APPLICATION NOTE

The Calnex Analysis Tool (CAT) provides a range of pre-defined ITU-T masks to verify that the performance of network devices meets the relevant standards. The CAT also lets you define your own masks; this application note shows you how.

Calnex
Insight and Innovation

A GUIDE TO WRITING USER-DEFINED MASKS

CAT

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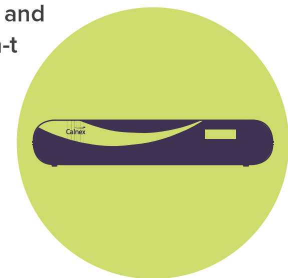
Define your own masks with the Calnex Analysis Tool (CAT)

Paragon-X and Paragon-t



Sentinel

The CAT lets you choose from a range of industry-standard masks against which you can analyse TIE, MTIE and TDEV results. These Calnex-supplied masks are defined using an XML syntax and mathematical descriptions of the mask segments, as opposed to explicit corner point or intermediate-point coordinates. This makes it relatively easy to define new masks, especially those based on mathematical functions rather than straight lines.

INSTALLING A NEW MASK

For Paragon-X, Paragon-t and Sentinel, the CAT is installed at:

C:/Program Files (x86)/Calnex/CAT

All the Calnex-supplied masks are located in a subdirectory called Mask_XML (shown below). You must place any user-written masks in this directory to access them. User-written masks work in the same way as the Calnex-supplied masks.

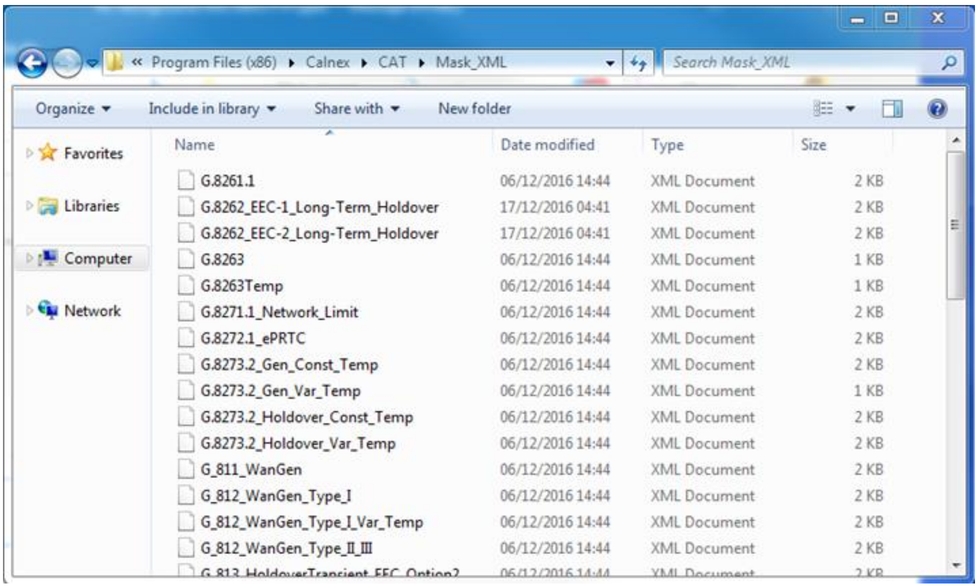
To add a new mask:

1. The easiest way to do this is to copy an existing XML file to a directory you have previously created, then edit the file as required and save it back into the Mask XML directory.
2. Restart the CAT.
3. Check the new mask is available in the masks drop-down list for the relevant metric.

Notes:

- All masks are parsed at launch of the CAT. If any are invalid, they will either be missing from the list (if the error prevents parsing) or they will be present but the mask will be incomplete. There is minimal error handling or feedback so care must be taken while writing custom masks.
- Since there is no separate User Mask directory, installing the Paragon GUI software/CAT software (for example, re-installing or installing a later version as part of normal upgrade activity) will recreate the Mask_XML directory and install only the Calnex-supplied masks. User masks will, as a result, be lost.

  It is therefore recommended that you keep a copy of any masks you write in a separate directory (and keep a back-up separately), and copy them back into the Mask_XML directory after any re-install.



This screenshot shows Windows 7; other Windows versions will vary in detail.

XML STRUCTURE

The XML file is made up of a series of ranges that define the line segments of the mask as polynomials. The polynomials are of the form:

(a.xb + c) + (d.xe + f)

where a and d are multipliers, b and e are exponents, c and f are offsets, and x is the x-axis of the graph (for MTIE/TDEV this is the observation interval; for TIE it is time).

All valid masks must be contained within a root <MASK> tag otherwise it will not be recognised as a valid mask.

At the start of the file, you define the name and tool tip text that will be displayed on the GUI when the mask is loaded.

An example XML file structure is shown below.

```
<?xml version="1.0" encoding="utf-8" ?>
<MASK>
  <!-- The size of the NAME field and TOOLTIP field are not limited -->
  <!-- but only 32 characters will display fully on the GUI. -->
  <!-- It is best to keep to this guideline or at the very least -->
  <!-- make the initial 32 characters unique amongst all masks.-->
  <!-- |.......name display size........|-->
  <NAME>G.8262 Wander Generation EEC Op1</NAME>
  <TOOLTIP>ITU-T G.8262 Wander Generation EEC Option 1</TOOLTIP>

  <MTIE>
    <!-- Mask definition for MTIE and related measurements -->
    <!-- TAGS -->
    <!-- FROM, TO with special keywords 'END' 'START' -->
    <!-- OFFSET, MULTIPLIER, EXPONENT, RESOLUTION -->
    <!-- An ADJUSTMENT tag allows a further formula to be added -->
    <!-- It has the exact same tags as the regular formula -->
    <RANGE>
      <FROM>0.1</FROM>
      <TO>1</TO>
      <OFFSET>40</OFFSET>
    </RANGE>
    <RANGE>
      <FROM>1</FROM>
      <TO>100</TO>
      <MULTIPLIER>40</MULTIPLIER>
      <EXPONENT>0.1</EXPONENT>
      <RESOLUTION>1</RESOLUTION>
    </RANGE>
    <RANGE>
      <FROM>100</FROM>
      <TO>1000</TO>
      <MULTIPLIER>25.25</MULTIPLIER>
      <EXPONENT>0.2</EXPONENT>
      <RESOLUTION>10</RESOLUTION>
    </RANGE>
  </MTIE>

  <TDEV>
    <!-- Mask definition for TDEV and related measurements -->
    <RANGE>
      <FROM>0.1</FROM>
      <TO>25</TO>
      <OFFSET>3.2</OFFSET>
    </RANGE>
    <RANGE>
      <FROM>25</FROM>
      <TO>100</TO>
      <MULTIPLIER>0.64</MULTIPLIER>
      <EXPONENT>0.5</EXPONENT>
      <RESOLUTION>1</RESOLUTION>
    </RANGE>
    <RANGE>
      <FROM>100</FROM>
      <TO>1000</TO>
      <OFFSET>6.4</OFFSET>
    </RANGE>
  </TDEV>

</MASK>
```

XML MASK DEFINITION – EXPLANATORY NOTES

MASK

The root tag which holds the entire mask definition.

NAME

The name of the mask as displayed in the drop-down menus on the GUI. This should be short and unique. Note the display area limit markers as described in the comments section of the example XML file opposite.

TOOLTIP

A longer text string that is displayed when the mouse hovers over the mask name.

MTIE, TDEV, TIE, MAFE

This section will be applied to the relevant metric.

TWO-SIDED

For TIE masks, setting TWO-SIDED to TRUE, will produce a positive and negative mask. When set FALSE, the mask will be positive only.

RANGE

Each mask definition is simply a series of ranges; there is no limit to the number of ranges you can define. The combination of ranges makes up the mask. Note that it is possible to provide an incomplete mask with missing ranges. In this case the missing sections will NOT be interpolated for pass/ fail testing. (Note that no known real mask would have such gaps.)

TO, FROM

Defines the x-axis (time or observation interval) start and end points for the range. These are entered as numerical values in seconds.

In addition, there are two special cases, 'START' and 'END' which are used to provide a convenient way of defining the first valid measurement point (sample number 1) and the last measurement point (which is the total size of the capture and is dynamic).

Note that overlapping ranges will not cause an error but will be executed in order of definition. Thus the behaviour of these two ranges is subtly different:

Example 1:

A - RANGE: 10 – 100
B - RANGE: 100 – 1000

Example 2:

C - RANGE: 100 – 1000
D - RANGE: 10 – 100

In the first example, at time reference point 100, the measurement will be tested in range A. For the second example, the measurement will be tested in range C. To avoid confusion, it is recommended that ranges are defined in logical order.

OFFSET, MULTIPLIER, EXPONENT

For each range, a formula can be expressed in the following syntax:

Mask Value (τ) =

OFFSET + MULTIPLIER . (τ^{EXPONENT})

For example: M (τ) = $10 + 40\ \tau^{0.5}$

Where OFFSET is in units of ns and MULTIPLIER is in units of 10^{-9}. This means that, for example, a MULTIPLIER of 1 on its own would result in a line with a slope of 1 ns per second (1 part per billion).

This is how it would usually be defined in the standard:

Table 1 – Wander generation (MTIE) for EEC-Option 1 with constant temperature

MTIE limit [ns]	Observation interval τ [s]
40	$0.1 < \tau \leq 1$
$40\ \tau^{0.1}$	$1 < \tau \leq 100$
$25.25\ \tau^{0.2}$	$100 < \tau \leq 1000$

All the formula elements are optional and can be missed out, so taking the G.8262 SEC Option 1 mask as an example, the mask definition can be implemented as follows:

MTIE limit = 40

for RANGE = $0.1 < \tau \leq 1$

OFFSET = 40

MTIE limit = $40\ \tau^{0.1}$

for RANGE = $1 < \tau \leq 100$

MULTIPLIER = 40

EXPONENT = 0.1

MTIE limit = $25.25\ \tau^{0.2}$

for RANGE = $100 < \tau \leq 1000$

MULTIPLIER = 25.25

EXPONENT = 0.2

RESOLUTION

To calculate an exponential curve from 10s to 10,000s can result in many points. Since the size of each range can also be very different, the RESOLUTION tag can be used to define the incremental value to be added to 'τ' for each point.

For example, if the range is 100 to 200, then it is perfectly acceptable just to miss out the resolution (one second will be assumed). However, in the 10 to 10,000 example you may want to specify 100, or even 1000.

ADJUSTMENT

Some masks have an option for temperature adjustments. This will take the form of:

Mask Value (τ) =

OFFSET + MULTIPLIER . (τ^{EXPONENT}) + Adjustment (τ)

Where Adjustment (τ) =

Adj_OFFSET + Adj_MULTIPLIER . ($\tau\ \text{Adj}^{\text{EXPONENT}}$)

So, M (τ) = (O + M . (τ^{E})) + (O′ + M′ . ($\tau^{E'}$))

For example:

M (τ) = $10 + 40\ \tau^{0.5} + 0.5\ \tau$

The Adjustment tag formula is simply added to the offset and multiplier/exponent formulas in each range.

The Adjustment tag also allows masks to be specified using a quadratic:

$ax^2 + bx + c$ can be specified using:

MULTIPLIER = a

EXPONENT = 2

ADJUSTMENT MULIPLIER = b

ADJUSTMENT OFFSET = c

Note that when using ADJUSTMENT terms it is possible to create an inefficient formula that could be simplified but the tool takes no steps to simplify, for example:

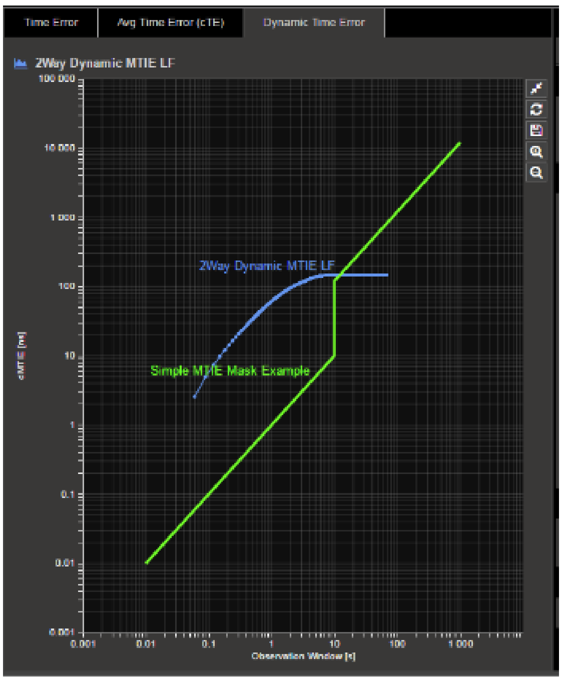
Mask Value = $10 + 40\ \tau^{2} + 20 + 40\ \tau^{2}$

will be calculated term by term despite the fact it could have been simplified to $30 + 80\ \tau^{2}$ at entry.

SIMPLE EXAMPLES

An example XML mask definition that will produce the 2-slope MTIE mask is shown below.

```
<?xml version="1.0" encoding="utf-8" ?>
<MASK>
  <!-- |......name display size........|-->
  <NAME>Simple MTIE Mask Example </NAME>
  <TOOLTIP>Simple 2-slope MTIE mask example</TOOLTIP>
  <MTIE>
    <RANGE>
      <FROM>0.01</FROM>
      <TO>10</TO>
      <MULTIPLIER>1</MULTIPLIER>
    </RANGE>
    <RANGE>
      <FROM>10</FROM>
      <TO>1000</TO>
      <MULTIPLIER>12</MULTIPLIER>
    </RANGE>
  </MTIE>
</MASK>
```

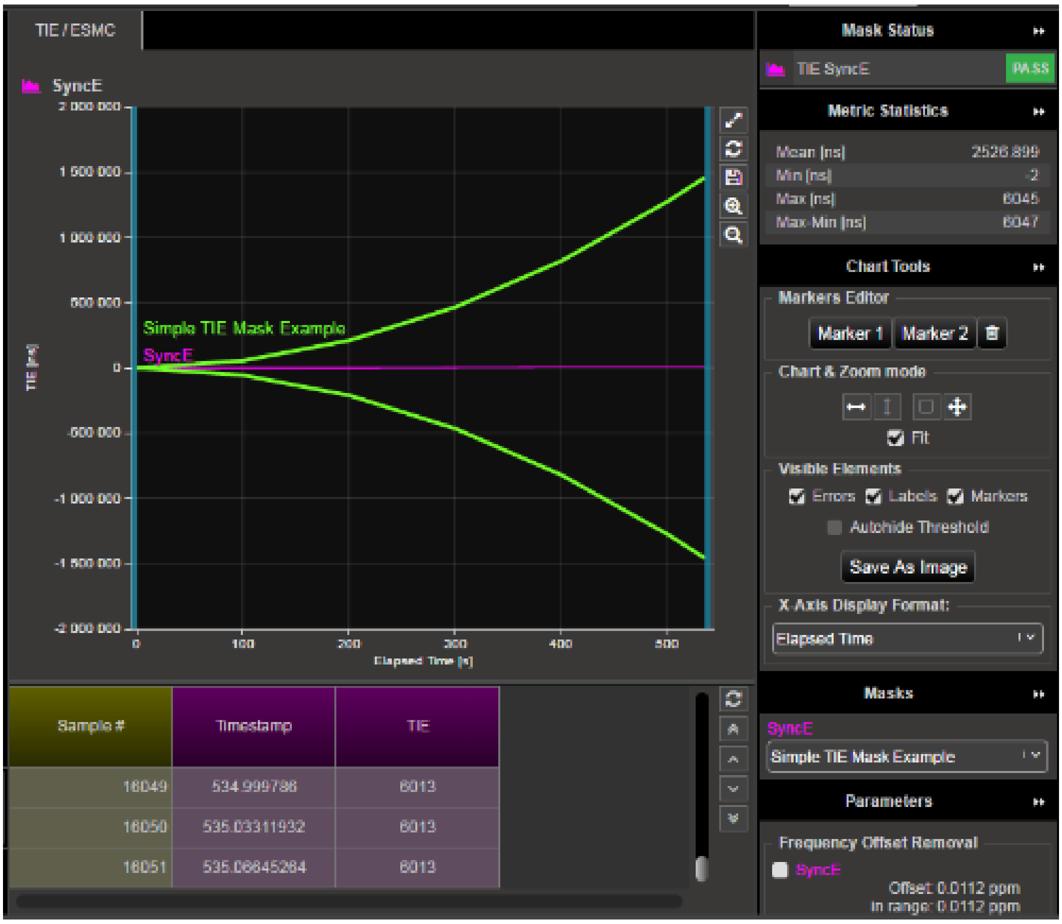


EXAMPLE 2

The example below shows a two-sided TIE mask defined using a quadratic.
The mask is defined as:

$5.\tau^2 + 50.\tau + 120$

```
<?xml version="1.0" encoding="utf-8" ?>
<MASK>
  <!-- |......name display size........|-->
  <NAME>G.8262 EEC-1 Long-Term Holdover </NAME>
  <TOOLTIP>G.8262 Sect 11.2.1 EEC-1 TIE Mask</TOOLTIP>
  <TIE>
    <!-- These masks are polynomials e.g. ax^2 + bx + c -->
    <!-- Use <ADJUSTMENT> for the square term -->
    <TWO-SIDED>TRUE</TWO-SIDED>
    <RANGE>
      <FROM>0.1</FROM>
      <TO>END</TO>
      <OFFSET>120</OFFSET>
      <MULTIPLIER>50</MULTIPLIER>
      <EXPONENT>1</EXPONENT>
      <ADJUSTMENT>
        <MULTIPLIER>5</MULTIPLIER>
        <EXPONENT>2</EXPONENT>
      </ADJUSTMENT>
    </RANGE>
  </TIE>
</MASK>
```



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