Memo Cover Sheet

NenuFAR Low Noise Amplifier – 01
(LWA Memo #232)

NenuFAR Low Noise Amplifier Measurements

27 May 2026

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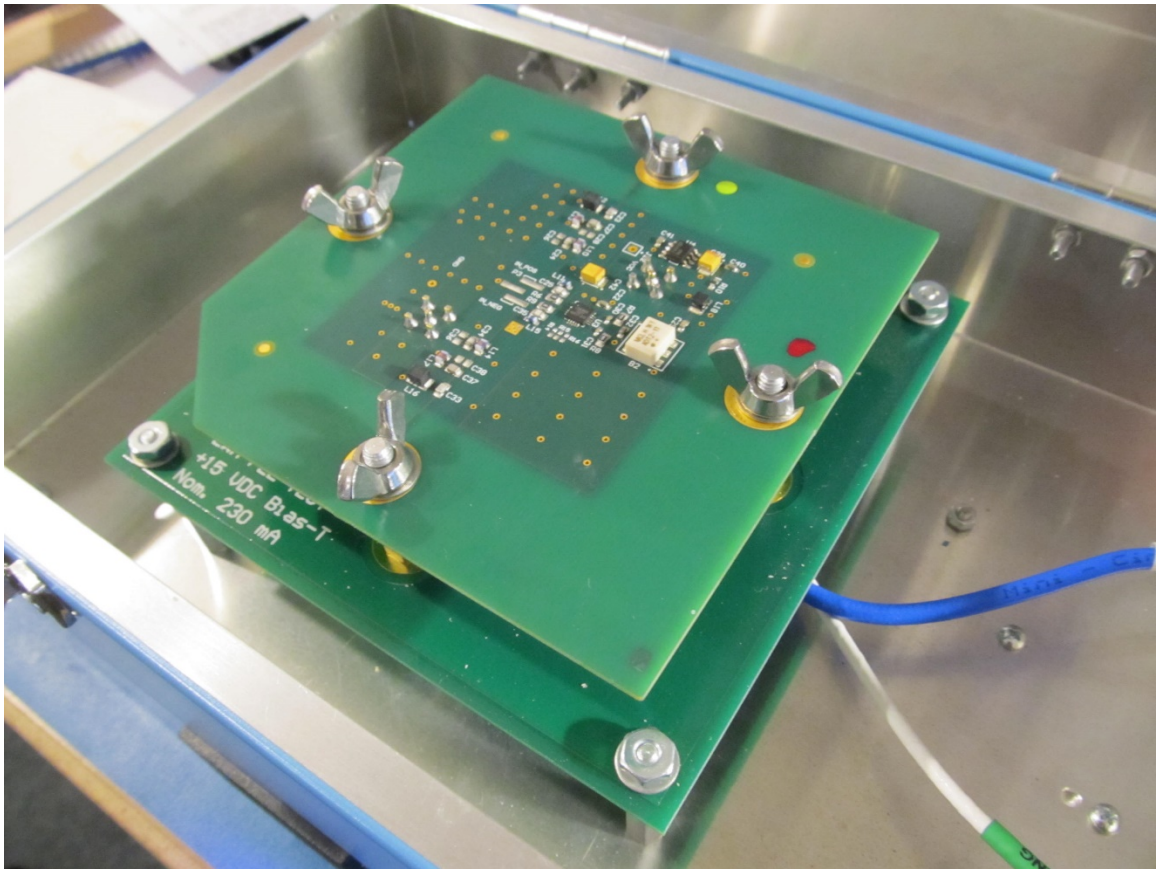
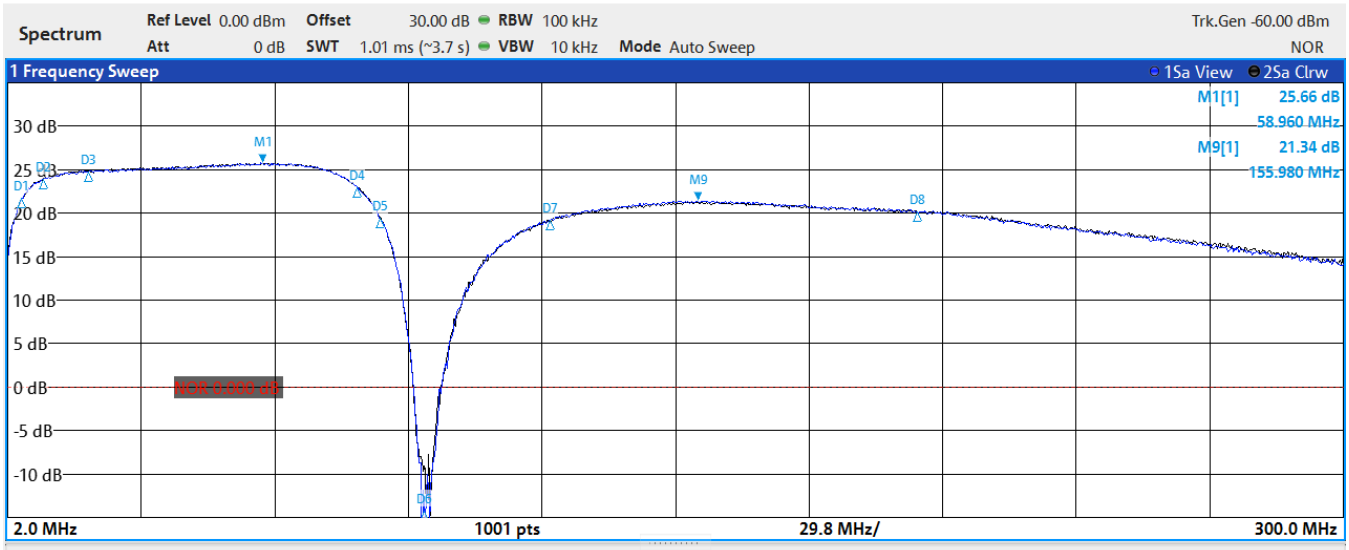


Gain measured with Spectrum Analyzer /Tracking Generator

Gain of both polarizations from 2 to 300 MHz ↓

Gain measured with R&S FPL1003 spectrum analyzer. PCB polarizations indicated by a Red and Green dot on the PCB. This plot was taken at 5.5 Vdc input but there was no significant change from 5. 5 to 15 Vdc input. However, at 5.0 Vdc input, the gain at frequencies above 100 MHz decreased slightly. FM band notch is about 40 dB down. Note that marker M1 is the Reference Marker set to the highest Peak at 58.96 MHz and marker M9 was set to the next highest Peak at 155.8 MHz. All other markers are Delta Markers with M1 Reference (see Marker Table below plot).



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	58.96 MHz	25.66 dB		
D1	M1	1	-53.964 MHz	-4.00 dB		
D2	M1	1	-48.964 MHz	-1.79 dB		
D3	M1	1	-38.964 MHz	-0.92 dB		
D4	M1	1	21.036 MHz	-2.80 dB		
D5	M1	1	26.036 MHz	-6.27 dB		
D6	M1	1	36.036 MHz	-39.90 dB		
D7	M1	1	64.036 MHz	-6.47 dB		
D8	M1	1	146.036 MHz	-5.54 dB		
M9		1	155.98 MHz	21.34 dB		

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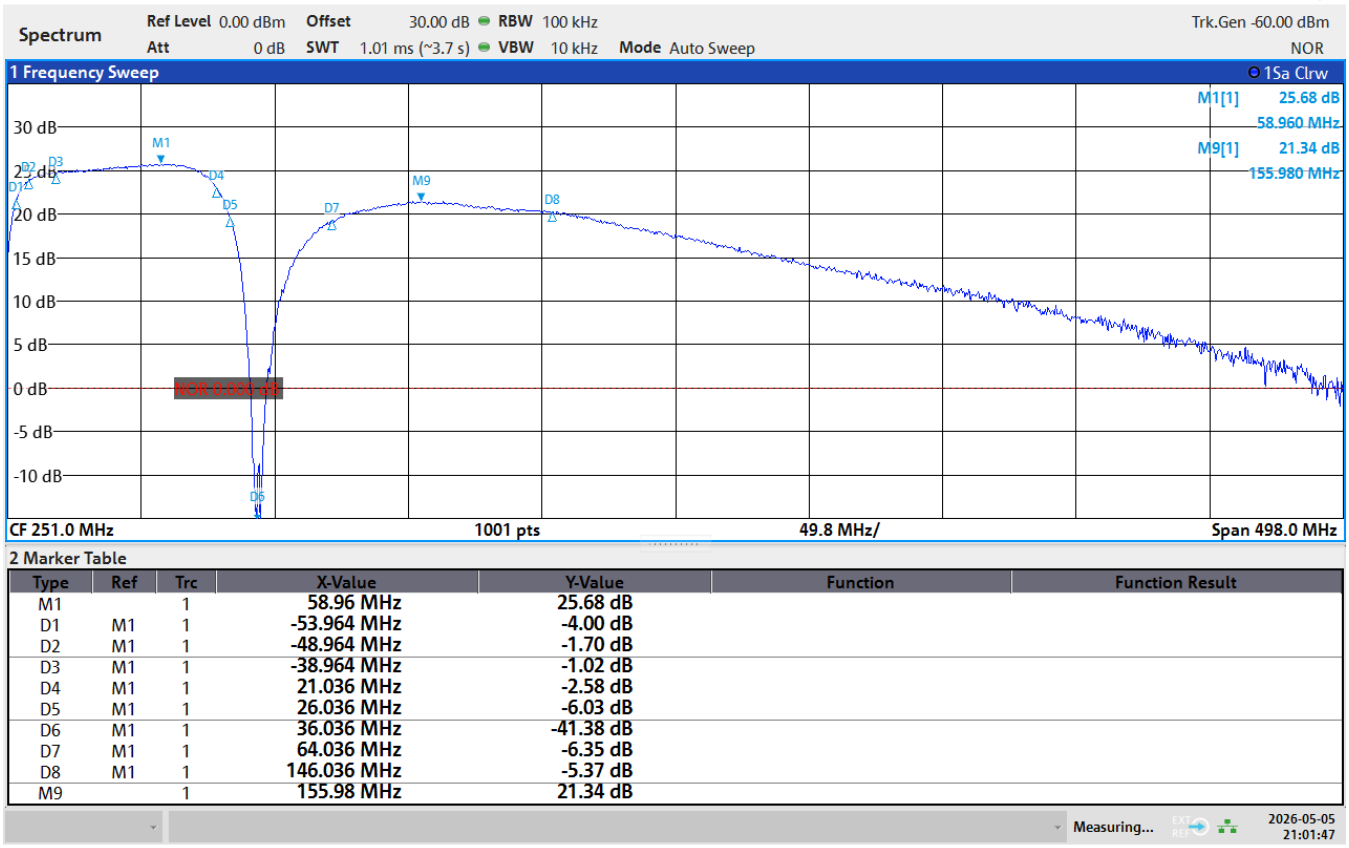
Gain from 2 to 500 MHz to show LNA response at higher frequencies ↓

Marker M1 was set to the highest Peak (58.96 MHz) and Marker M9 was set to the next highest Peak (155.98 MHz). All other Markers are Delta markers with M1 Reference. The gain out to 2 GHz also was examined for spurious emissions but none were found.



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Basic spectrum analyzer/tracking generator setups:

FEE Test Fixture version 2 with 1 m long precision test cables to spectrum analyzer/tracking generator

10 dB attenuator on tracking generator RF output (net output power –60 dBm)

30 dB attenuator on spectrum analyzer RF input (Ref Level Offset 30 dB)

Spectrum analyzer/tracking generator normalized only with 10 dB attenuator on TG output

Frequency start/stop or center frequency/span as shown on plots

Resolution bandwidth (RBW): 100 kHz

Video bandwidth (VBW): 10 khz

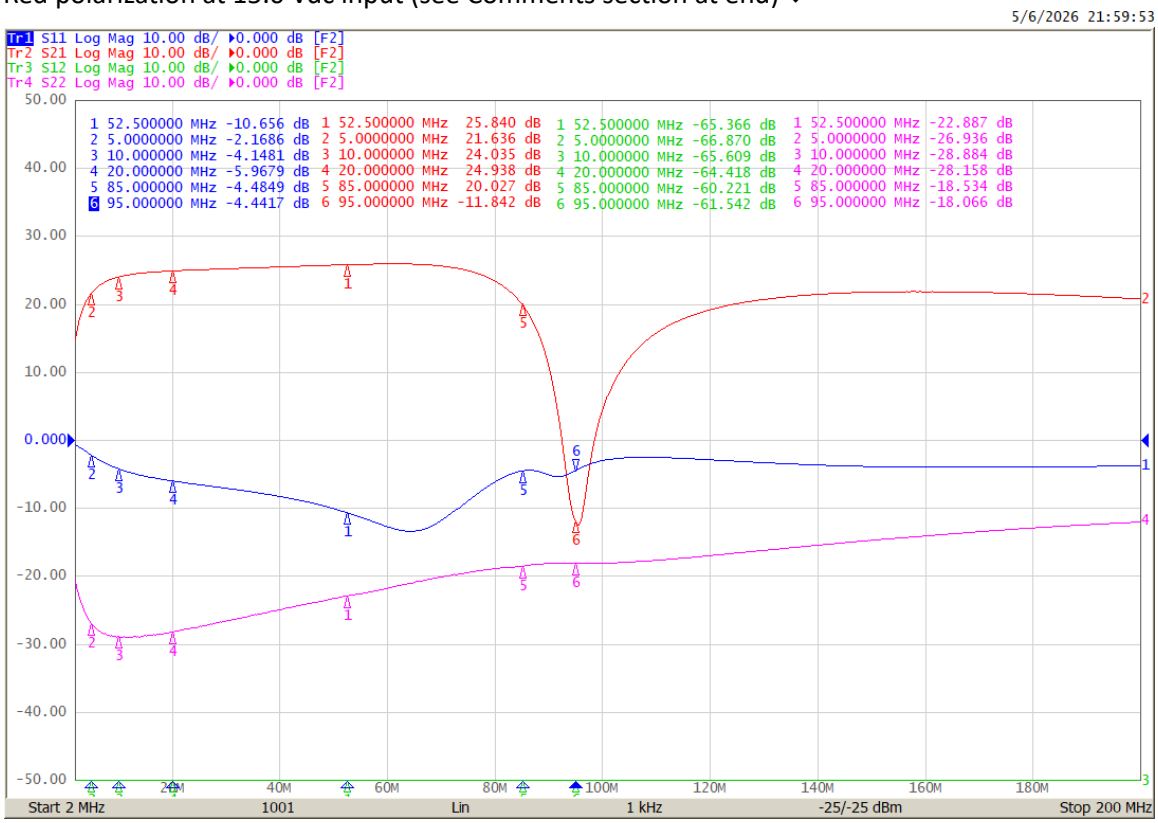
Attenuator: Auto (0 dB)

Sweep time: Auto

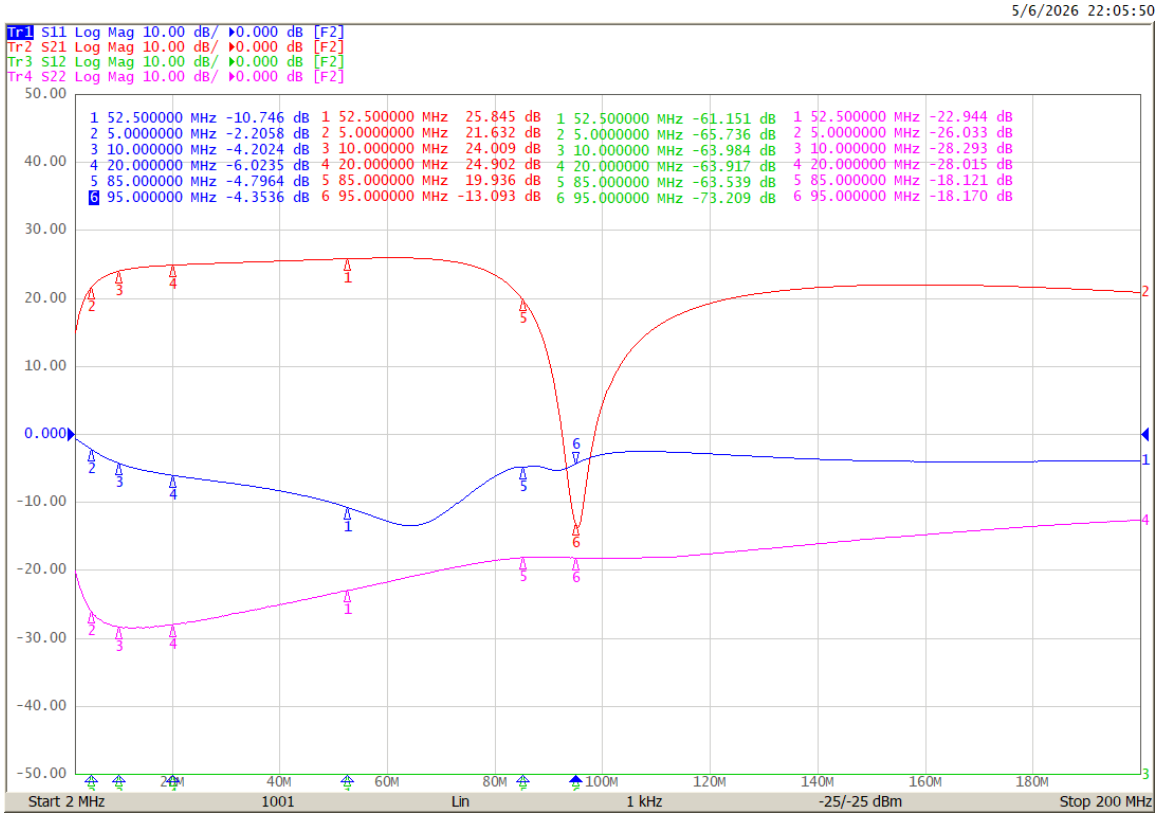
Measurement points: 1001

S-Parameters measured with CMT S5045 VNA from 2 to 200 MHz

Red polarization at 15.0 Vdc input (see Comments section at end) ↓



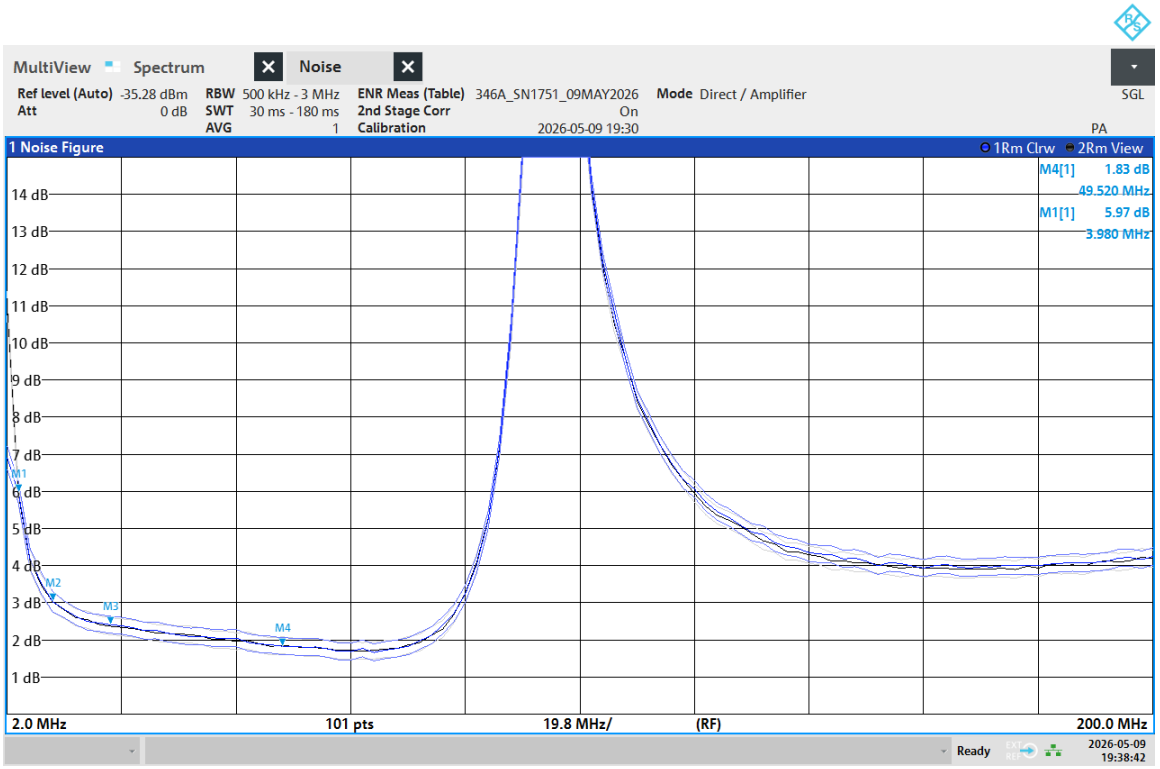
Green polarization at 15.0 Vdc input (see comments) ↓



Noise figure & Gain using Noise Figure Application in Spectrum Analyzer

Note: These measurements are at 5.5 Vdc input with no discernible change at 15.0 Vdc input

Noise figure (see Composite Display plot on next page for Marker Table) ↓



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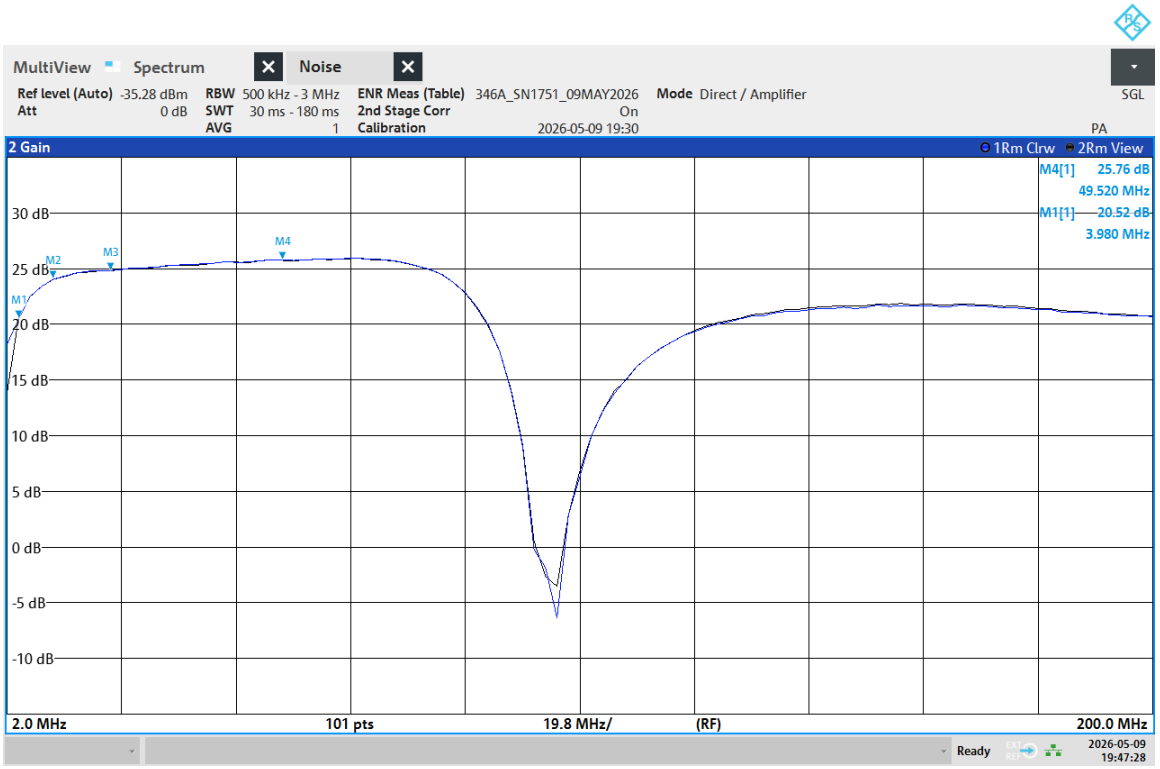
Gain (see Composite Display plot on next page for Marker Table) ↓



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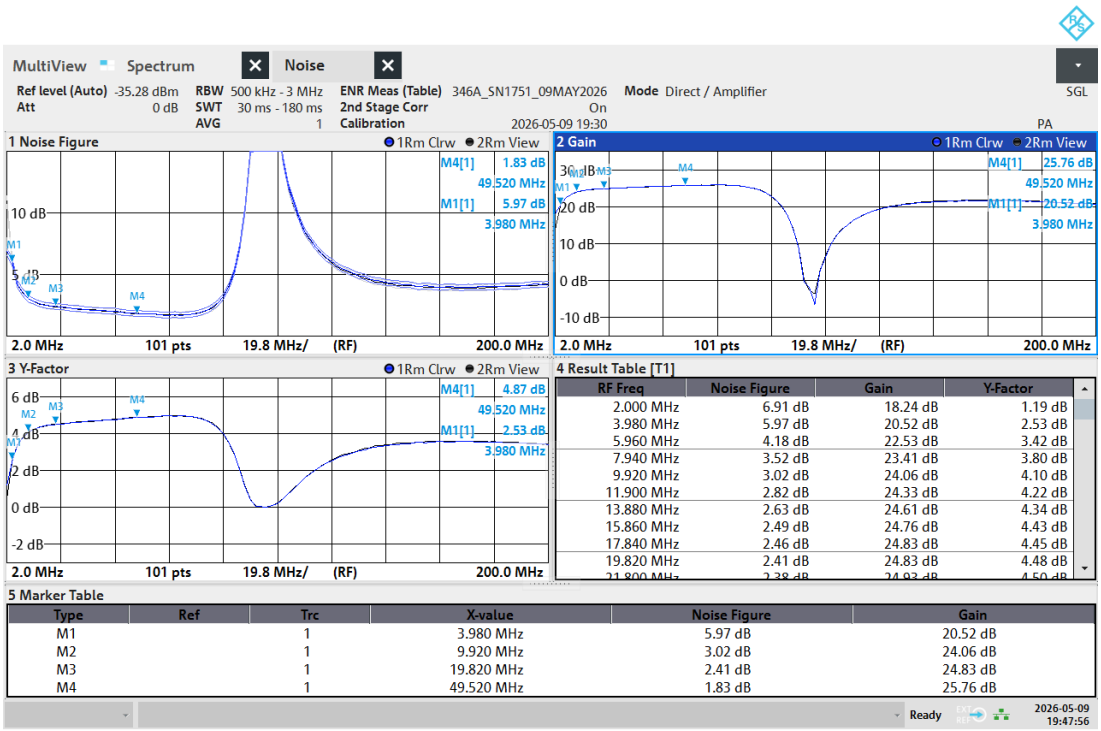
Noise figure composite display ↓



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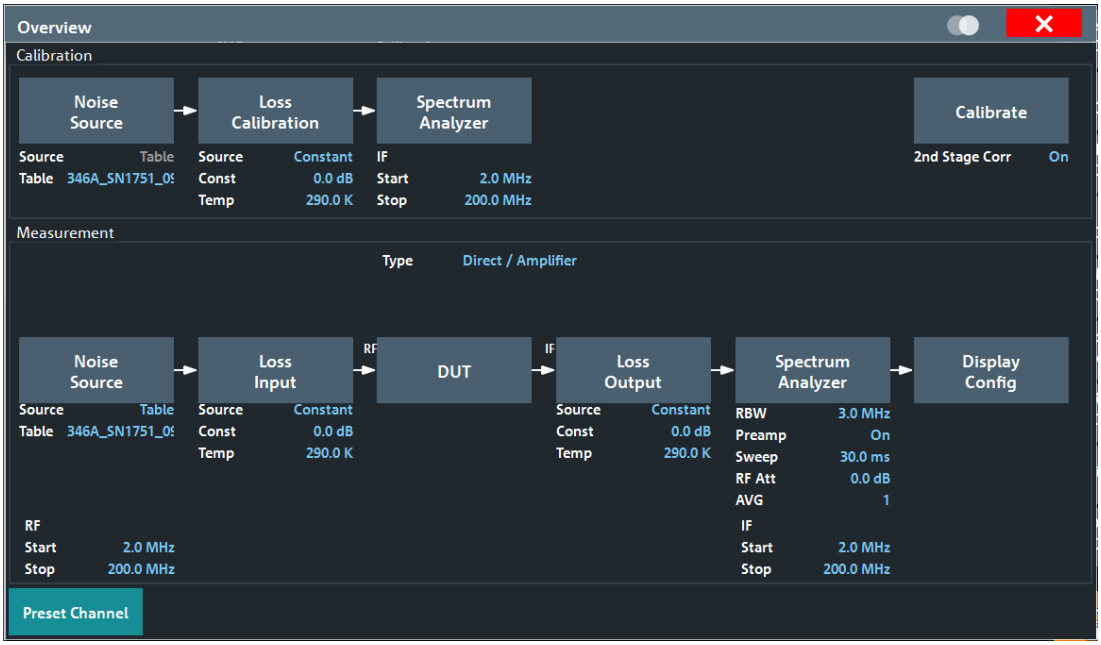
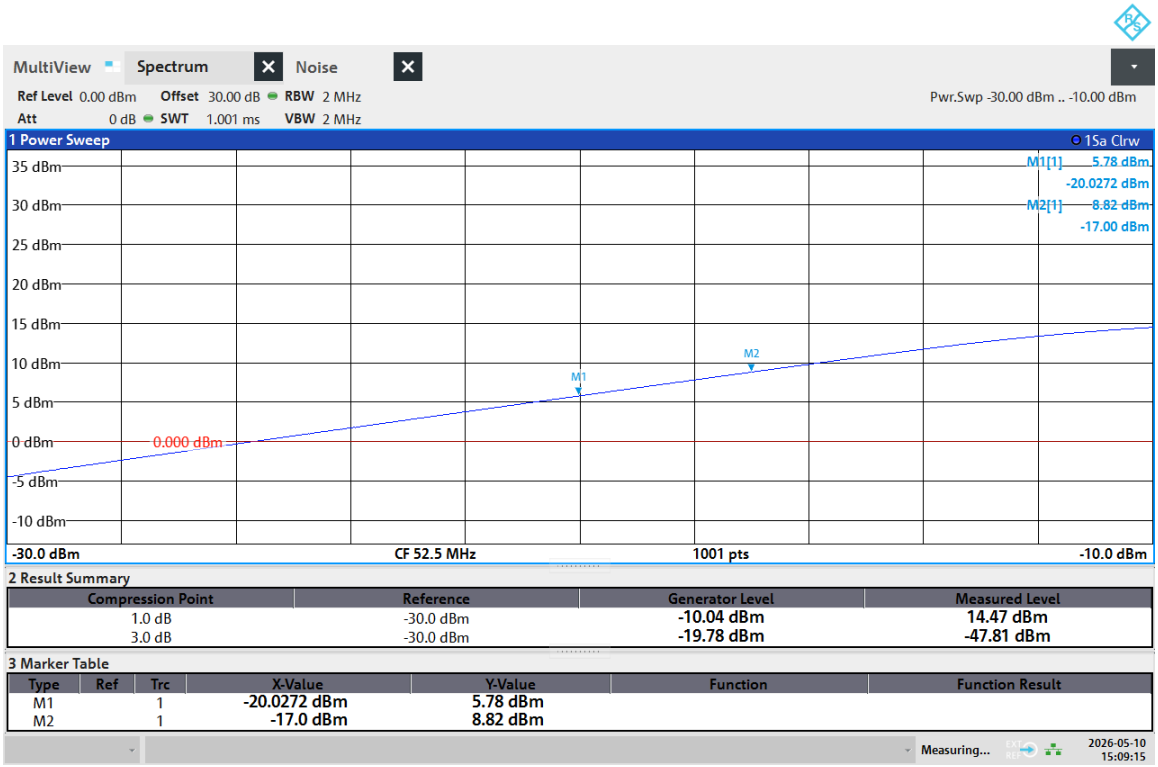
Noise figure setup Overview ↓



Frequency table RBW and Sweep time settings (special settings required below 10 MHz):
Freq. 2.00 MHz, RBW. 500 kHz, Sweep. 180 ms
Freq. 3.98 MHz, RBW. 1 MHz, Sweep. 90 ms
Freq. 5.96 MHz, RBW. 1 MHz, Sweep. 90 ms
Freq. 7.94 MHz, RBW. 2 MHz, Sweep 45 ms
Freq. 9.92 MHz, RBW. 2 MHz, Sweep 45 ms
Freq. ≥ 10 MHz, RBW. 3 MHz, Sweep 30 ms

1 dB compression

1 dB compression measured at 52.5 MHz (mid-frequency) with 15.0 Vdc input ↓. The 1 dB compression point occurs at –10.0 dBm input power level at which point the LNA output power is +14.4 dBm. Markers are at arbitrary positions. No change in compression was indicated when input voltage was reduced to 5.5 Vdc. 3 dB compression levels also are indicated in the Result Summary table. Note: Load current increases from approximately 65 mA to at least 85 mA during the high point of a power sweep.



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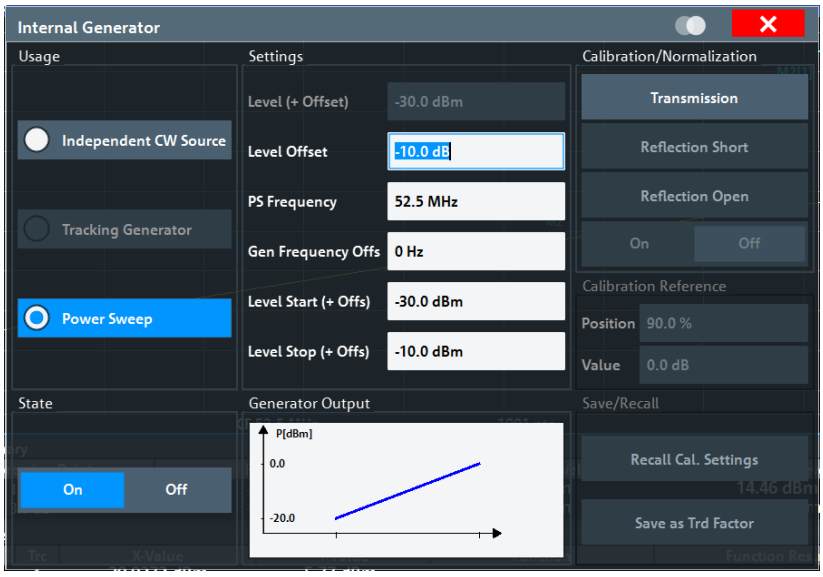
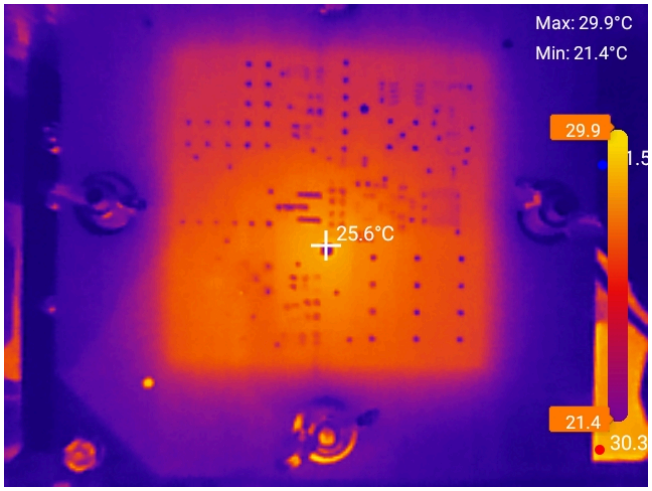
Power Sweep Setup ↓ (Internal generator has 10 dB attenuator to improve impedance matching; this attenuator is taken into account so that Level Start and Level Stop indicate actual power levels into the DUT)

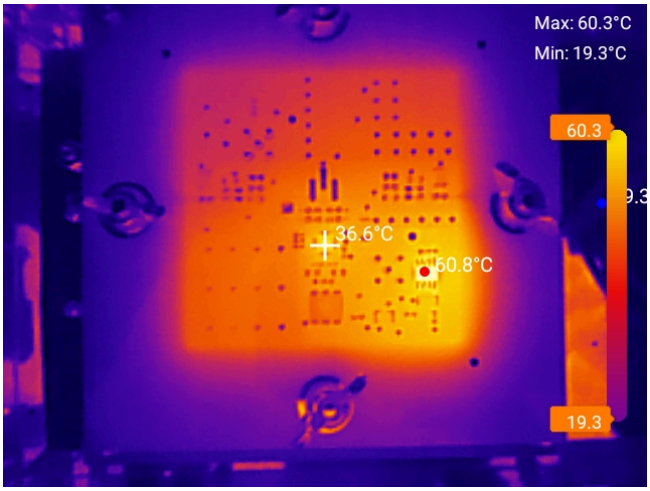


Thermal images measured with TopDon TC003 Thermal Imager

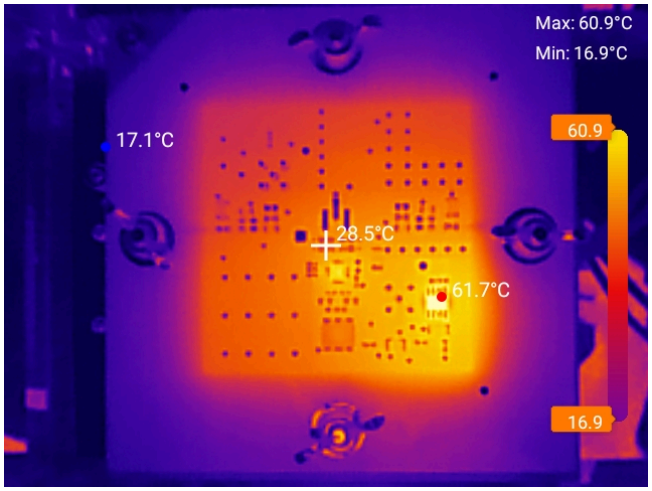
Note: The LWA FEE Test Fixture allows only one polarity to be powered at a time

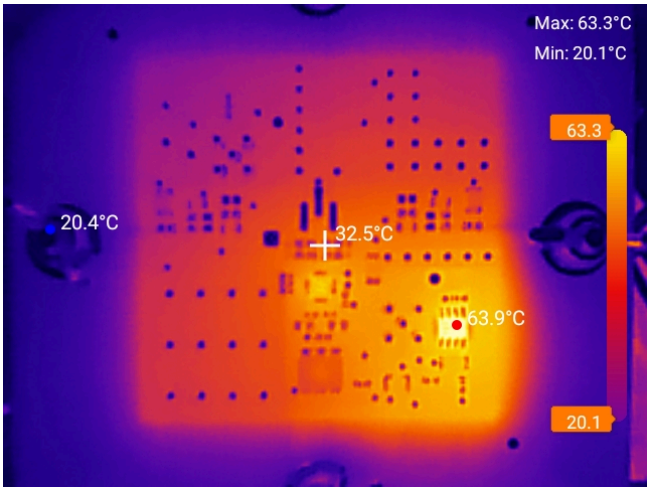
Left ↓: Thermal image with cross-hairs on the hottest point. This image is of the upper PCB surface with the Red polarization (on lower PCB surface) powered by 5.5 Vdc with –70 dBm RF input. Right ↓: Thermal image showing the two hottest points on the upper PCB surface with the Green polarization (on upper PCB surface) powered by 15.0 Vdc with –70 dBm RF input.





Left & Right ↓: Thermal images of the upper PCB surface with the Green polarization (on upper PCB surface) powered by 15.0 Vdc during 1 dB compression point measurements with –30 to –10 dBm RF input power sweep.





Comments:

Measurement configuration:

The LWA FEE Test Fixture allows only one polarization to be powered at a time so it was not possible to determine if there is any interaction between the two polarizations.

S-parameters:

Calibration and measurements performed as described in *FEE S-Parameter Measurement Procedures with FEE Test Fixture V2*, Rev. 0.6 (20 February 2025). The VNA ports were calibrated with the LWA FEE Calibration Fixtures (Red) at 0 dBm power levels but then both ports were reduced to –25 dBm for the measurements. Refer to the plots for other VNA settings. There were no noticeable variations in the S-Parameters with input voltages from 5.5 to 15.0 Vdc. At 5.0 Vdc input voltage (below the specified range), the forward gain (S21) and the output reflection loss (S22) decreased slightly above 100 MHz.

Noise Figure: The FPL1003 spectrum analyzer is equipped with the FPL1-K30 Noise Figure software option, which provide measurement and analysis tools and a 28 Vdc voltage source for controlling the noise source. The analyzer was Calibrated prior to measurements using the 2nd Stage Correction feature. During Calibration, the noise source (HP 346A) was connected directly to the analyzer RF input. Special Resolution Bandwidth (RBW) and Sweep Time settings were required for the noise figure measurements below 10 MHz as shown in the Noise Figure measurement section above.

Hand capacitance effects:

There were no apparent test fixture effects on the S-parameter measurements; hand capacitance effects noted only when actually touching components on the PCB.

Load current (–70 dBm input signal level):

5.5 V input: Green 64.4 mA, Red 63.2 mA

15.0 V input: Green 65.3 mA, Red 63.8 mA

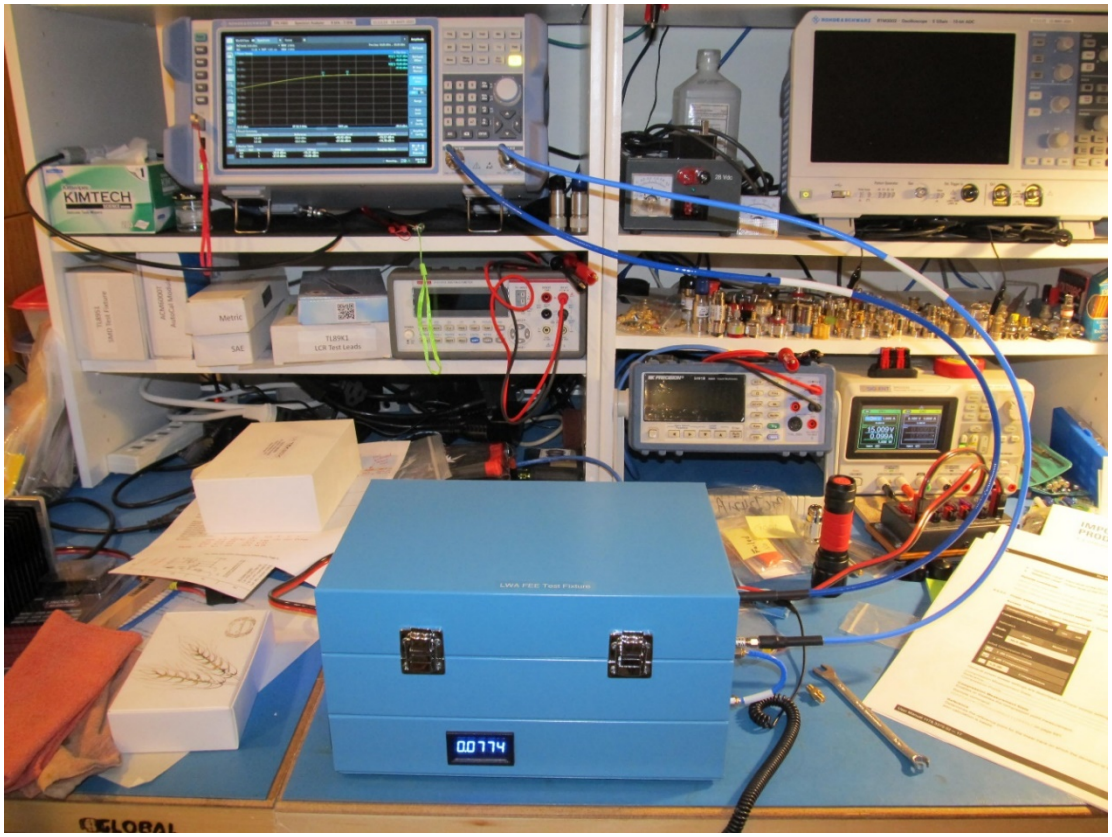
Note 1: Load current increased up to at least 85 mA noted during 1 dB compression measurements

Note 2: It was determined later that the nenuFAR amplifier is operated at 9 Vdc in working systems (per Craig Taylor)

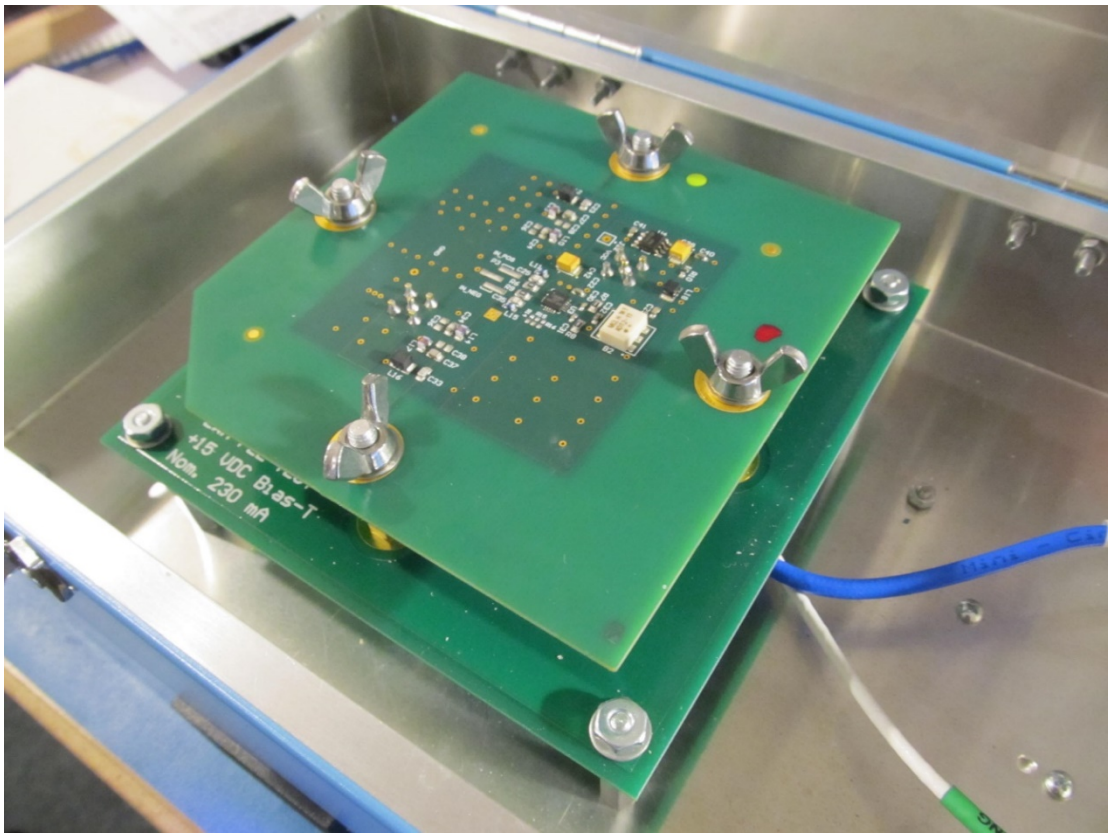
Test Equipment:

- LWA FEE Test Fixture V2 with external dc power input selected
- Siglent SPD3303X 3-channel variable linear power supply
- Rohde & Schwarz FPL1003 spectrum analyzer with tracking generator & K30 noise figure option
- Bird 5A-MFN-10 10 dB N-M:N-F attenuator, TG output
- Mini-Circuits VAT-30+ 30 dB SMA-M:SMA-F attenuator, Test Fixture RF Output (not used with VNA)
- Copper Mountain Technologies S5045 VNA with v26.1.1 software
- LWA FEE Calibration Fixtures, Red (short, open, load, thru)
- Test cables, type N-M to SMA-M, 2x
- HP 346A noise source, s/n 2614A01751
- Topdon TC003 thermal imager

LWA FEE Test Fixture V2 in foreground with lid closed; spectrum analyzer upper background



NenuFAR circuit board in test fixture


+15 VDC Bias-T
Nom. 230 mA

Document information

Author: Whitham D. Reeve

Revision: 0.0 (Started with initial spectrum analyzer measurements, 05 May 2026)
0.1 (VNA & thermal measurements, 06 May 2026)
0.2 (Added noise figure measurements, 09 May 2026)
0.3 (Added 1 dB compression measurements & add'l thermal images, 10 May 2026)
0.4 (Added power sweep window image, 15 May 2026)
0.5 (Distribution, 25 May 2026)
0.6 (Updated after LWA Coordination Meeting on 27 May 2026)

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