

Introduction

Automatic Fixture Removal (AFR) plug-in serves to simplify a device under test (DUT) measurement process based on a Vector Network Analyzer (VNA) when direct access to DUT is not possible. A principal challenge in these cases is correct elimination of fixture effects.

Methods Available for Automatic Fixture Removal

CMT AFR plug-in offers three different types of correction methods, covering different fixture properties:

- Time Gating
- Filtering
- Bisect

	Time Gating	Filtering	Bisect
Calculation Base	Time Domain	Time - Frequency Model	Frequency Domain
Principle	Conventional Time Domain Gating	LMS Joint Estimation Algorithm	Advanced Solution of Nonlinear Equations System
Filtering properties	YES	YES	NO

Table 1: The reference table above illustrates basic principles and differences between the methods.

Fixture Properties	Time Gating	Filtering	Bisect
Electrical Fixture Length More Than 4x Rise Time	YES	YES	NO
Electrical Fixture Length Less Than 4x Rise Time	NO	NO	YES
Electrical Fixture Length Close to 4x Rise Time		YES	YES
There Are Some Impedance Variations Along Fixture Length	YES	NO	NO
There Are No Impedance Variations Along Fixture Length	NO	YES	NO

Table 2: The reference table above shows convenient correction method selection guide.

Time Gating Method

Time Gating - requires long electrical length of fixture leading transmission lines or high VNA maximum frequency for correct filtering in time domain

- This method uses a conventional time domain gating algorithm, which implies the definition and extraction of fixture parameters separated by distance or time. For this method to work, appropriate resolution should be provided in the time domain. This resolution depends on the maximum VNA frequency and electrical length of the fixture.
- **It is recommended to choose a fixture with an electrical length greater than 4x the Rise Time of VNA.**



- To determine the time gate points related to the beginning, middle or the end of the fixture(s), impulse responses analysis is performed in auto mode.
- To reduce the side lobes of the impulse response of measured data and achieve maximum available resolution in the time domain, gating procedure with appropriate shifting, and adjusting phase at the end of frequency range is performed. Windowing functions are applied to smooth the sharpness of the original response.
- Time domain gating supports 2xThru and 1xReflect methods of fixture parameter definition and further de-embeds them.

Filtering Method

Filtering – requires high quality fixture transmission lines with no impedance variation

- This method is a modified time domain gating algorithm. It filters all required signals according to signal flow graph representation of a fixture, connected to a VNA. Filtering procedure is conducted at the same time for all parameters, rather than sequentially over time for each of them (i.e., the estimations of fixture parameters depend on each other).
- The filtering approach utilizes an LMS joint estimation algorithm to determine fixture parameters in accordance with a time-frequency model.
- Joint estimation of fixture parameters, obtained during reflection measurements, allows this method to separate different parts of the fixture even when signals (side lobes of impulse responses of these reflectors) according to the flow graph overlap in the time domain significantly. In other words, this algorithm potentially has a better resolution for separating signals (propagating inside the fixture) than the traditional time gating method.
- Filtering supports 2xThru and 1xReflect methods of fixture parameter definition and further de-embeds them.

Bisect Method

Bisect - requires symmetric 2xThru fixtures with low reflection level

- This method splits a set of measured S-parameters of a reciprocal fixture into two halves. To perform this splitting, only frequency domain data is used.
- Bisect allows de-embedding when electrical length of the fixture is not enough to provide appropriate time domain resolution and using time-based methods such as the Time-Gating or Filtering is not possible.
- This method does not possess the filtering property and is not able to separate different signals along fixture length.
- To achieve suitable measurement results by using the Bisect method the fixture should have a sufficiently low reflection level. Recommended level is no higher than -20 dB over the measured frequency range.

- It is assumed that the VNA will have an impedance Z_0 at each port.
- Bisect supports 2xThru fixtures.

Conclusion

Have questions about how to use the Automatic Fixture Removal plug-in? Reach out to support@coppermountaintech.com or [watch this video](#) to learn more.

