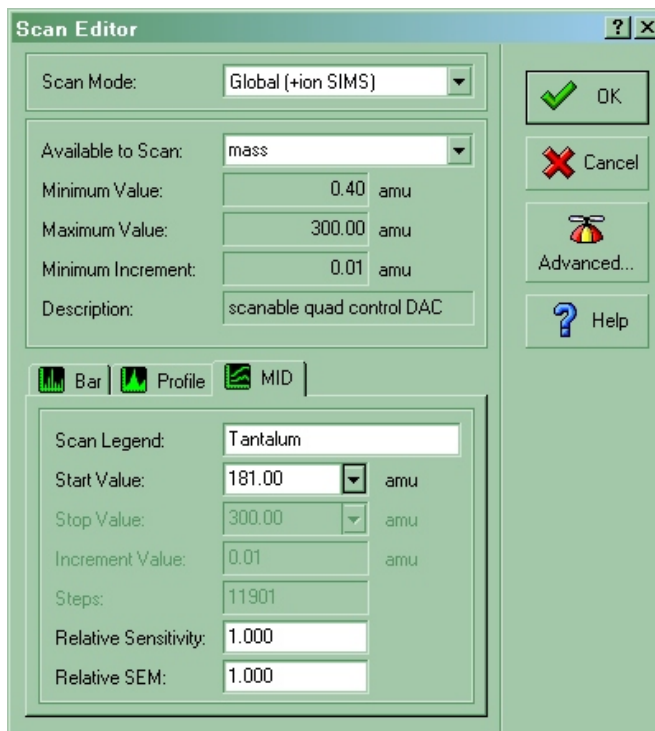


Figure 26 Scan Editor dialog box

3. Change the **Start** value the required mass value. Click the down arrow to the right of the mass value to display the pop-up periodic table.

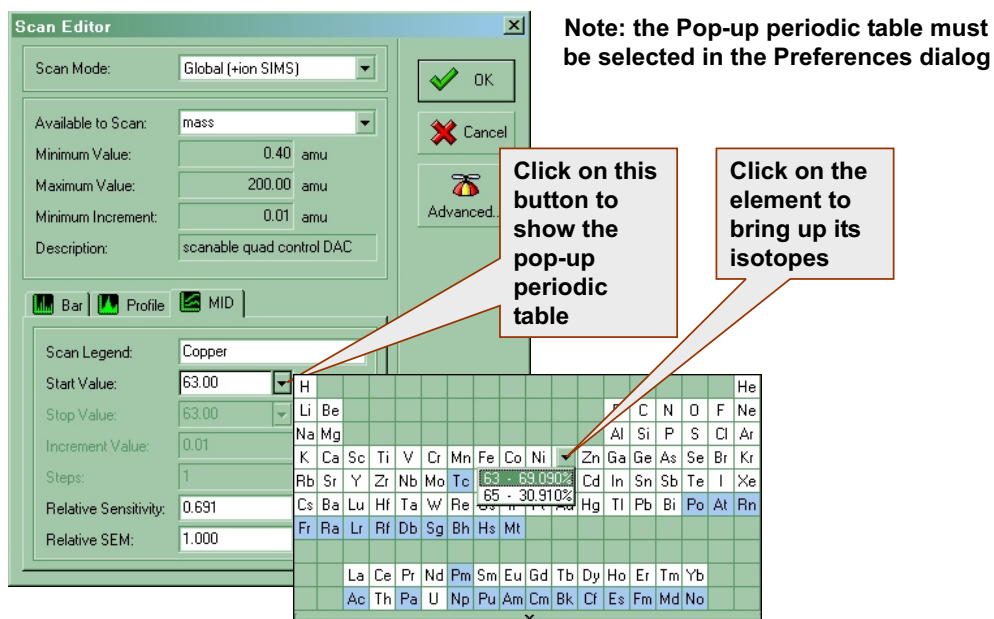



Figure 27 Pop-up periodic table

When using the pop-up periodic table the Scan Legend, mass and Relative Sensitivity are all entered automatically.


The Relative Sensitivity (RS) is set to the isotopic abundance. However, it is advisable to change this value to 1.0 because the RS is only applied to displayed values, it is not applied to the values used by the RC Interface unit for endpointing. This will lead to a discrepancy between the displayed values and endpoint variables like **slope** and **limit**.

4. Enter a new **Scan legend** to make it easy to identify the layer.
5. Ensure the Relative Sensitivity is set to 1.0.
6. Click **OK**. The **Scan Editor** dialog box is closed.

To add a mass scan to the scan tree (for an additional layer):

1. Select the last **Scan** box in the scan tree, by clicking on it.
2. Select the Tool Bar **Next scan** tool A new **Scan** is added to the scan tree.

3. Select the required mass for the scan, as shown above.

To delete a mass scan from the scan tree:

1. Select the required **Scan** box in the scan tree, by clicking on it.
2. Select the Tool Bar **Delete** tool, The **Scan** is deleted from the scan tree.


The first scan in the tree cannot be deleted.

It is recommended that the **Dwell Time** (the time used to acquire a single point in the scan) for each scan is set to 250 ms for the initial tests:

1. Double-click on the **SEM** input device box. The **Input Selection** dialog box is opened.
2. Select the Dwell Time **mS** radio button.
3. Enter **250** in the **Dwell Time** text box.
4. Click **OK**. The **Input Selection** dialog box is closed.

When the scan tree is edited, any attached views are automatically deleted. To attach a view to each of the scans in the scan tree:

Add Views to the Scan so the data can be seen

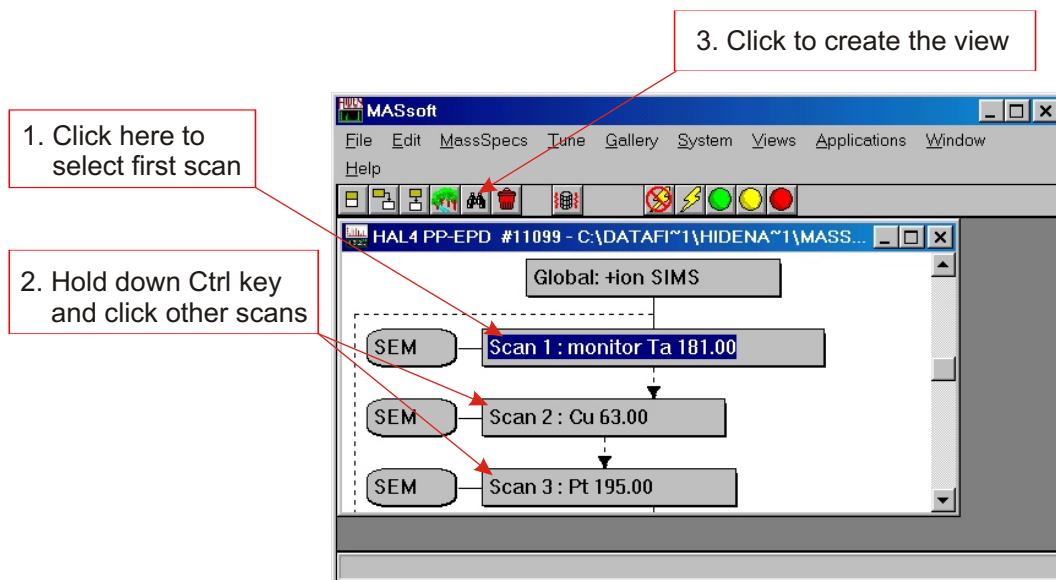


Figure 28 Add views to a template

1. Click on the first **Scan** box.
2. Hold down the **ctrl** key.
3. Click on each of the other Scan boxes in turn. This will select all of the scans.
4. Select the Tool Bar **Attach view** tool, A new view is created for each scan.



To close and save the template file:

1. On the **File** menu click **Close**.
2. Click the **Yes** button. The file is closed and saved.
3. Use Windows **Explorer** to set the files for each template to be read-only. This prevents the files being overwritten.

When the Template has been created a corresponding Script File must be created.

It is strongly recommended that the script file be given the same base name as the experiment file e.g. if the template is called Template.exp the script file should be named Template.run.

The endpoint step number in the script file must match the process step number that ends by endpoint.

Before the Template file can be used in production the endpoint parameters need to be determined. These parameters are best determined by examining the data produced by etching a wafer.

4.5 To run a template manually

To determine the endpoint parameters it is necessary to acquire data from the etch of a wafer using the new template file.

The template file is now ready to be run, but the steps required to start it automatically from the etch module process controller have not yet been performed.

To acquire data either set up a Script Interpreter script to run the template and run it from a PM recipe or the wafer may be etched under manual control.

If the wafer is etched under manual control the PM will not send a start signal to IMP-EPD so the IMP-EPD will not acquire data. To acquire data manually the event sequence in the Template file that waits for the start signal must be disabled and the template must be manually run from MASsoft.

To run a template manually:

1. Copy the required template file, as described in Section 4.2.
2. Make a copy in a temporary folder. The file will be deleted after use.
3. On the **File** menu click **Open**. The **Open** dialog box is displayed.

4. Select the template file, copied in Step 1.
5. Click **OK**. The file is opened.

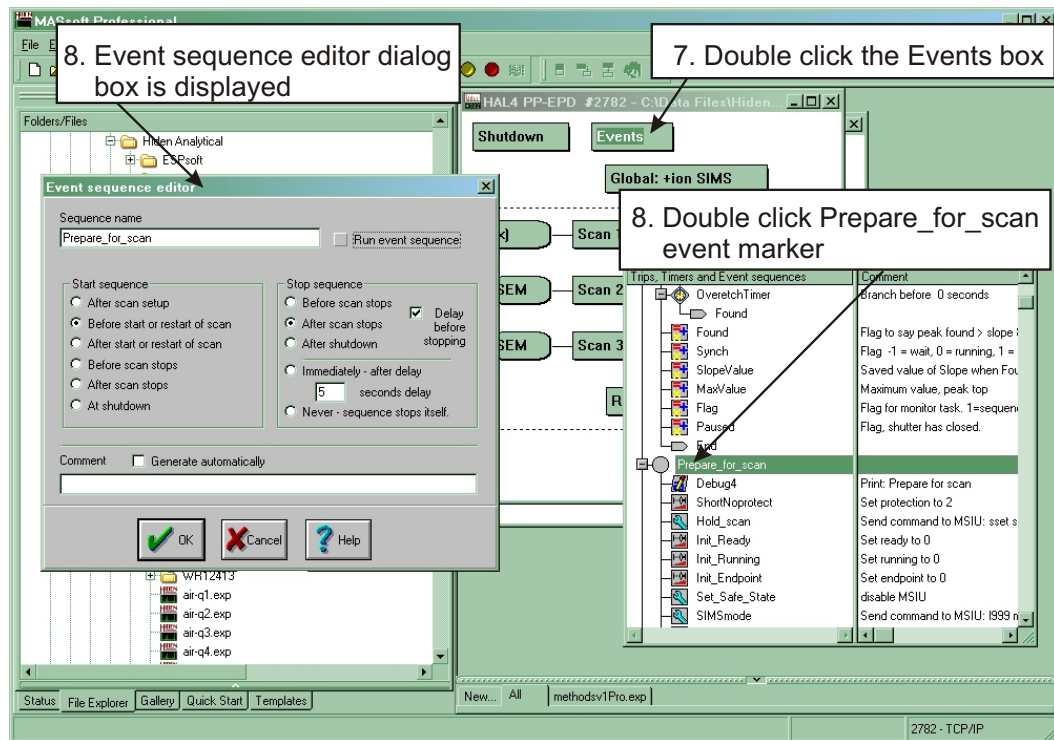




Figure 29 Run a template manually

6. Click on the scan tree window.
7. Double-click on the **Events** box. The **Event editor** window is opened.
8. Double-click on the **Prepare_for_scan** event sequence marker. The **Event sequence editor** dialog box is opened.
9. Deselect the **Run event sequence** option. This stops the task from running when the scan is started. The template file will not wait for a start signal from the PM or pause if the shutter is closed.
10. Click **OK**. The **Event sequence editor** dialog box is closed.
11. Ensure a test wafer is in position and ready to etch (shutter closed).

- | | |
|---|---|
| <p>12. Click the Tool Bar green Start button</p>  | <p>MASsoft downloads the scan parameters to the EPD.</p> <p>Before data acquisition starts, the Data Acquisition dialog box is opened.</p> |
| <p>13. Enter a file name, or accept the default name offered.</p> | <p>MASsoft generates default file names by using a number at the end of the existing name.</p> |
| <p>14. Click OK.</p> | <p>Parameter download completes and MASsoft displays the status Acquisition in progress (this takes about 30 seconds).</p> <p>Data acquisition will not now wait for the Start signal but will begin immediately.</p> |
| <p>15. When data acquisition starts begin the etch (open the shutter).</p> | |
| <p>16. When the last layer has been etched, press the Tool Bar red Abort button,</p>  | <p>Acquisition stops. The View shows the trend of each of the ions monitored. The resultant data file will be stored in the template folder.</p> |
| <p>17. Delete or move the template copy after endpoint parameters have been determined.</p> | |

4.6 Improving the IMP-EPD performance

Typical methods of optimising the sensitivity to get the most out of the IMP include:

If the system has not been optimised in SIMS mode for a long time tuning the system may increase the signal intensity.

When monitoring masses, which have no signal in adjacent mass channels, use a local environment file to set the **delta-m** or **resolution** (depending on mass) parameter more negative just for this mass. This will increase its intensity and, as there are no signals either side of it, will not result in 'tailing' into the adjacent mass channel. (Tailing is where the bottom part of a mass peak overlaps into the next mass channel.) Tailing can sometimes be seen when monitoring many ions of a similar mass, for example Cr at 52 amu, Mn at 55 amu, Fe at 56 amu, Ni at 58 amu and Co at 59 amu. If tailing appears to be a problem in the data, try setting **delta-m** positive to make the peaks narrower.

If the signal intensity is too high for a peak (often seen on Al from Al₂O₃ substrates) the SEM signal may saturate at about 5x10⁶ c/s. Again, use a local environment to reduce the signal as follows:

Set the **delta-m** parameter to a more positive value (0 % is the normal value, 100 % the maximum), or set a focus plate slightly positive.

Don't reduce the **multiplier** voltage to try and reduce the count rate.

Dwell times can be critical for the appearance of IMP data; they may need to be increased from the default setting of 100 %. Shorter dwell times usually mean noisier data, which can affect endpoint detection. Each application may require a different dwell time. Things to take into account when setting dwell time are:

- The number of masses that need to be monitored.
- The approximate time it will take to endpoint.
- The width of the layer it is endpointing on.

Obviously, for a very thin layer with a very long dwell time, it is possible that the etch could go through the layer without the EPD acquiring enough data points to satisfy the endpoint criteria and the endpoint may not be found. Typically, dwell times are set between 200 and 700 ms. The dwell times of the masses not used for endpointing are not critical and may be shorter than that used in the scan monitoring the endpoint material.

The sample rotation will be seen in the acquired data, but should not cause a problem in finding the endpoint. However, the effect of the rotation can be removed to a certain extent by setting the dwell time to match the period of the rotation. If the rotation speed is r revolutions per minute and the wafer has Cn symmetry, then the dwell time should be:

$$60000 r.Cn$$

It is better to monitor fewer masses with longer dwell times, than to monitor every element on the wafer with very fast dwell times. Often scans are generated that use more than one mass to represent each layer. Using a high signal, with low background noise, select only one mass to represent each layer and then increase the dwell times on this mass.