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Noise Figure Measurement Setup with VDI Noise Source and SAX Modules

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General Overview

Introduction

This document provides information on how to make millimeter-wave Noise Figure and Gain measurements using a VDI Spectrum Analyzer Extension (SAX) Module and Noise Source.

For input power limitations, safety guidelines, general operating practices and recommendations for all equipment used in this measurement solution, please refer to the appropriate user manuals and/or datasheets.

This document is accurate as of June 1, 2021.

Equipment Requirements

The following equipment will be needed for this measurement solution:

- VDI Noise Source (WRX.xNS)
- VDI Spectrum Analyzer Extension Module (WRX.xSAX in Configuration C)
- Keysight Spectrum Analyzer (N90x0B with N9069M0E Noise Figure Measurement Application Option)
- Keysight Signal Generator (MXG or similar)*
- PreAmplifier**
- Waveguide Isolator†
- DUT (e.g. LNA – Low Noise Amplifier)

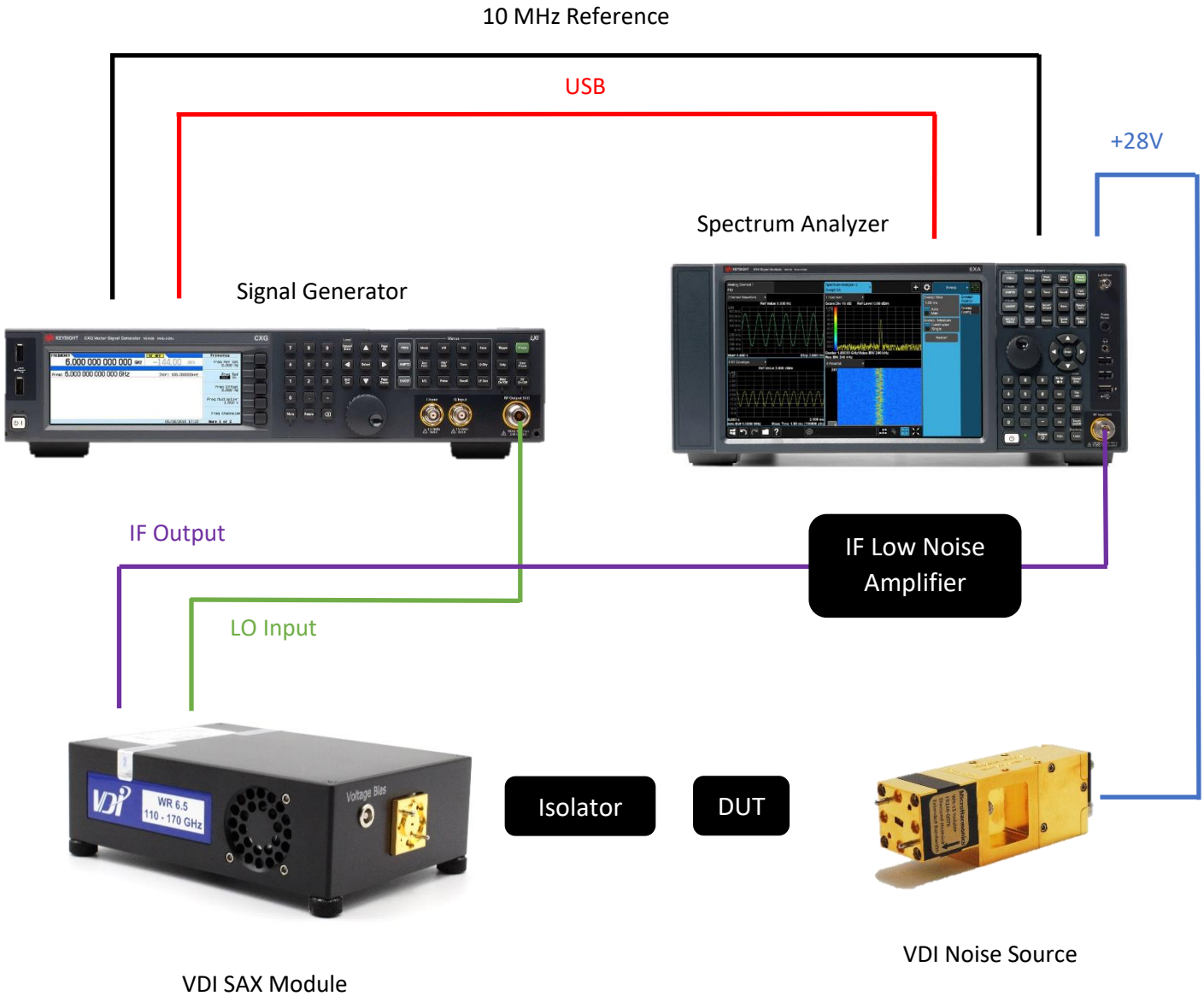
*Other signal generators may be used, but will need to communicate and be controlled by the Keysight Spectrum Analyzer. The signal generator must be able to drive the LO Input Port of the VDI SAX Module across the required frequency range and power level.

**Connected between the IF Output Port of the SAX and the RF Input Port of the Spectrum Analyzer. This may not be required for certain applications.

†VDI recommends the use of a waveguide isolator between the DUT output and the RF Input Port of VDI SAX Module to improve impedance match and reduce possible standing waves.

Block Diagram and Hardware Configuration Details

Typical block diagram for the Noise Figure Measurement setup is shown below.



Generating and Loading ENR File

Generating ENR File Compatible with Spectrum Analyzer

ENR vs. Frequency data values can be entered manually using the “Edit Meas Table” menu item described in the “Verify ENR Table” section, later in this document.

Alternatively, you can upload a .csv file with ENR vs. Frequency data values (see example below for ENR file format). VDI Noise Sources will have an appropriately formatted ENR file included in the shipped documentation.

Sample ENR File Format

Comments shown in red. Red text is not included on the .csv file.

```
[Filetype ENR],
[Version A.27.05], Instrument (Spectrum Analyzer) Software Revision Number*
[Serialnumber b1-05], Noise Source Serial Number
[Model vdi6.5ns_r1], Noise Source Model Number
1.09995E+11,11.02815447
1.10995E+11,11.17974241
1.11995E+11,11.91899908
1.12995E+11,11.08859996
1.13995E+11,10.90244843
1.14995E+11,11.08731449
…
```

*Software Revision Number on the file provided by VDI will default to A.27.05. But should be reviewed and adjusted by the user if they use a different SA or revision number.

Load ENR .csv File onto Spectrum Analyzer

- Load ENR File onto a USB Drive
- Connect USB Drive to Spectrum Analyzer
- Press [Recall] soft key

- Click on ‘ENR Table’ on the list of menu options (left column).
- Click on ‘Meas (Common) Table’
- Click on ‘Recall From’
- Navigate to and Click on the ENR .csv file you want to upload
- Click on ‘Recall’

Spectrum Analyzer Setup

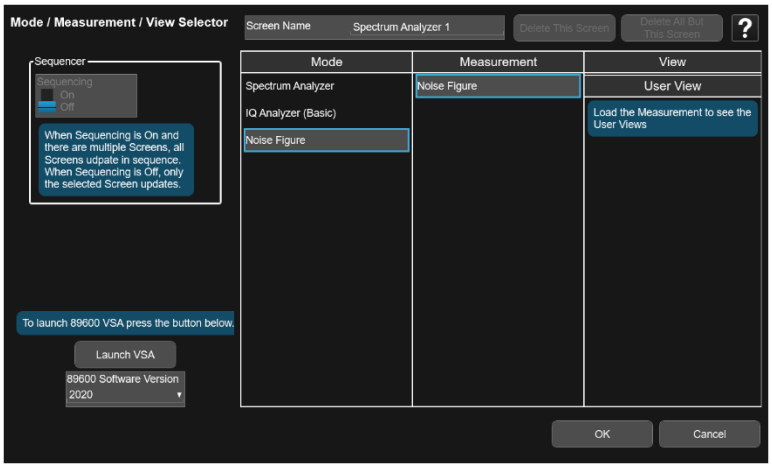
Verify Hardware Configuration

- Verify hardware connections, as shown on Page 4 of this document.

Software Configuration and Setup

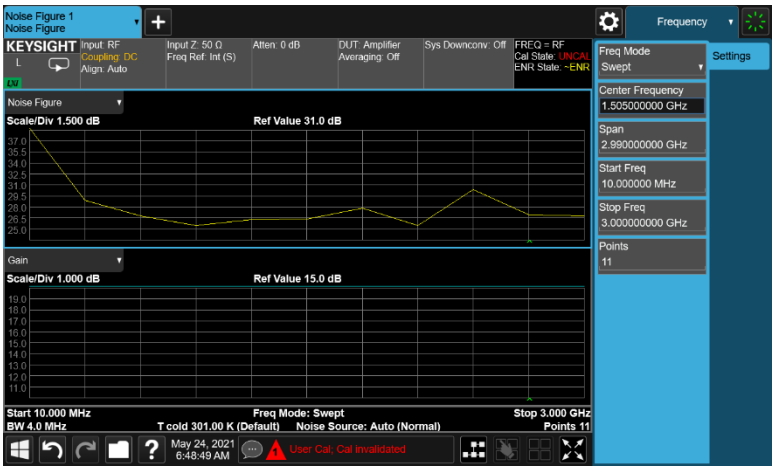
- Press [Mode/Meas] soft key

- Default Mode should be set to ‘Spectrum Analyzer’
- Set to ‘Noise Figure’
- Press ‘OK’



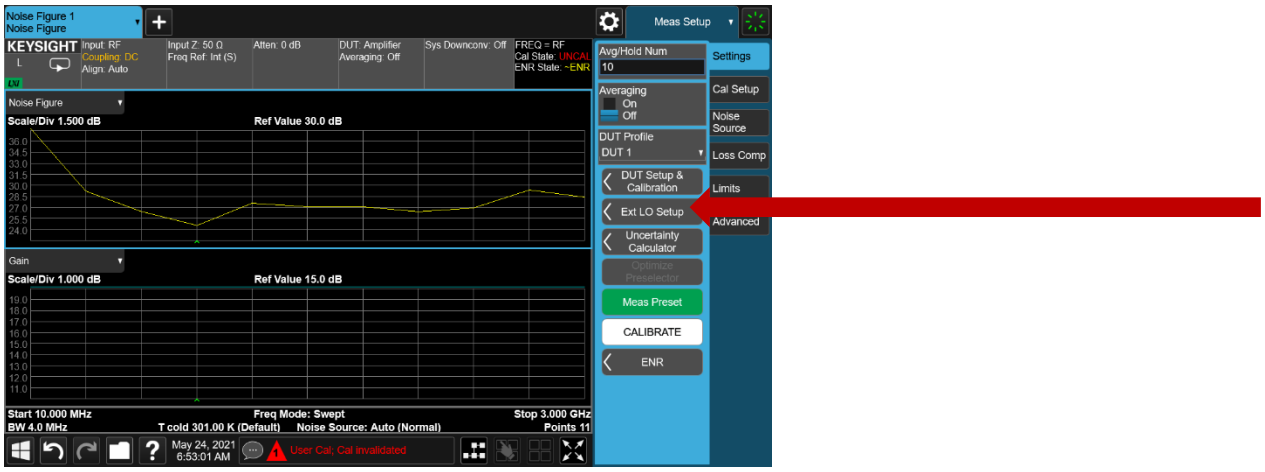
Spectrum Analyzer Setup - continued

- After pressing ‘OK’, you should see the following screen (showing Noise Figure and Gain plots)



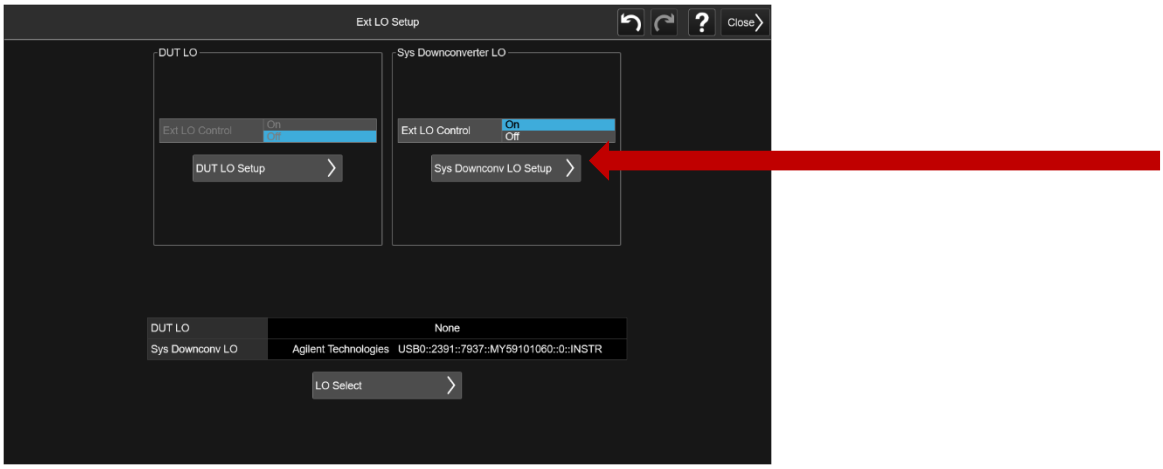
- Press [Meas Setup] soft key

- Click on ‘Ext LO Setup’

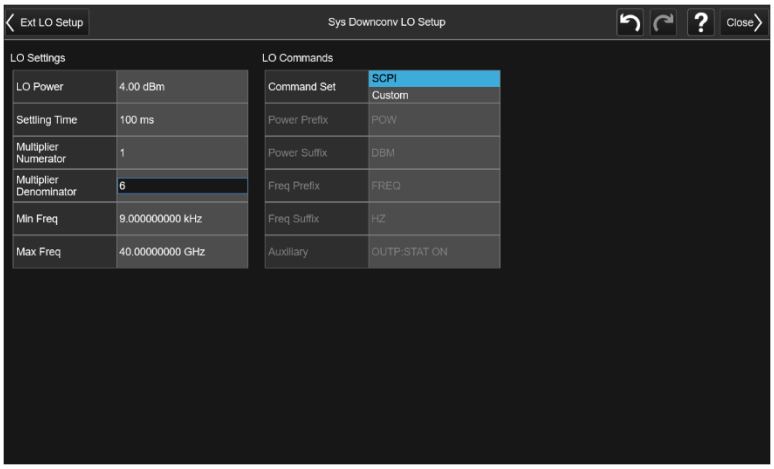


Spectrum Analyzer Setup - continued

- Click on ‘Sys Downconv LO Setup’



- Enter appropriate settings for the LO Signal Generator (See Example below)
- Click ‘Close’ when complete



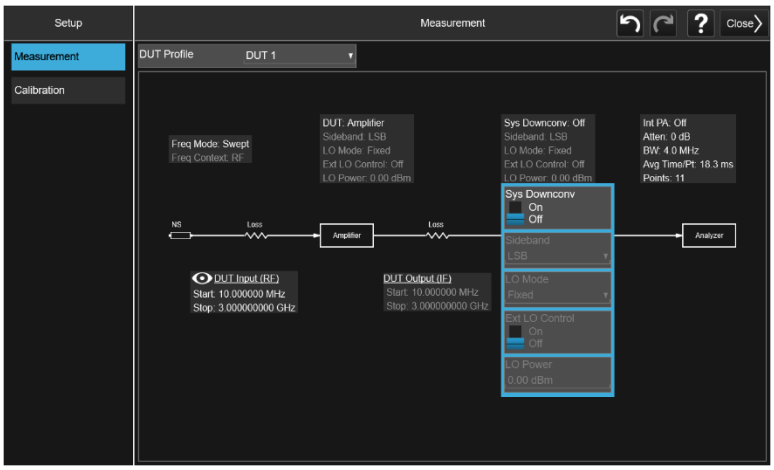
Example System Down-Converter LO Setup

- LO Power: 4dBm [This sets the output power from the external signal generator]
    - This may depend on system down-converter LO input power specifications. Set LO power appropriately based on system down-converter module.
- Settling Time: 100ms (Default, can be adjusted if needed)
- Multiplier Numerator: 1
- Multiplier Denominator: 6 [Set by the LO Harmonic Factor of the system down-converter]
- Min Freq: 9kHz [Default, Based on your Signal Generator]
- Max Freq: 40 GHz [Default, Based on your Signal Generator]

Spectrum Analyzer Setup - continued

- Click on ‘DUT Setup & Calibration’

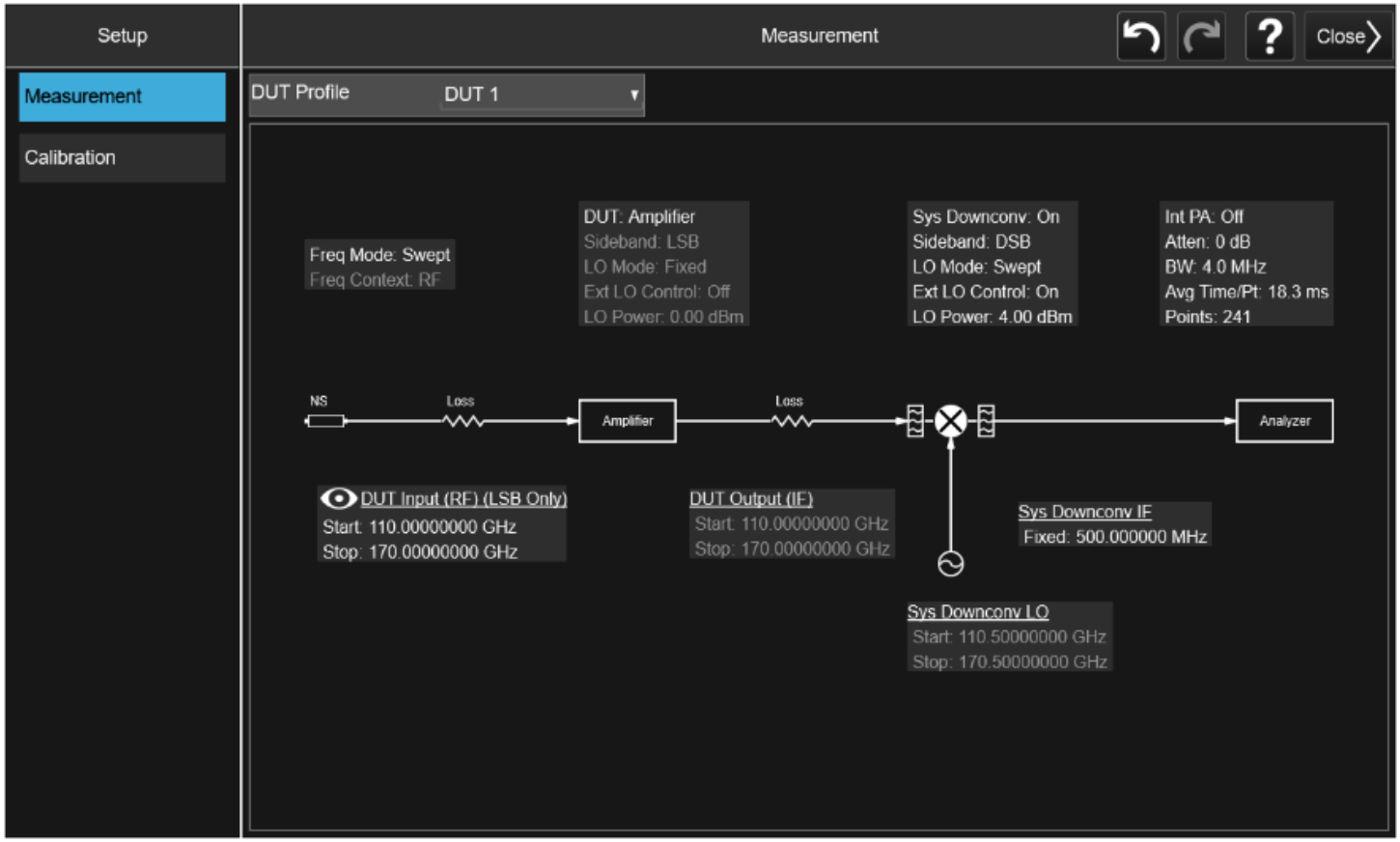
- Click on ‘Sys Downconv’ drop down menu and turn it on.



- Set parameters as shown below:
  - Sys Downconv: ON
  - Sideband: DSB
  - LO Mode: Swept
  - Ext LO Control: ON
  - LO Power: 4dBm [Set based on previous LO Signal Generator settings in System Down-Converter LO Setup]

Spectrum Analyzer Setup - continued

- Set remaining system parameters based on your system requirements.
- Example shown below to measure waveguide low noise amplifiers across 110-170 GHz using a WR6.5NS and a WR6.5SAX
- Click ‘Close’ when complete.



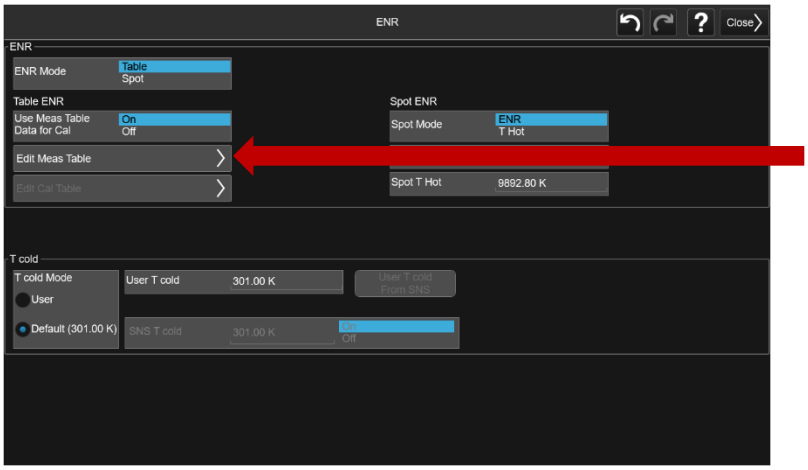
Spectrum Analyzer Setup - continued

Verify ENR Table

Verify ENR Table has loaded correctly

- Click on ‘ENR’

- Verify that ENR Mode is set to ‘Table’ not ‘Spot
  - ‘Spot’ can be used if user wants to set a flat, fixed ENR value across the full band
- Click on ‘Edit Meas Table’ to verify that the ENR data has loaded correctly
- Click ‘Close’ after ENR data has been verified



Calibration

- Connect equipment as shown on Page 4, without the DUT (i.e. connect VDI Noise Source directly to VDI SAX Module – Additional waveguide sections may be needed for proper waveguide flange connections)
- Click ‘Calibrate’
    - Can be a slow sweep, depending on sweep parameters
- After Calibration procedure is complete, Noise Figure and Gain plots should be close to 0dB, as shown below.

Calibration and Measurement – continued

Measurement

- Once Calibration procedure is complete, disconnect the VDI Noise Source and the VDI SAX.
- Connect DUT between the VDI Noise Source and VDI SAX Module (as shown on Page 4).
- Apply Voltage Biases to DUT, as needed.
- Example plot of VDI WR8.0AMP-LN is shown below