Gating
## removes operator and connector influences in RF measurements

INTRODUCTION

Gating for cables is used to remove the influence of operator's cable preparation in the measurement results. This function provides the opportunity to selectively remove or reduce unexpected mismatches in transmission occurring out of the defined gate (caused by separated wires, slightly open foil or compression connectors for coaxial cables).
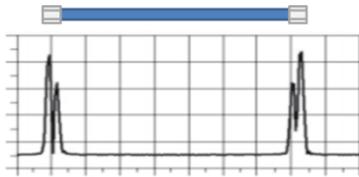
Gating is a function designed to set a measuring "gate" in the "time domain", that means to set start and stop positions. Gating as a function is available for several years in vector network analysers (VNA's). It was developed and used first for printed circuit board (PCB) measurements to remove the remaining cable and connectors after calibration. As these components were very short and the impedance of the strip lines on the PCB very close to the nominal impedance (Z_0), it worked quite well. As this function was available in VNA's and same VNA's were also used to test 100m cables, gating was used also in the cable factory. This application note shows how gating can be used for cable measurements and which limitations exist. Gating can make the life of operators easy but it cannot work wonders. This application note consists also in some guidelines which have to be followed to successful measure long cables.

TEST SETTINGS & MEASUREMENTS WITH GATING

Gating can be used only in linear frequency scale. To have a more accurate result, a higher stop-frequency is required. The higher the stop frequency is, the shorter the representative length in time domain per point becomes. These following conditions must be fulfilled:

- The frequency steps must be equal to the start frequency: $\quad \Delta f = f_{min}$
- The number of points must be:

$$n = \frac{f_{max}}{\Delta f} = \frac{f_{max}}{f_{min}}$$

- The cable's length (DUT) must be shorter than the calculated maximum length l_{max}:

$$l_{max} = \frac{c_0 \cdot NVP}{2 \cdot f_{min}} = \frac{n \cdot c_0 \cdot NVP}{2 \cdot f_{max}}$$

- Resolution per point in time domain:

$$l_{res} = \frac{l_{max}}{n}$$

c_o:	Speed of light in vacuum
NVP:	Nominal Velocity of Propagation in % of c_o
l_{res}:	Length resolution per point in time domain
l_{max}:	Maximum possible length of the DUT(device under test)

Example: $c_0=3*10^8 m/s;$ $\quad$ *NVP=66%;* $\quad$ $f_{min}=500kHz;$ $f_{max}=3GHz$

→Δf=f$_{min}$	⇨Δf=500kHz
→n=3GHz/500kHz	⇨n=6000
→l$_{max}$=(3*10^{8}m/s*0.66)/(2*500kHz)	⇨l$_{max}$=198m
→l$_{res}$=198m/6000	⇨l$_{res}$=33mm

As Gating is not a very precise function, the removed length (offset) must be always longer than the impacted length (e.g. connector). In our tests, we have removed 4 points or 132mm.

Example 1: Cable with a peak at low frequency and high frequency mismatch caused by the connector
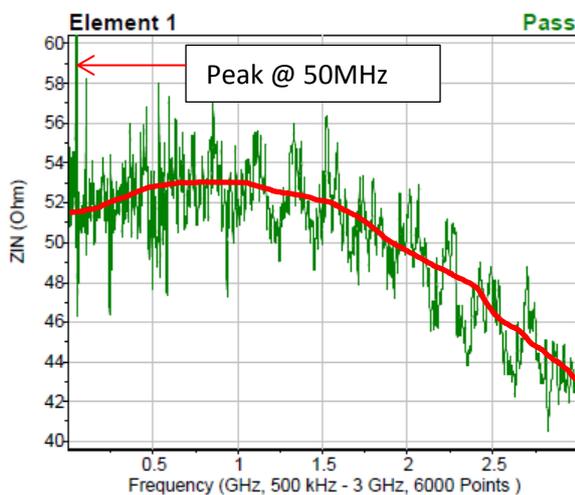

Fig.1: Impedance before Gating:
The Impedance mean value is dropping at high frequency
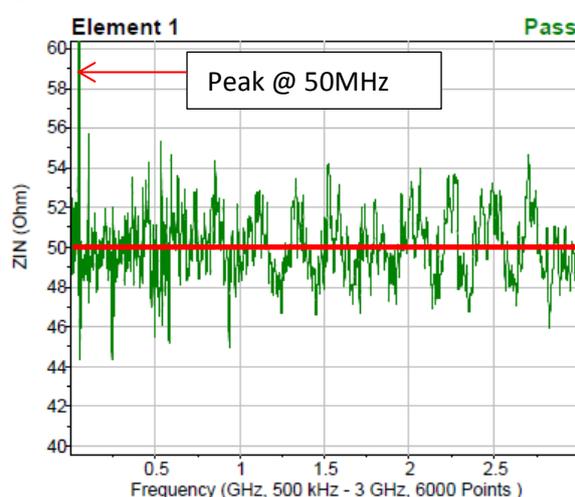

Fig.2: Impedance after Gating:
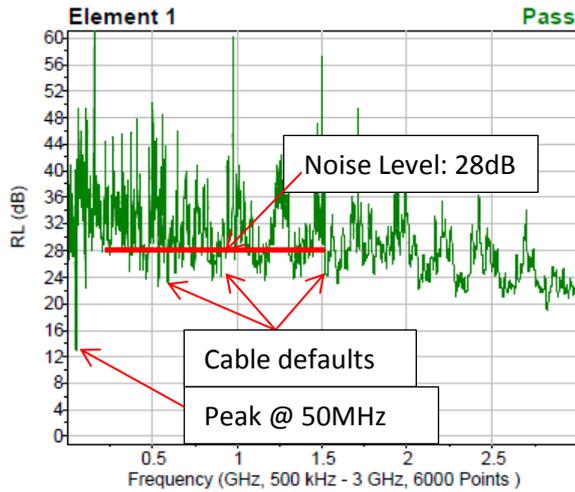The mean value is a straight line at 50Ω
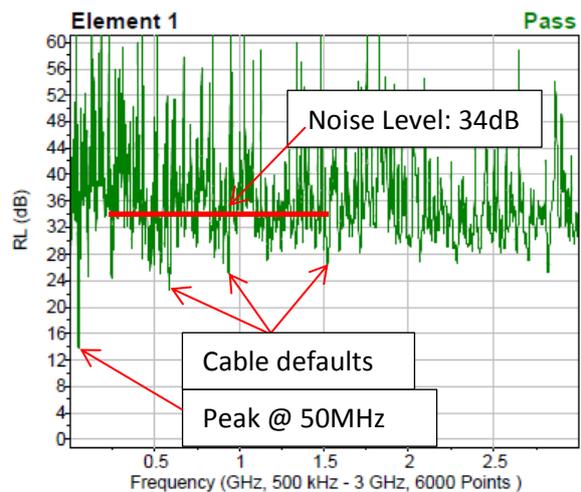
Fig.3: Return Loss before Gating

Fig.4: Return Loss after Gating

The graphs above show how Gating is removing the influence of the connector without changing the defaults in the cable (especially the peak @50MHz).

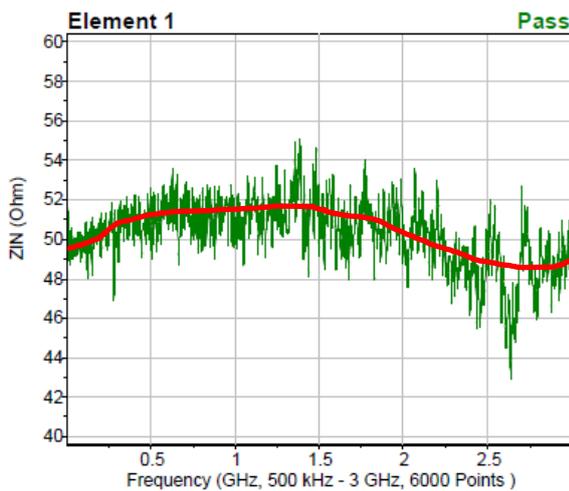**Example 2: Good coaxial cable with N-Connector:**

Fig.5: Impedance before Gating:
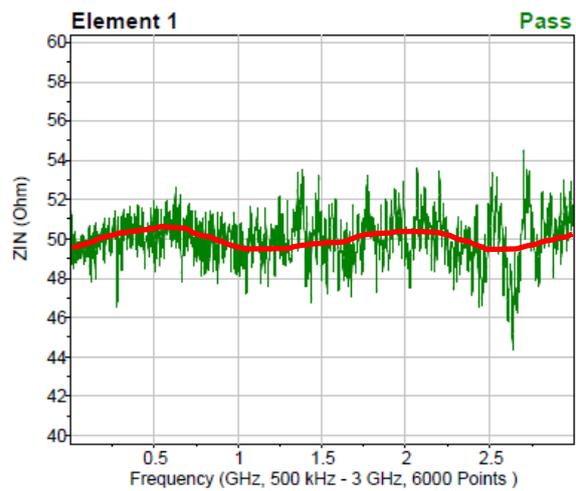The amplitude of the mean value (red line) is oscillating

Fig.6: Impedance after Gating:
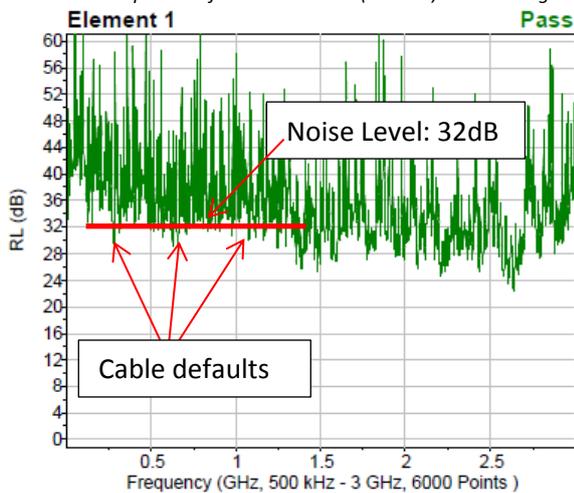The amplitude of the mean value is much smaller
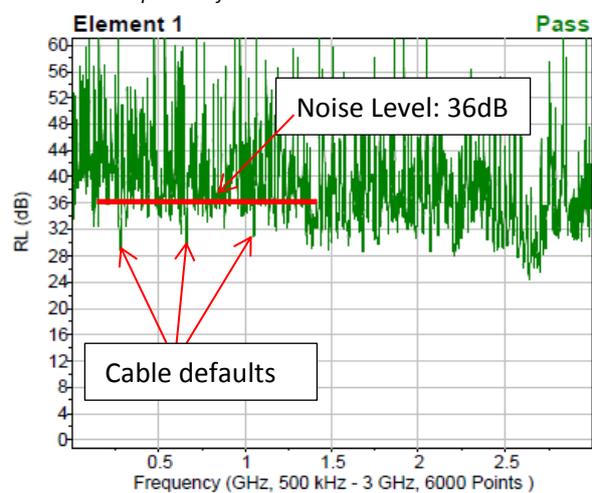

Fig.7: Return Loss before Gating

Fig.8: Return Loss after Gating

The graphs above show how Gating is removing the influence of the N-Connector and visualise the cable defaults. By removing the Connector the system noise is reduced, the cable defaults are better visible.

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Boundaries of Gating

As mentioned above the stop frequency goes directly into the resolution and the ability to cut a certain length. From this point of view the higher the stop frequency the better. Additionally many points allow cutting at the correct length where no influence of the preparation is visible anymore. This helps to remove the first connector without cutting also too much of the cable.

As a role of thumb, the maximum frequency should be at least the maximum frequency of the device under test. The numbers of points should be chosen according to the length which should be tested. If the maximum frequency is for example 3GHz and the NVP 66% the starting frequency (f_{min}) and numbers of points can be calculated as shown below:

For 3GHz and NVP of 66%:

Length	f_{min}	n
10m	8MHz	375
20m	4MHz	750
50m	1.6MHz	1875
100m	0.8MHz	3750

Tests conditions

The graphs of this application note result from tests performed with an automatic testing equipment type AESA Vega 2004 equipped with the coaxial option. The software utilised was the AESA OptiTest with the gating function.

The Gating function is available with the AESA equipment type Vega and Cobalt, for LAN and coaxial cables.

Fig.9: AESA Vega 2004 HF automatic measuring equipment

Conclusions

Gating is a good tool when used correctly. It can help to remove the influence of connectors or preparation. It is important to understand that certain rules have to be respected to get representative results. AESA offers its own Gating function, not depending on the analyser capabilities. With OptiTest (the AESA software), Gating is accessible for any analyser.

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