F1950 Intermodulation Product at 3.5 GHz

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- AT0069

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The Analog and Digital Company™

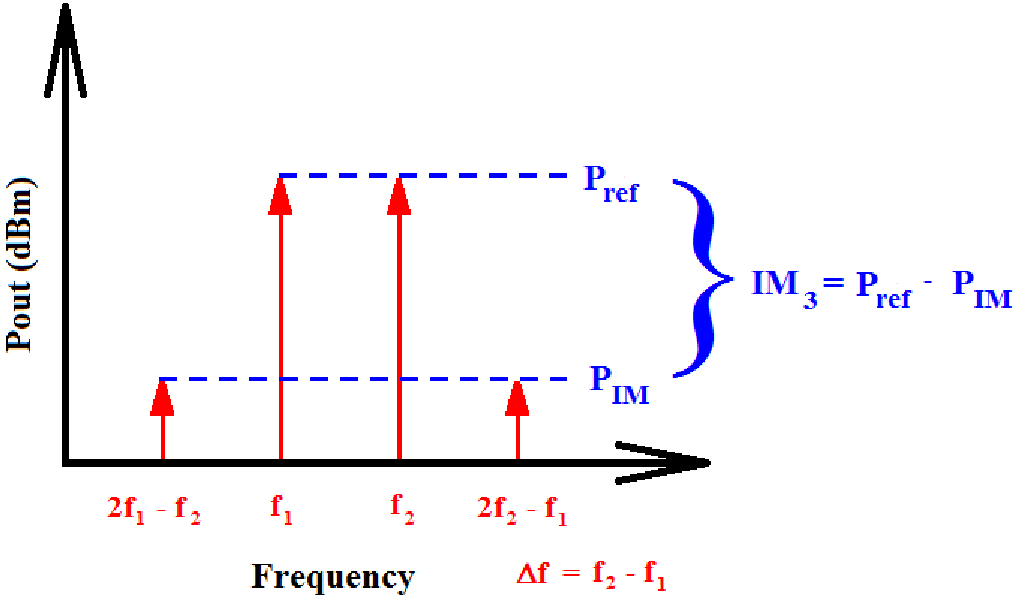
Agenda

- Customer is interested in the Third Order Input Intermodulation (IIP3) product for the F1950 Digital Step Attenuator at 3.5 GHz.
- Customer would like the data to be collected with the following conditions:
  - Tone spacing 10 MHz
  - Center frequencies 3.515 GHz and 3.615 GHz
  - Input power levels of +10, 0, and -7 dBm.
  - Attenuation States 0, 8, 12, 15, 20, 25, and 31.5 dB
- Our datasheet only shows the data at 0.900 GHz and 1.900 GHz.
- The IIP3 is typically around +65 dBm.

Test Procedure

- Due to the high intermodulation products value (typically +65 dBm) extreme care must be taken in the setup.
- Here is a table to show the required power need to be measure for IM_3 term assuming a IIP3 value of +65 dBm.
- IL is the insertion loss for the DUT at a attenuator setting.

Pin (dBm)	IM_3 (dB)	P_{im} (dBm)
+10	110	-100 - IL
0	130	-130 – IL
-7	144	-151 – IL



Test Procedure

- Equipment issues mean that ALL components must not interact.
- Any non-linearities must be eliminated or completely masked.
- Passive components, mostly filters, are used.
- Due to filters the following changes to the test plan are being done.
  - Tone spacing is 60 MHz. This allows the RF source tunable filters so there is 40 dB isolation one tone spacing away.
  - Center frequency will only be set for 3.5 GHz due to the limitation on setting the RF source tunable filters.
  - Added all major bits for testing.

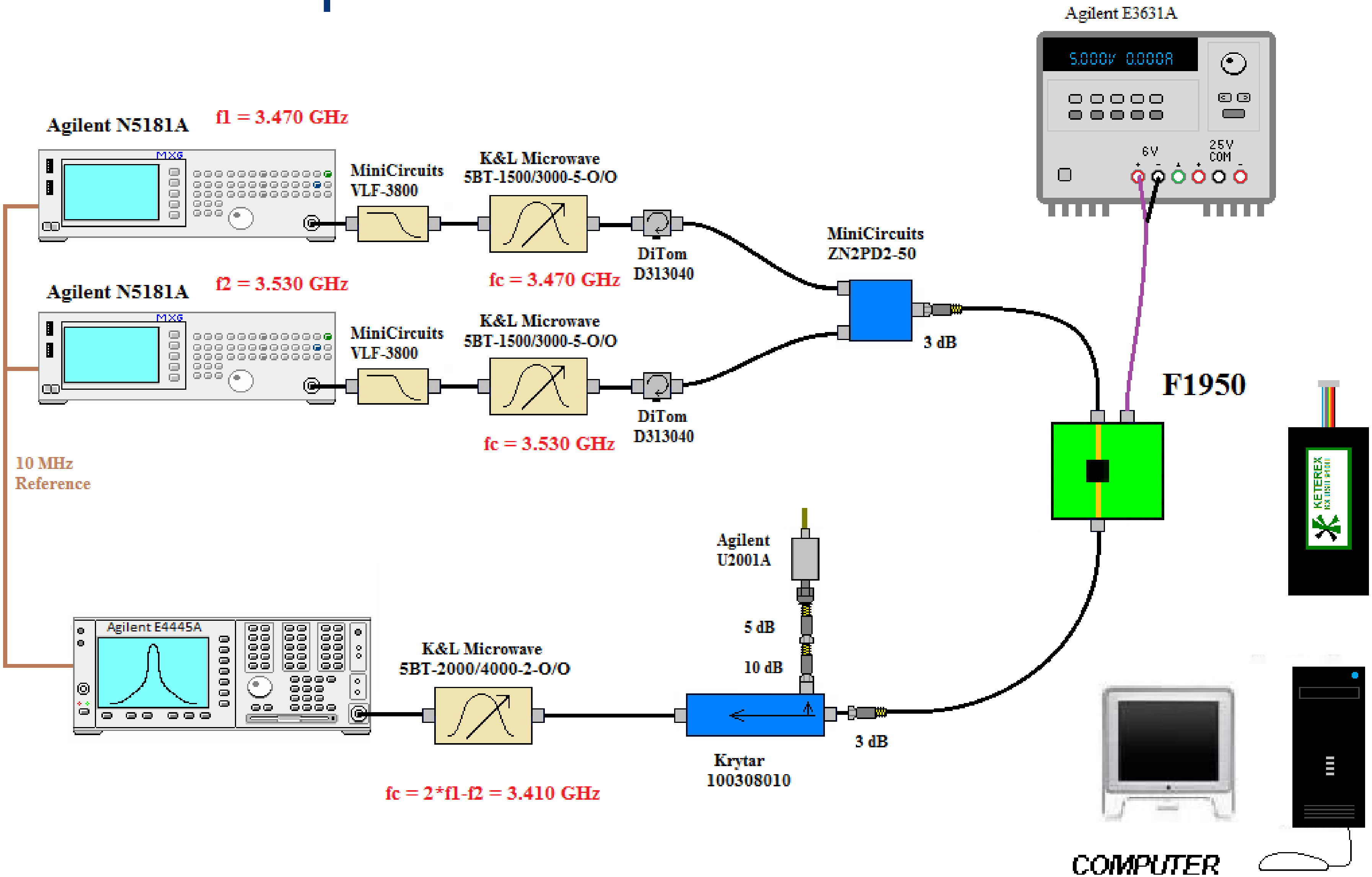
Test Procedure

- Test setup configuration:
  - Low pass filter on RF Sources reduce the harmonics by another 30 dB.
  - Reduce source coupling by
    - Tunable filters on RF Sources create 40 dB isolation at one tone spacing.
    - Isolators add another 20 dB of isolation
  - Add 3 pads before and after to create a better match.

Test Procedure

- Test setup configuration:
  - Input power was set for the required power.
  - Power sensor is required to measure the fundemental power at the output to measure the insertion loss of the DUT.
  - Power sensor is highly nonlinear. Adding a 15 dB pad creates a better match. Sensor had a dynamic range from -70 to +20 dBm so the extra loss can be accommodated.
  - Only the lower IM product is measured to reduce the loss from the DUT to the spectrum analyzer.

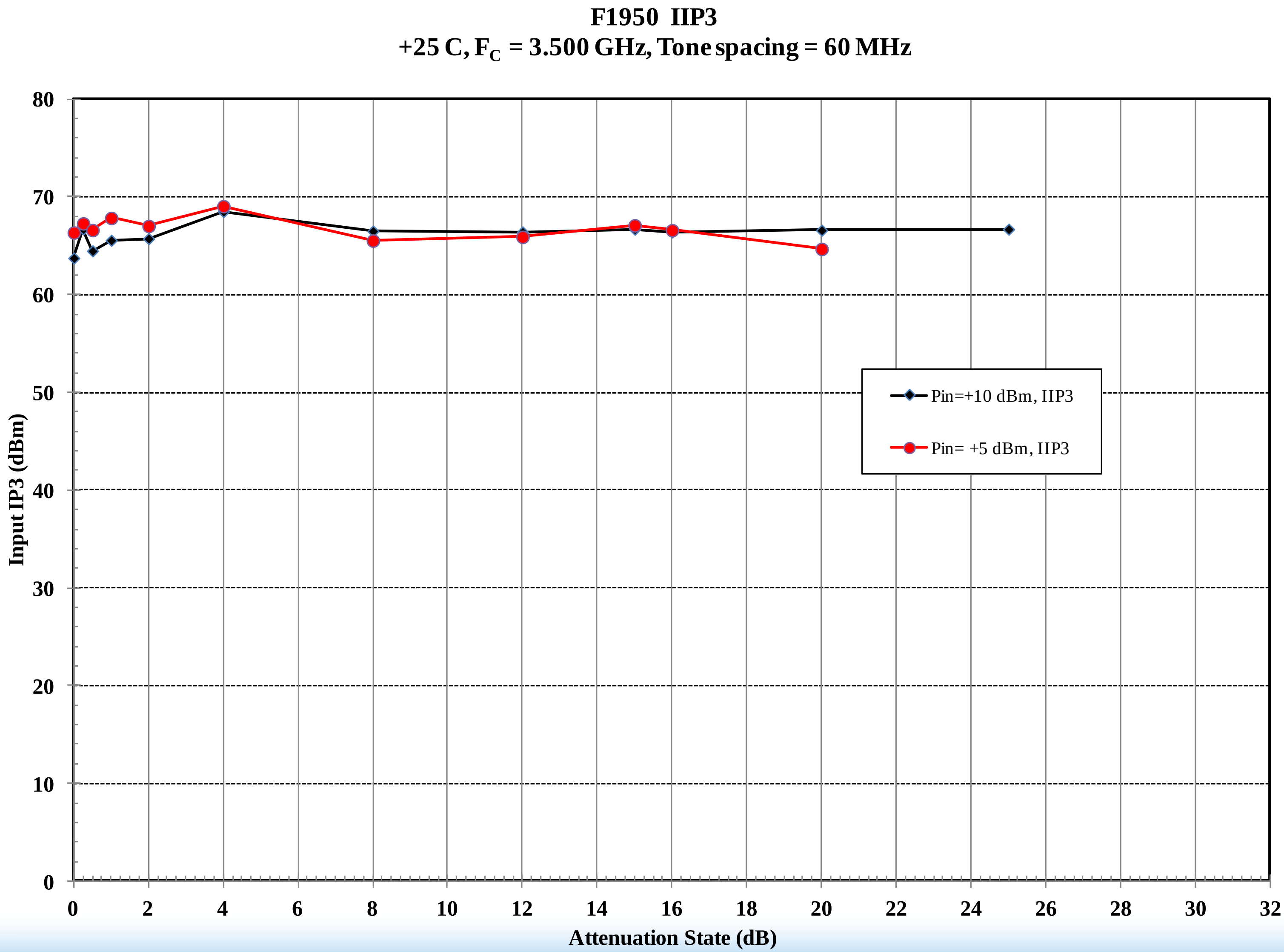
Test Setup


Agilent E3631A
5.000V 0.000A
6V
25V
COM
Agilent N5181A
f1 = 3.470 GHz
MiniCircuits
VLF-3800
K&L Microwave
5BT-1500/3000-5-O/O
DiTom
D313040
fc = 3.470 GHz
MiniCircuits
ZN2PD2-50
Agilent N5181A
f2 = 3.530 GHz
MiniCircuits
VLF-3800
K&L Microwave
5BT-1500/3000-5-O/O
3 dB
F1950
DiTom
D313040
fc = 3.530 GHz
10 MHz
Reference
Agilent
U2001A
5 dB
10 dB
Agilent E4445A
K&L Microwave
5BT-2000/4000-2-O/O
3 dB
Krytar
100308010
fc = 2*f1-f2 = 3.410 GHz
COMPUTER

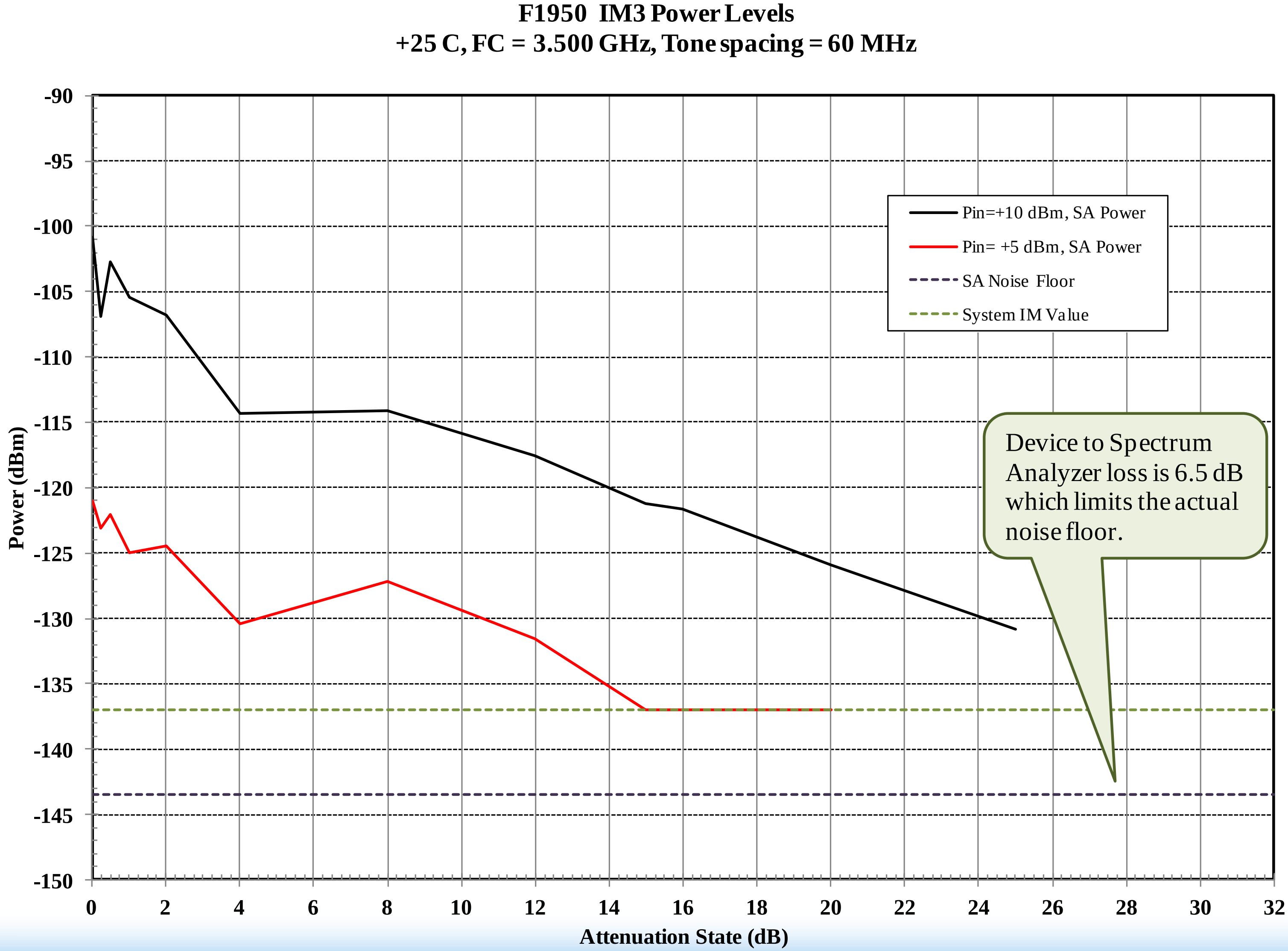
Test Setup Measurement

- With no RF power applied the Spectrum Analyzer has a noise floor of -149 dBm.
- With all the care taken in the setup, setting the input power to +10 dBm, and inserting a zero length transmission line, a IM_3 tone is still seen on the spectrum analyzer with a power level of -143.5 dBm.
- This yields a IIP3 of +83 dBm.

IIP3


F1950 IIP3
+25 C, F$_C$ = 3.500 GHz, Tone spacing = 60 MHz
Input IP3 (dBm)
Attenuation State (dB)
Pin=+10 dBm, IIP3
Pin= +5 dBm, IIP3
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

IM Power Measurements



Observations

- During the testing with an input power level of +5 dBm, the IM3 product was limited to the system IM3 for attenuation states greater than 15 dB.
- No testing can be done for input power of 0 and -7 dBm because the system noise is reached at the reference state (0 dB).

Conclusion

- At input power levels of +10 dBm and +5 dBm, the typical IIP3 is +66 dBm at 3.500 GHz.
- From the datasheet the input power compression for the F1950 Digital Step Attenuator is > +20 dBm. Since at both input power levels yield the same IIP3 value it is safe to assume the value is consistent for all input power levels below +5 dBm.

- ***IIP3 measurements at 3.500 GHz are similar to the measured data at 0.900 and 1.900 GHz in the datasheet.***
- ***This implies the IIP3 is around +65 dBm across the band.***