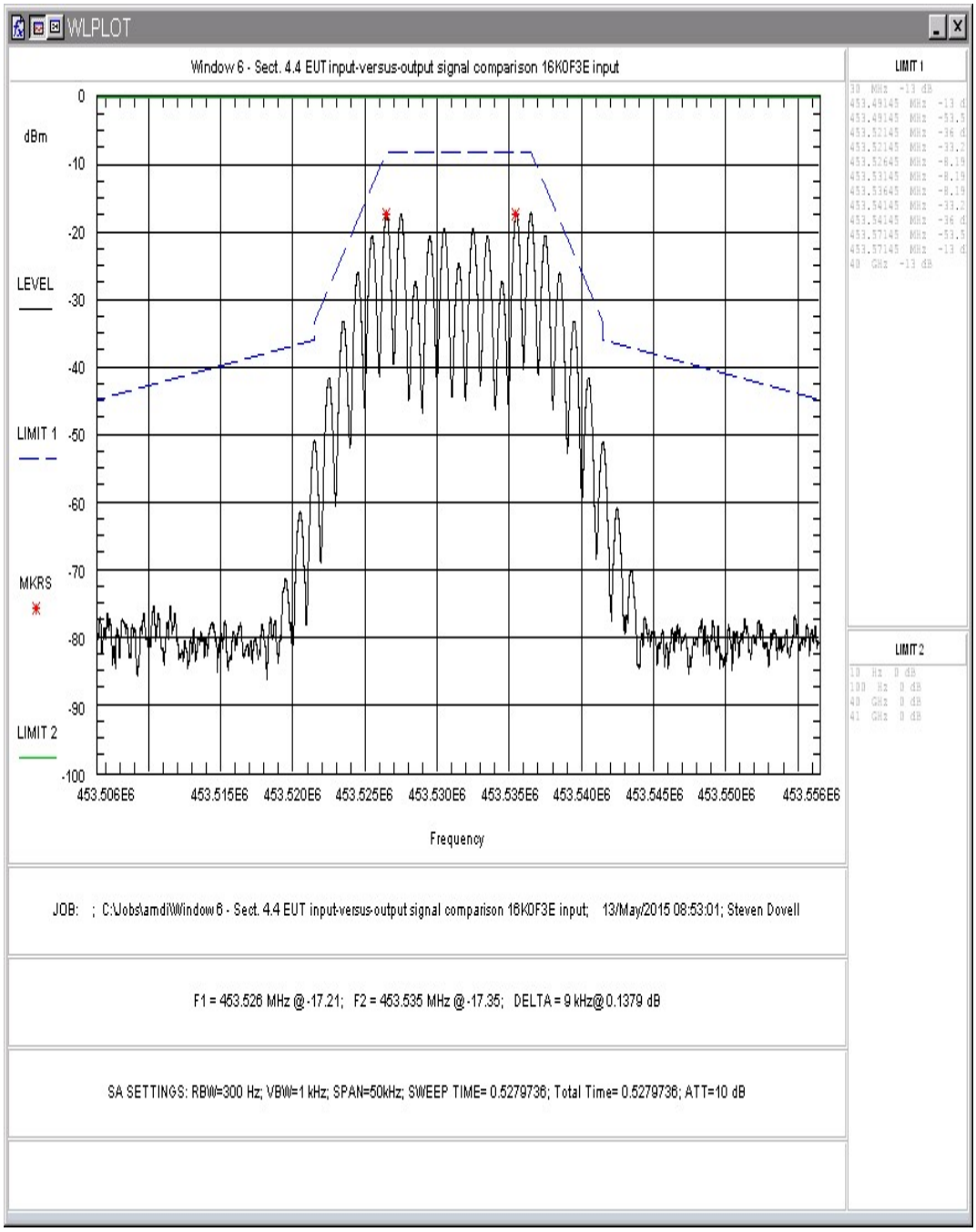

Figure 41. Window 6 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E input

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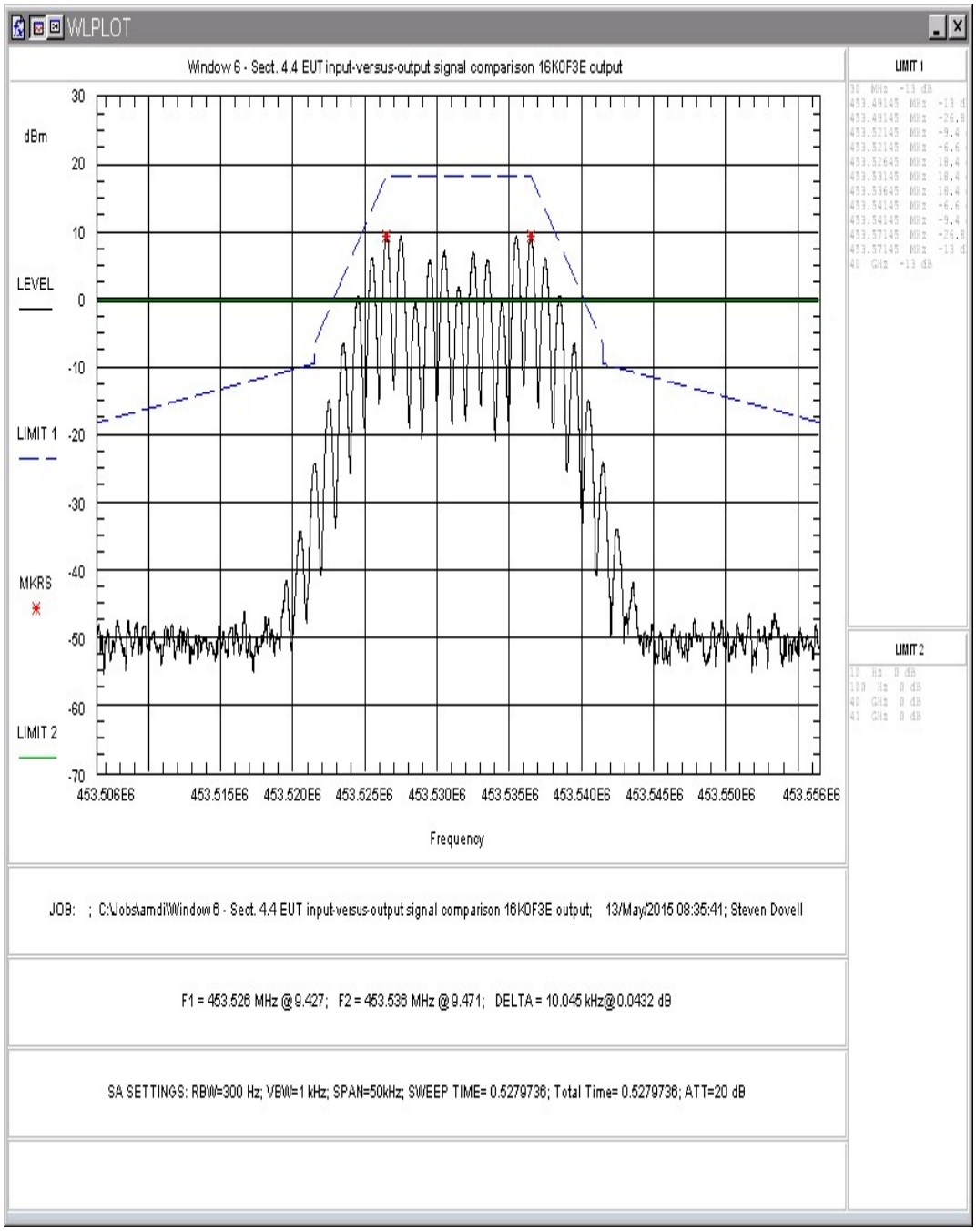

Figure 42. Window 6 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E output

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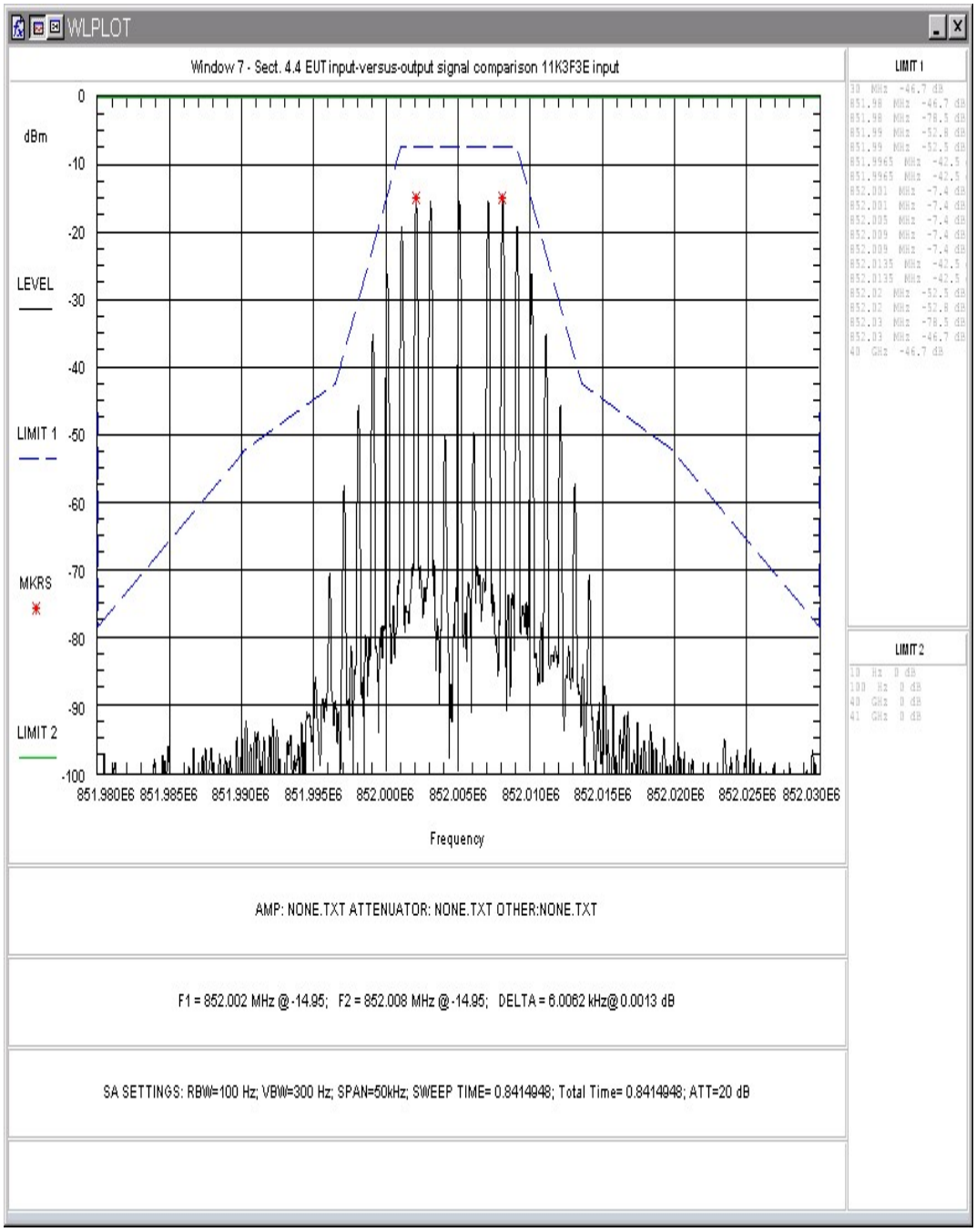

Figure 43. Window 7 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E input

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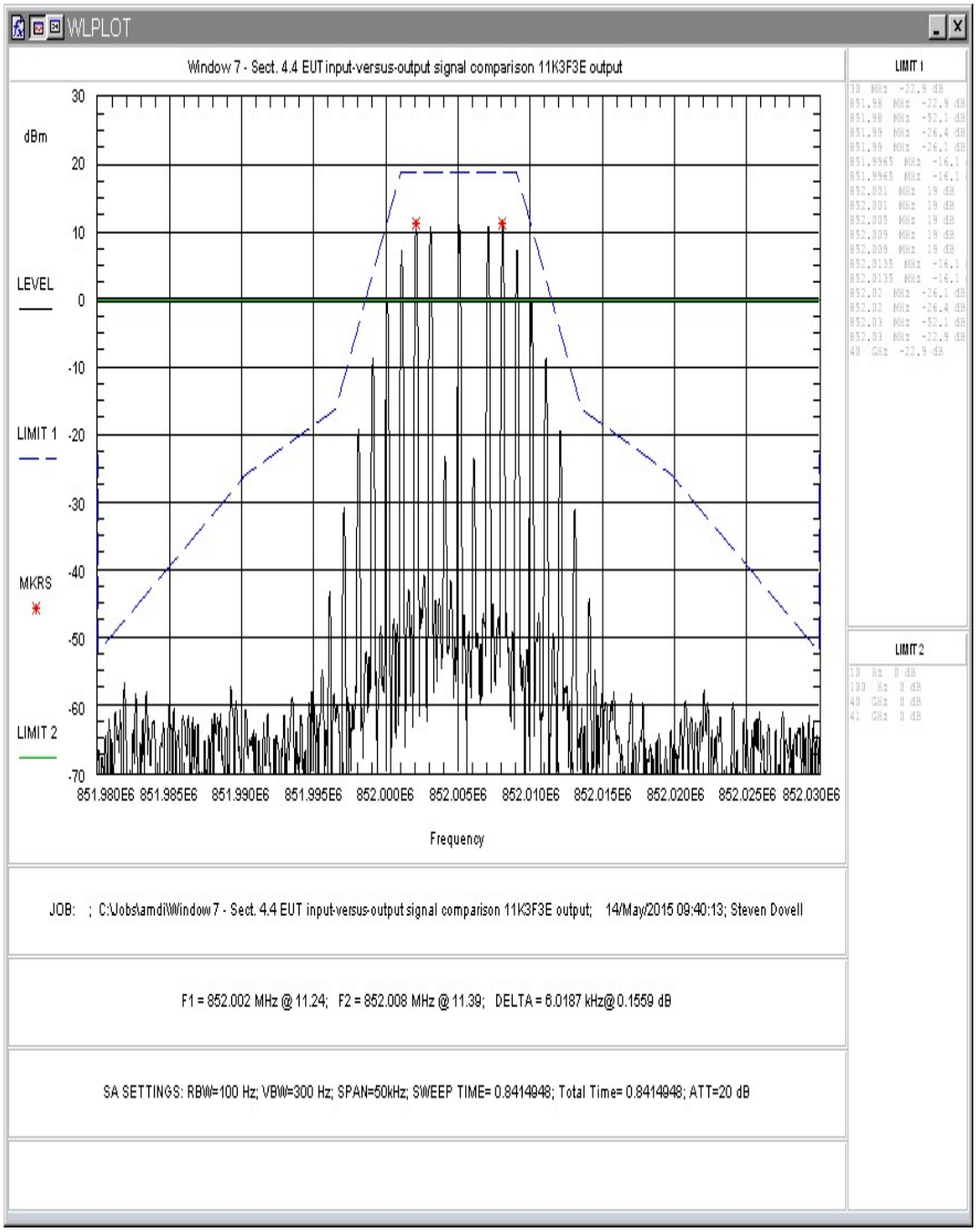

Figure 44. Window 7 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E output

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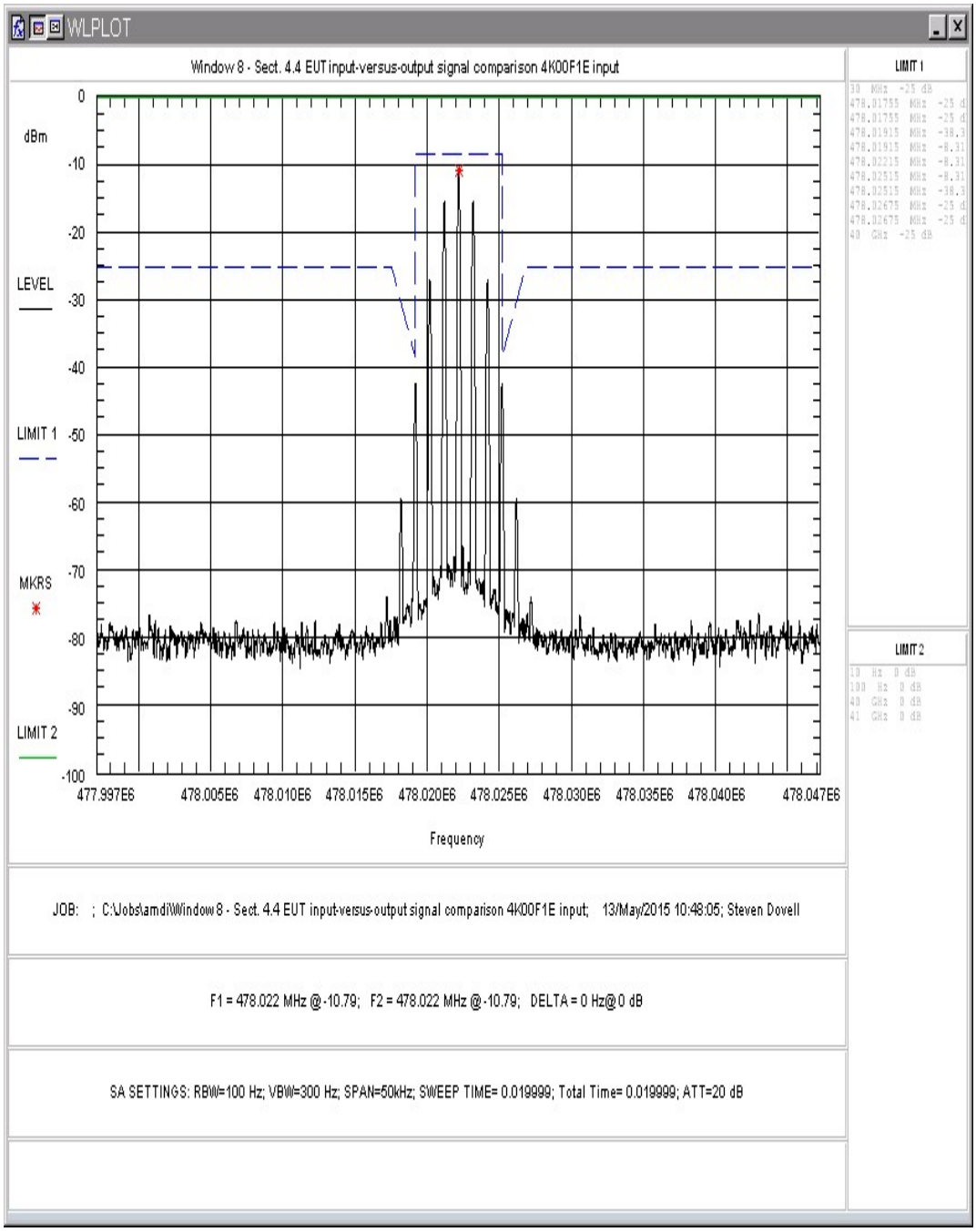

Figure 45. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 4K00F1E input

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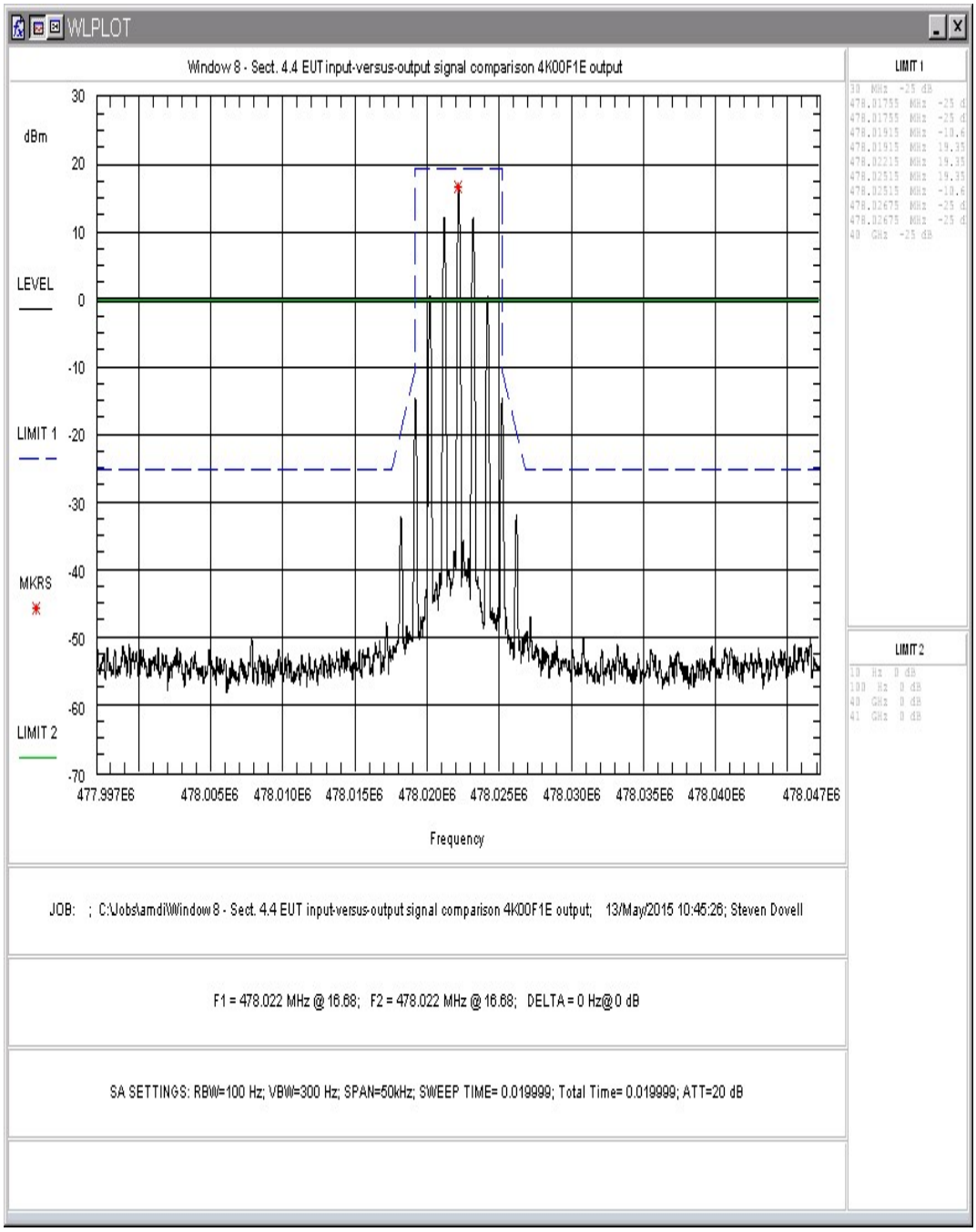

Figure 46. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 4K00F1E output

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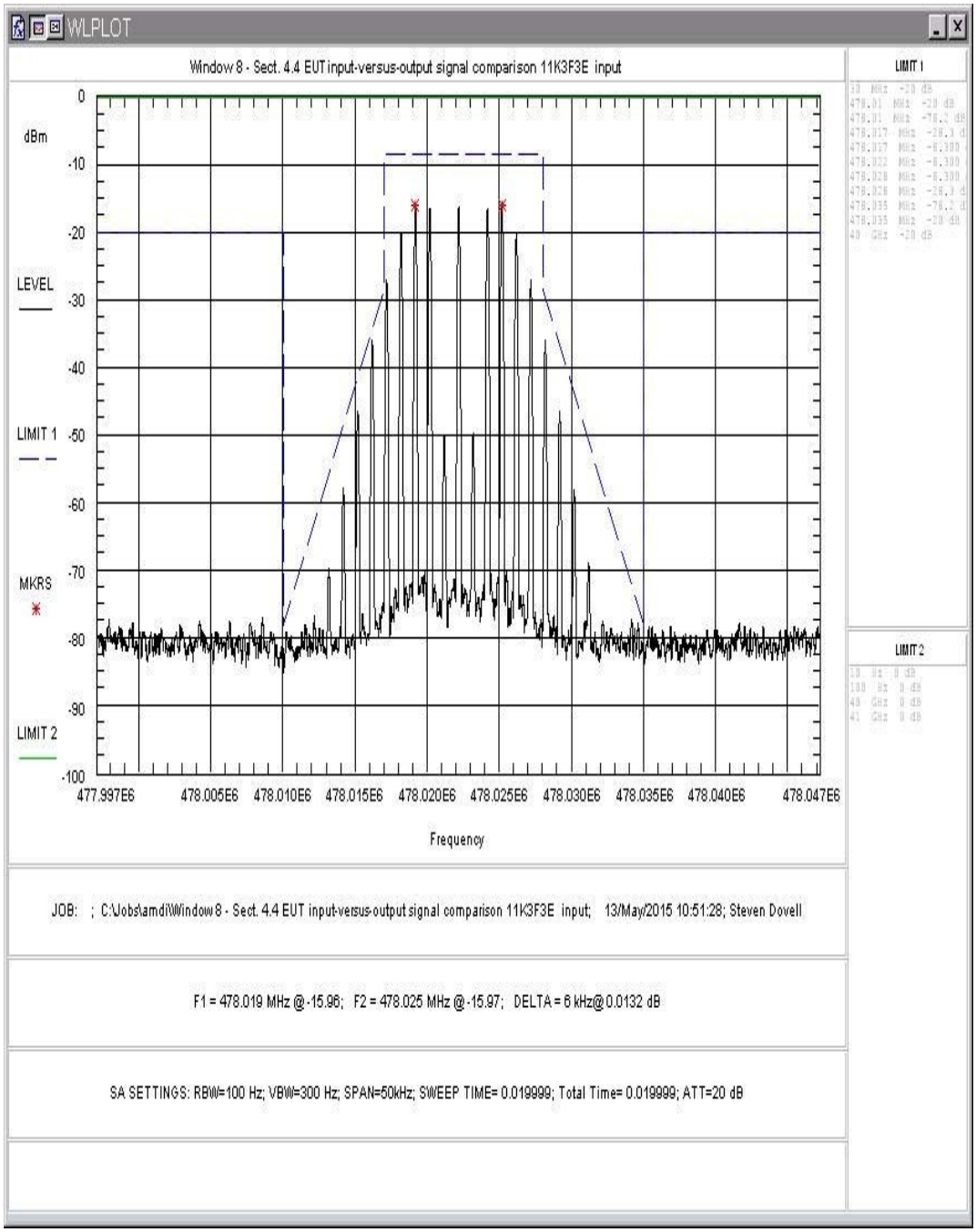

Figure 47. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E input

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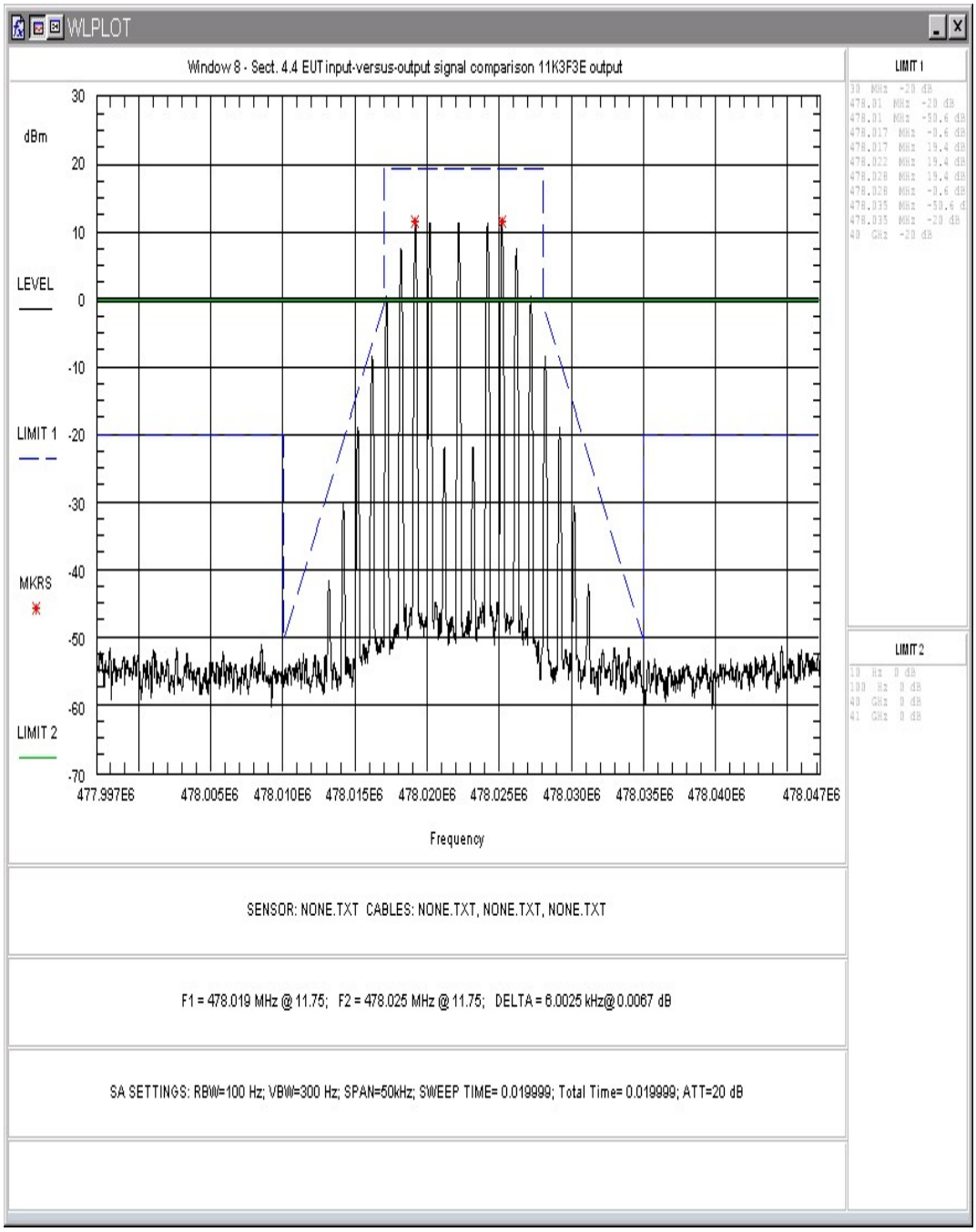

Figure 48. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E output

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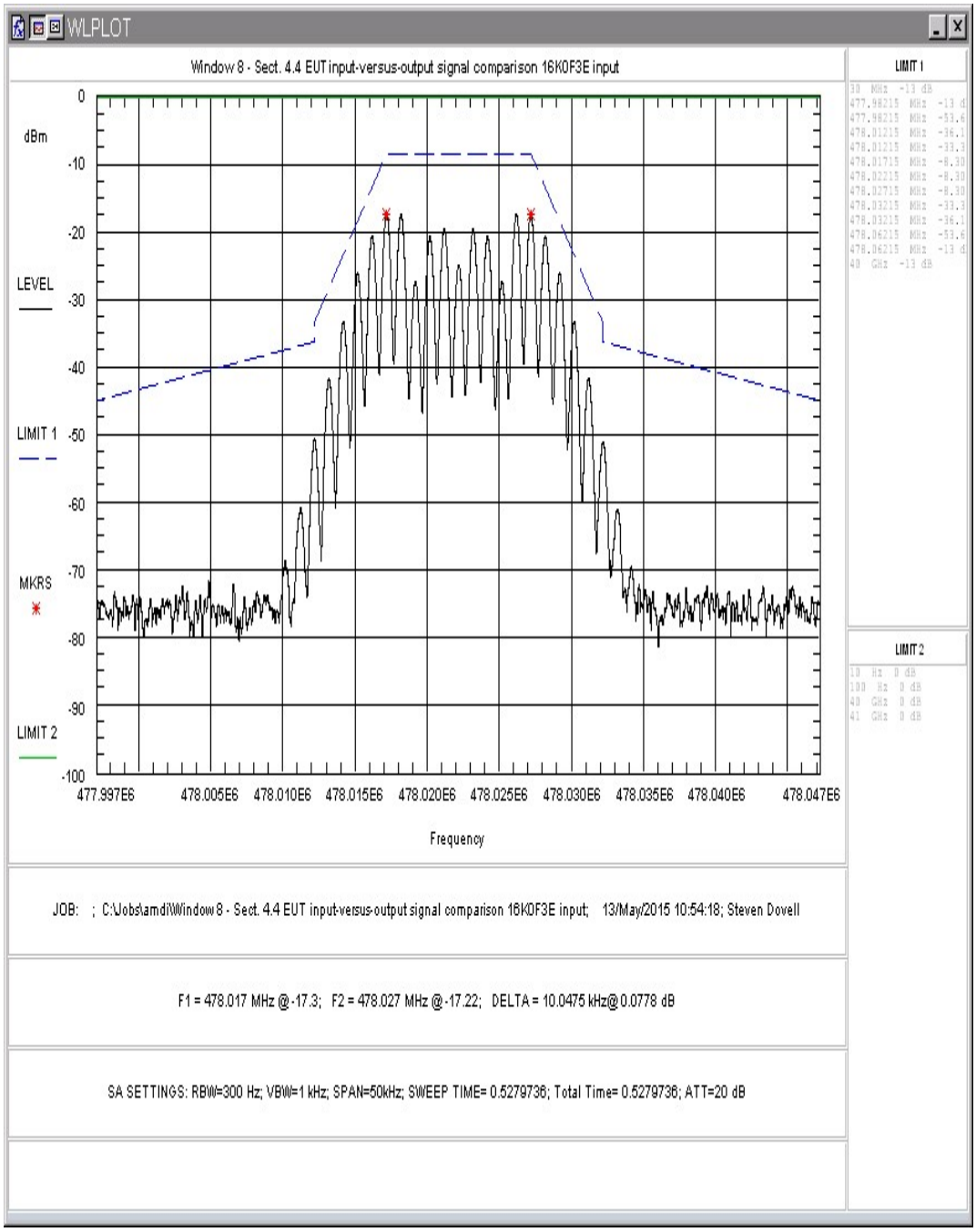

Figure 49. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E input

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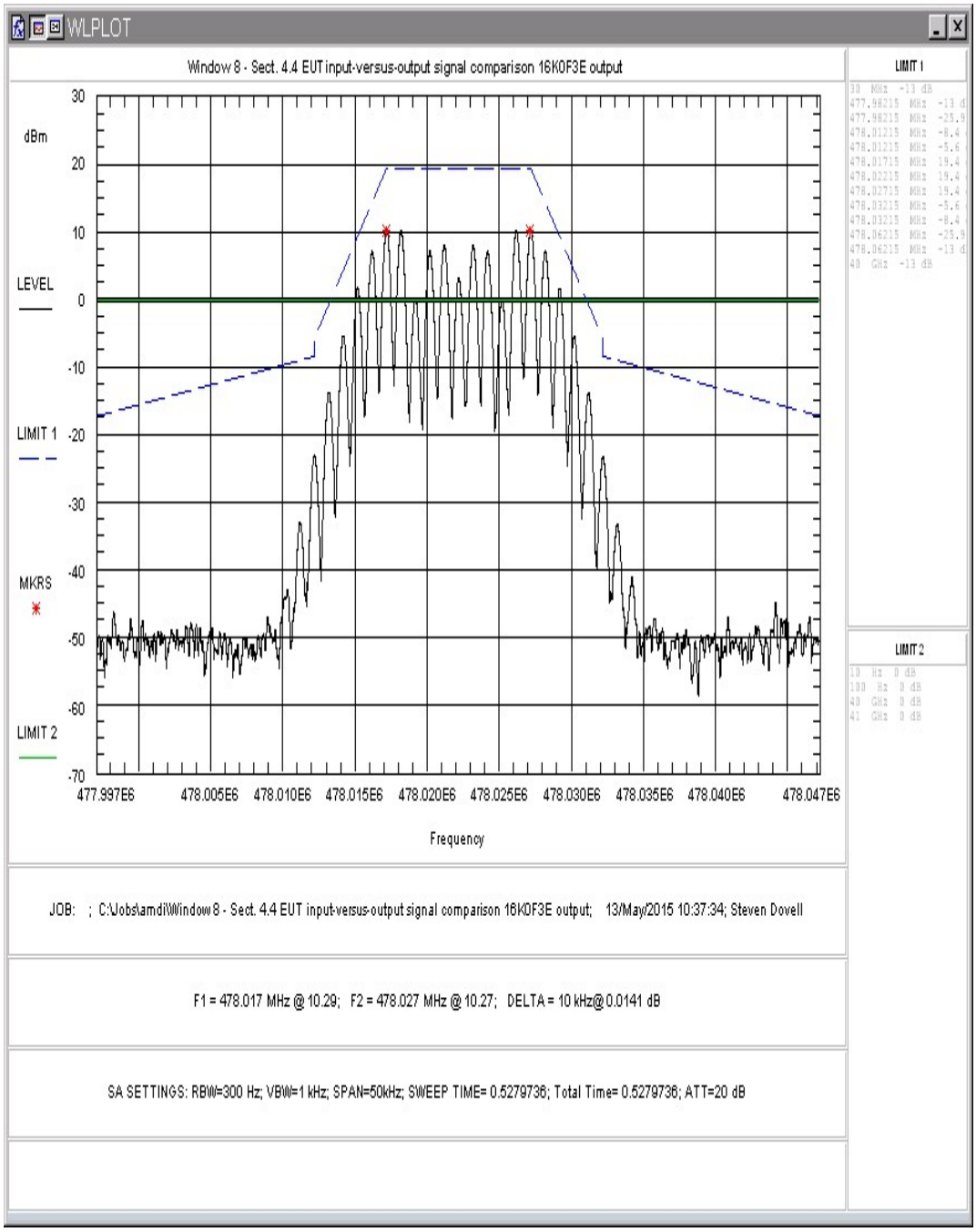

Figure 50. Window 8 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E output

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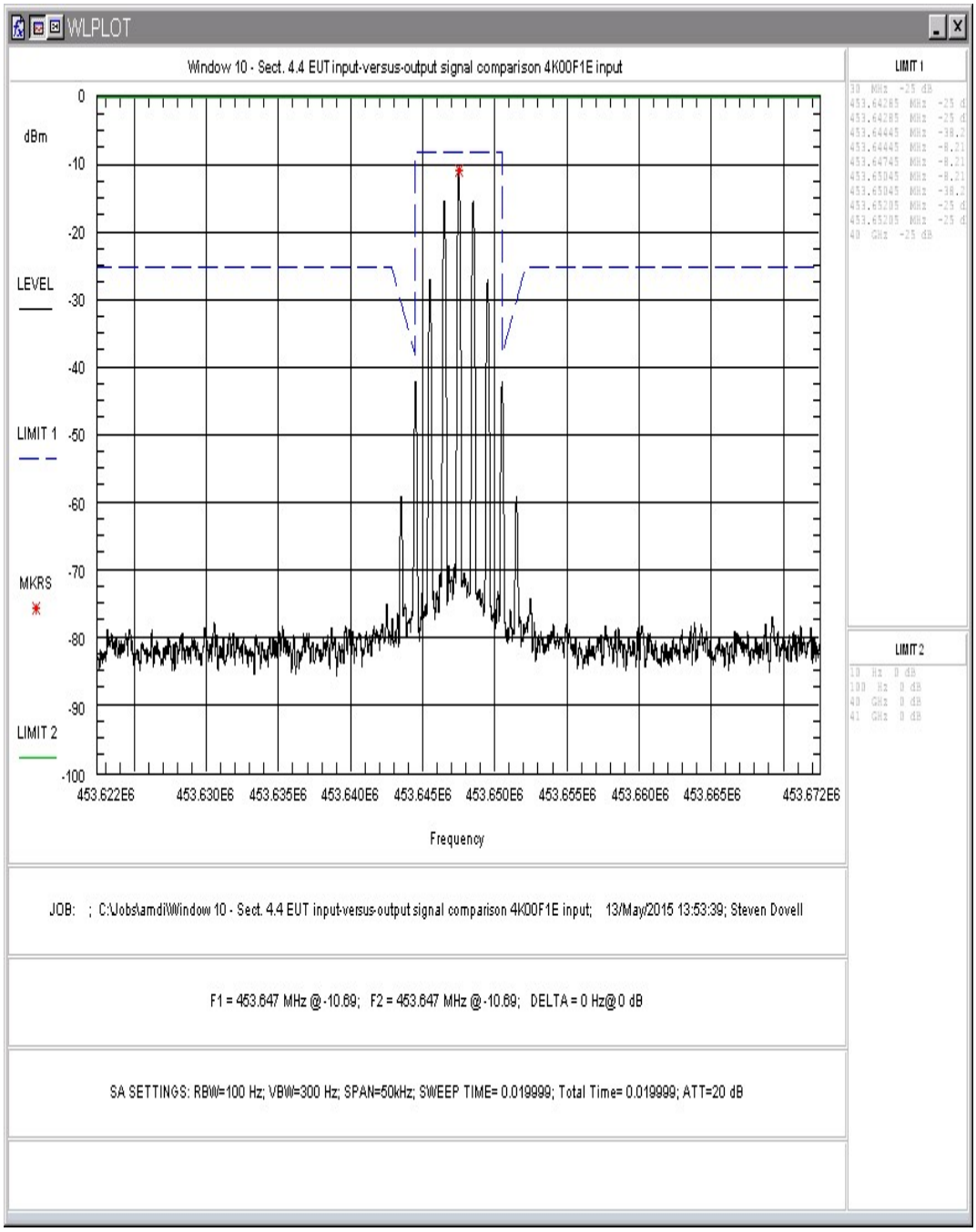

Figure 51. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 4K00F1E input

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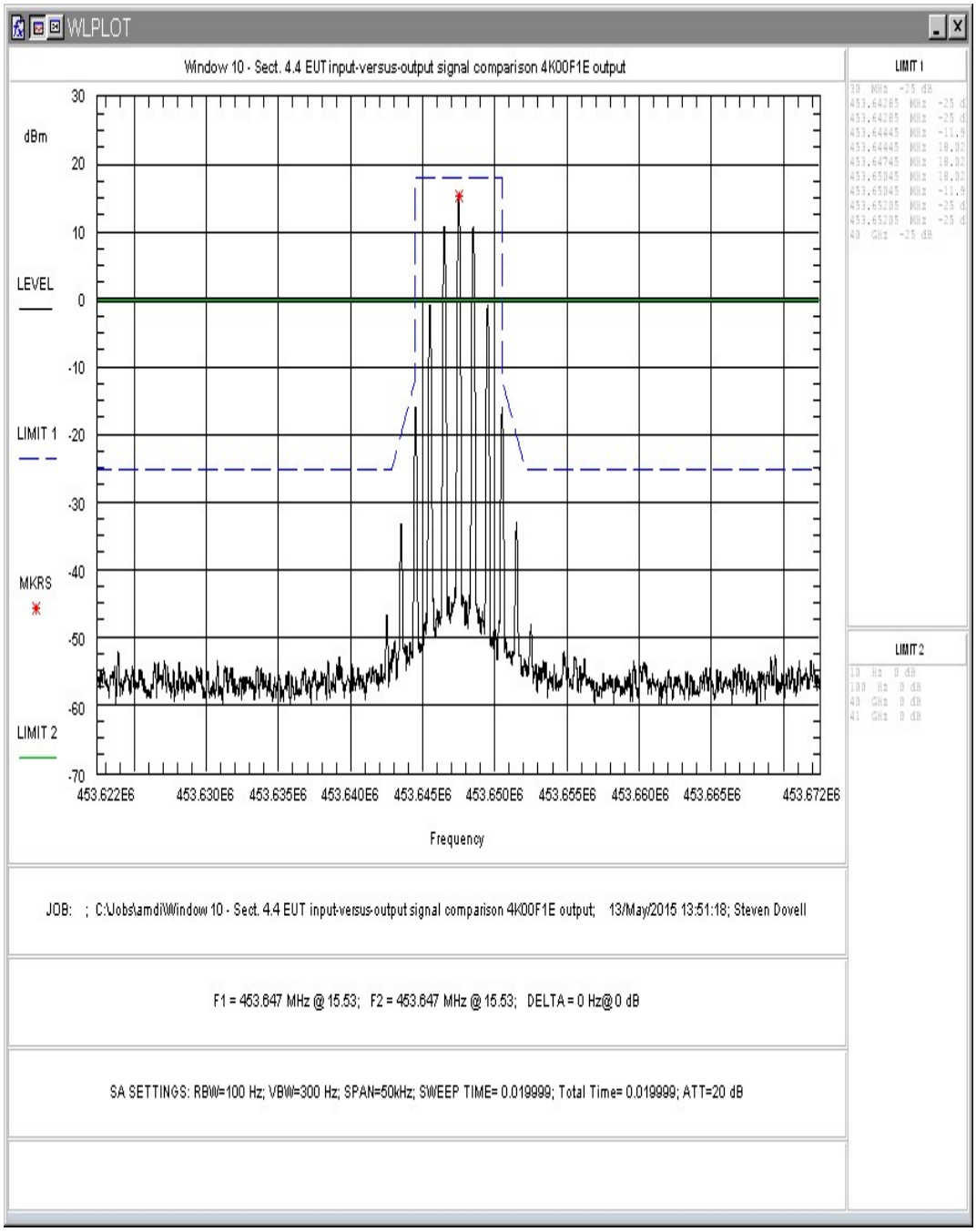

Figure 52. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 4K00F1E output

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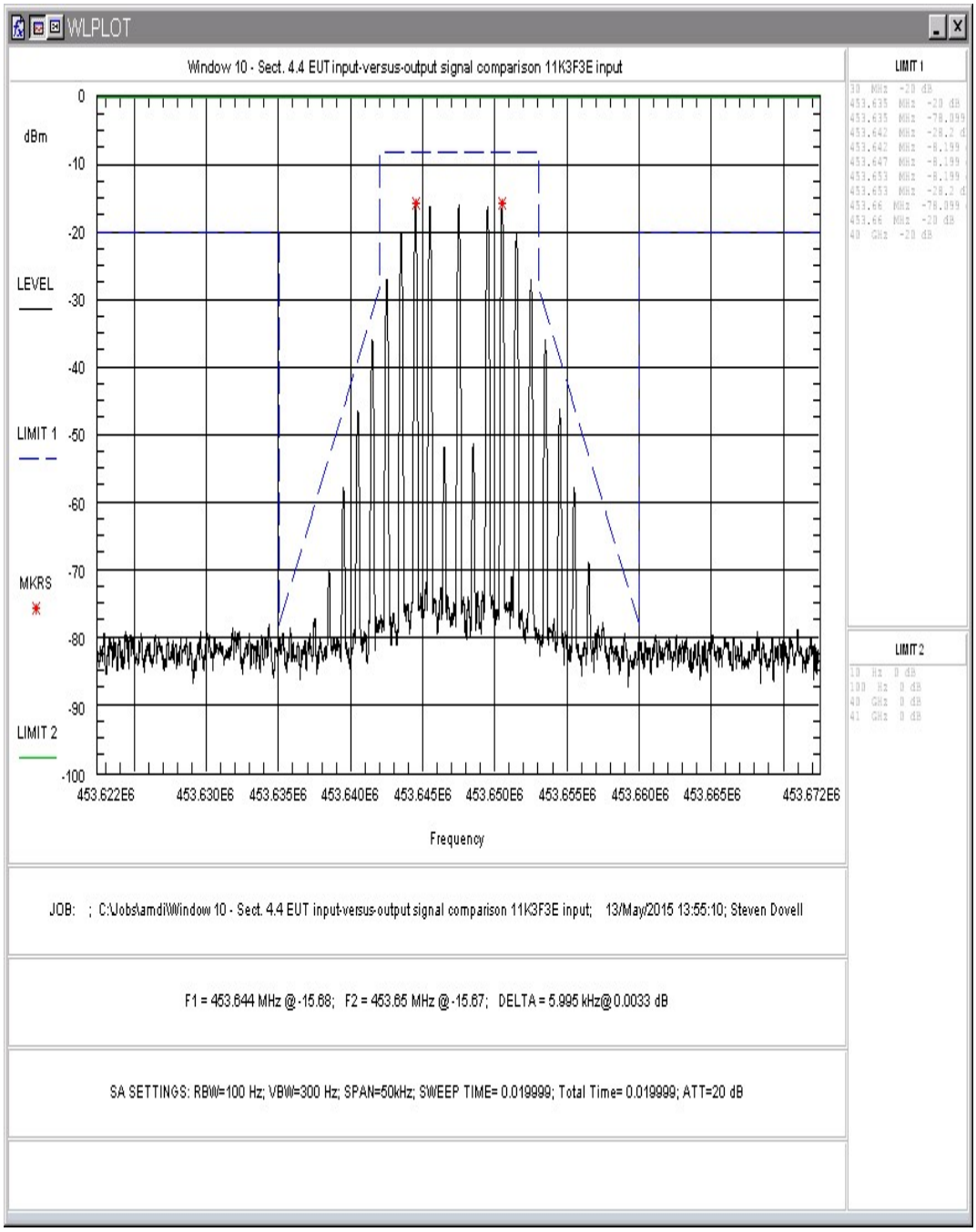

Figure 53. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E input

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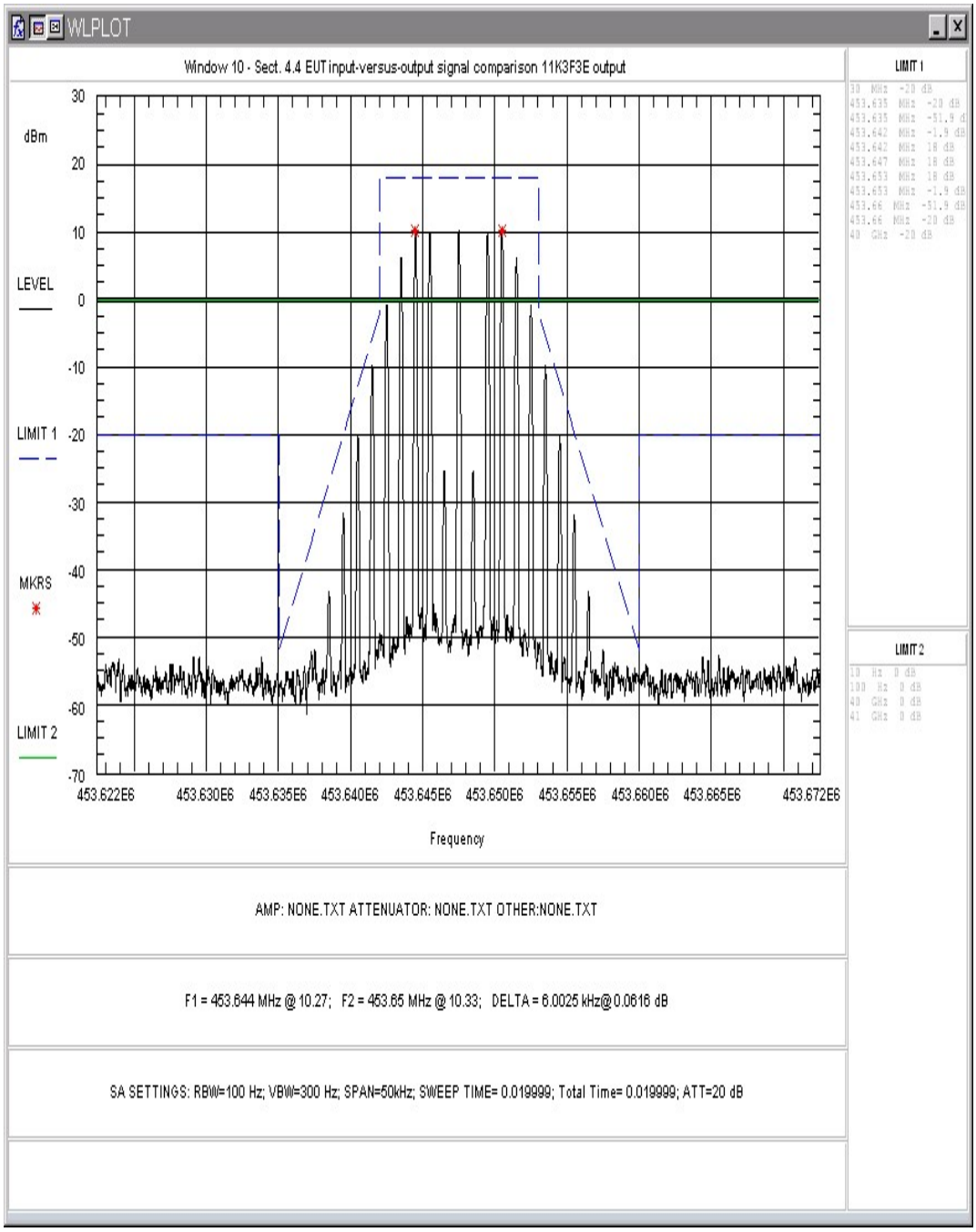

Figure 54. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E output

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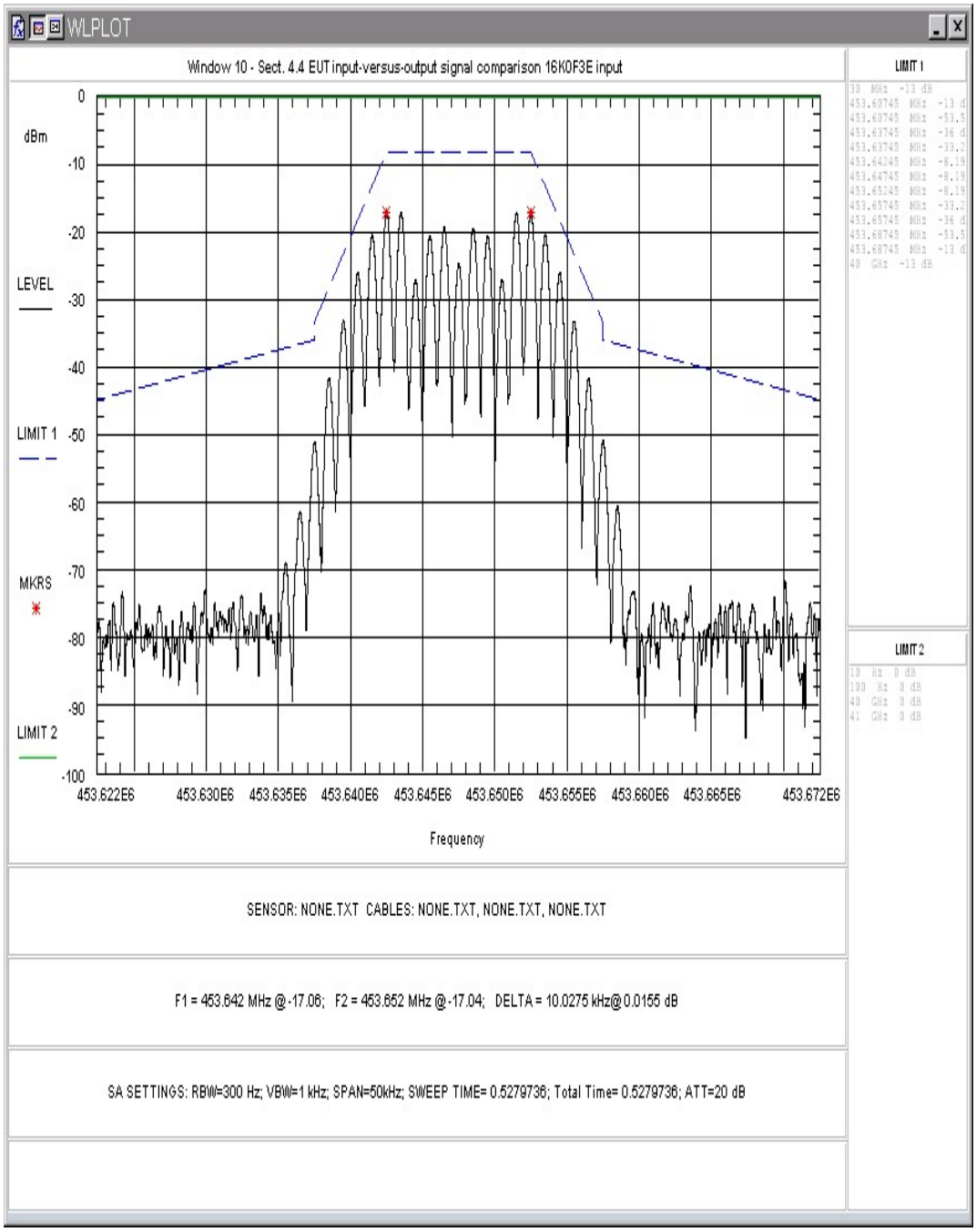

Figure 55. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E input

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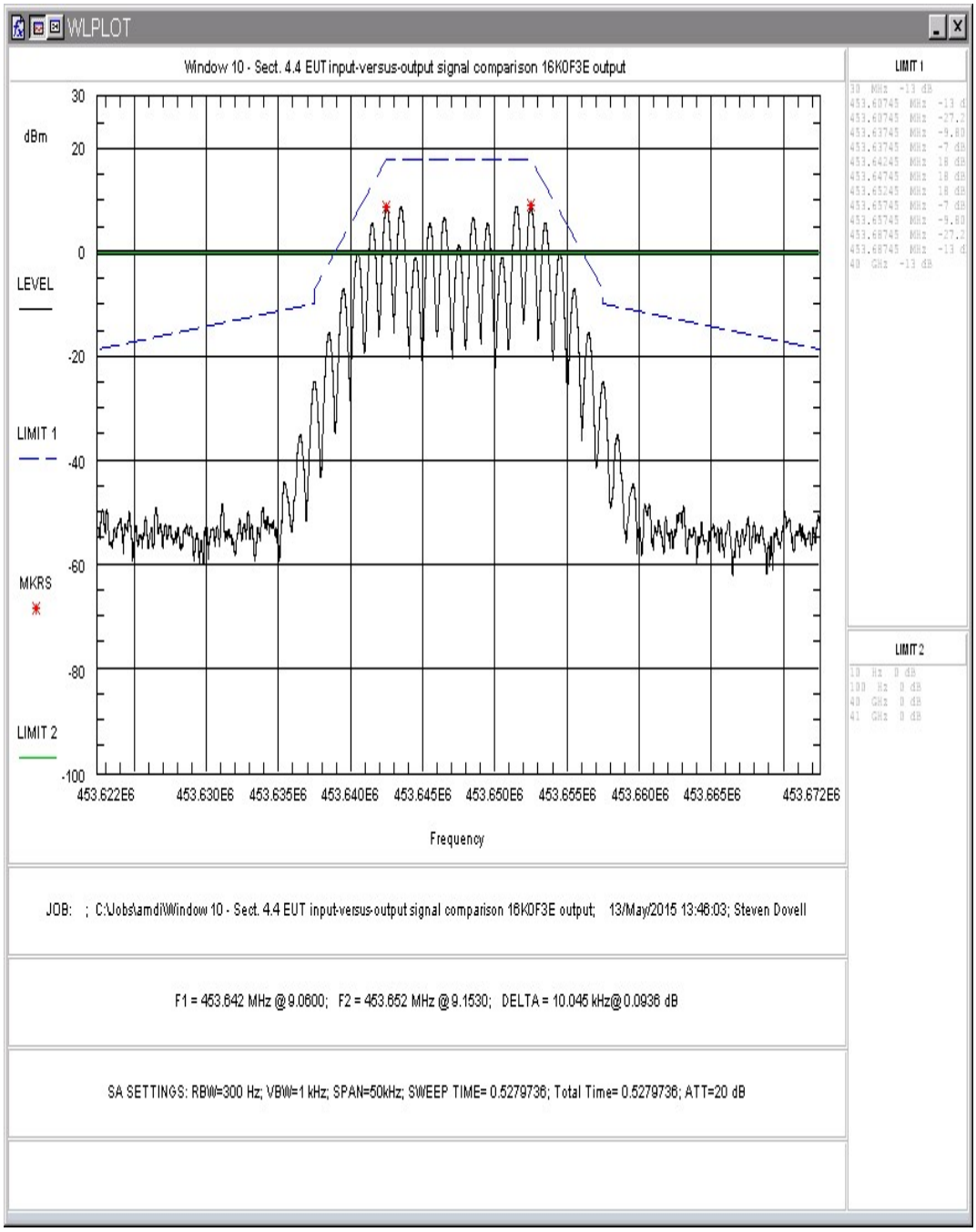

Figure 56. Window 10 - Sect. 4.4 EUT input-versus-output signal comparison 16K0F3E output

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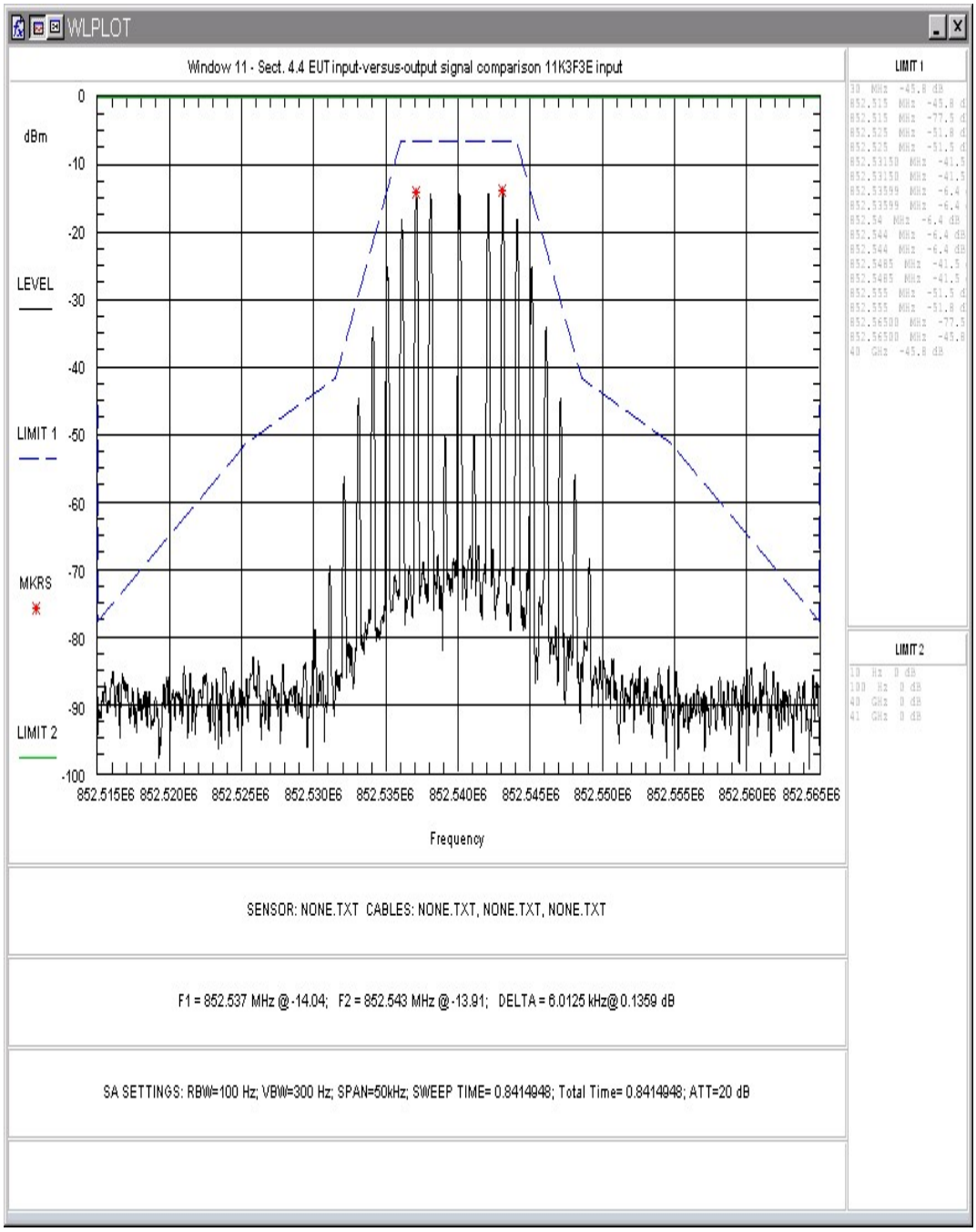

Figure 57. Window 11 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E input

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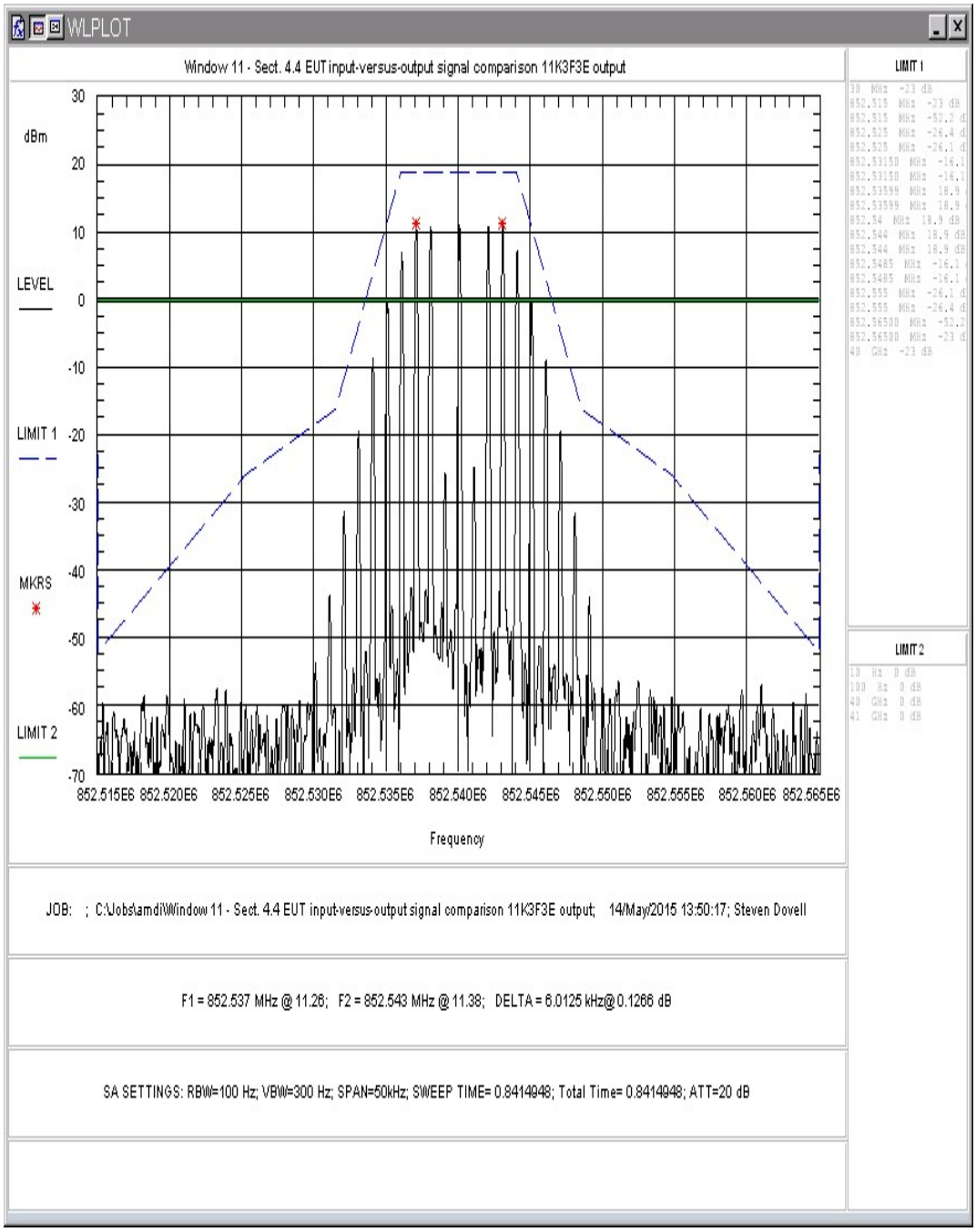

Figure 58. Window 11 - Sect. 4.4 EUT input-versus-output signal comparison 11K3F3E output

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4.4 EUT input/output power and amplifier gain

Procedure: KDB 935210 D05 Indus Booster Basic Meas v01 DR07-42107: Section 4.5

Section 4.5 specifies the following measurement of mean input and output power of a PLMRS and/or PSRS amplifier, booster, or repeater, to compute the gain of the device.

> Adjust the internal gain control of the equipment under test to the maximum gain for which the equipment certification is being sought. Any attenuation settings shall be set to their minimum setting. Input power levels (uplink and downlink) should be set to maximum input ratings while confirming that the device is not capable of operating in saturation (non-linear mode) at the rated input levels, including during the performance of the input/output power measurements.

Note: The EUT has no user attenuation or gain controls.

4.5.2 Measuring the EUT input and output power levels for determining amplifier/booster gain

The guidance of section 3.5.2 was used with the modifications listed in 4.5.2 a) through d):

> **3.5.2 Measuring the EUT mean input and output power**
>
> a) Connect a signal generator to the input of the EUT.
> b) Configure to generate the AWGN (broadband) test signal.
> c) The frequency of the signal generator shall be set to the frequency of (f0) as determined from 3.4.
> d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
> e) Set the signal generator output power to a level that produces an EUT output level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.
> f) Measure the output power of the EUT and record (see 3.5.3 or 3.5.4 for power measurement guidance).
> g) Remove the EUT from the measurement setup and using the same signal generator settings, repeat the power measurement on the input signal to the EUT and record as input power.
> h) Repeat the procedure with the narrowband test signal.
> i) Repeat the procedure for both test signals with input signal amplitude set to 3 dB above the AGC threshold level.
> j) Repeat for all frequency bands authorized for use by the EUT.

a) Configure the signal generator for CW operation instead of AWGN,

b) Select the analyzer positive peak detector instead of the power averaging (rms) detector,

c) Activate the max hold function instead of the trace average function,

d) Use in conjunction with guidance provided in 4.5.3.

4.5.3 Method 1: Power measurement with a spectrum or signal analyzer

a) Set the frequency span to at least 1 MHz.

b) Set the resolution bandwidth to 100 kHz.

c) Set the video bandwidth to ≥ 3 × RBW.

d) Set the detector to PEAK and trace mode to MAX HOLD.

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e) Place a marker on the peak of the signal and record the value as the maximum power.

4.5.5 Calculating the amplifier, booster, or repeater gain

After the input and output power levels have been measured as described above, the gain of the EUT can be determined from:

Gain (dB) = output power (dBm) − input power (dBm).

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4.4.1 Results:

See Table 8 for tabular gain results. See Figure 59 through Figure 76 for the plots which support the tabular data.

Table 8: Input / Output Power and Amplifier gain

Window	Output (dBm)	Input (dBm)	Gain (dB)
1	20.030	-10.270	30.300
2	19.690	-10.270	29.960
3	19.887	-10.154	30.041
4	21.212	-10.017	31.229
6	19.987	-10.086	30.073
8	19.687	-10.072	29.759
10	20.015	-10.090	30.105
7, 9, 12	20.009	-10.039	30.048
11	19.296	-10.008	29.304

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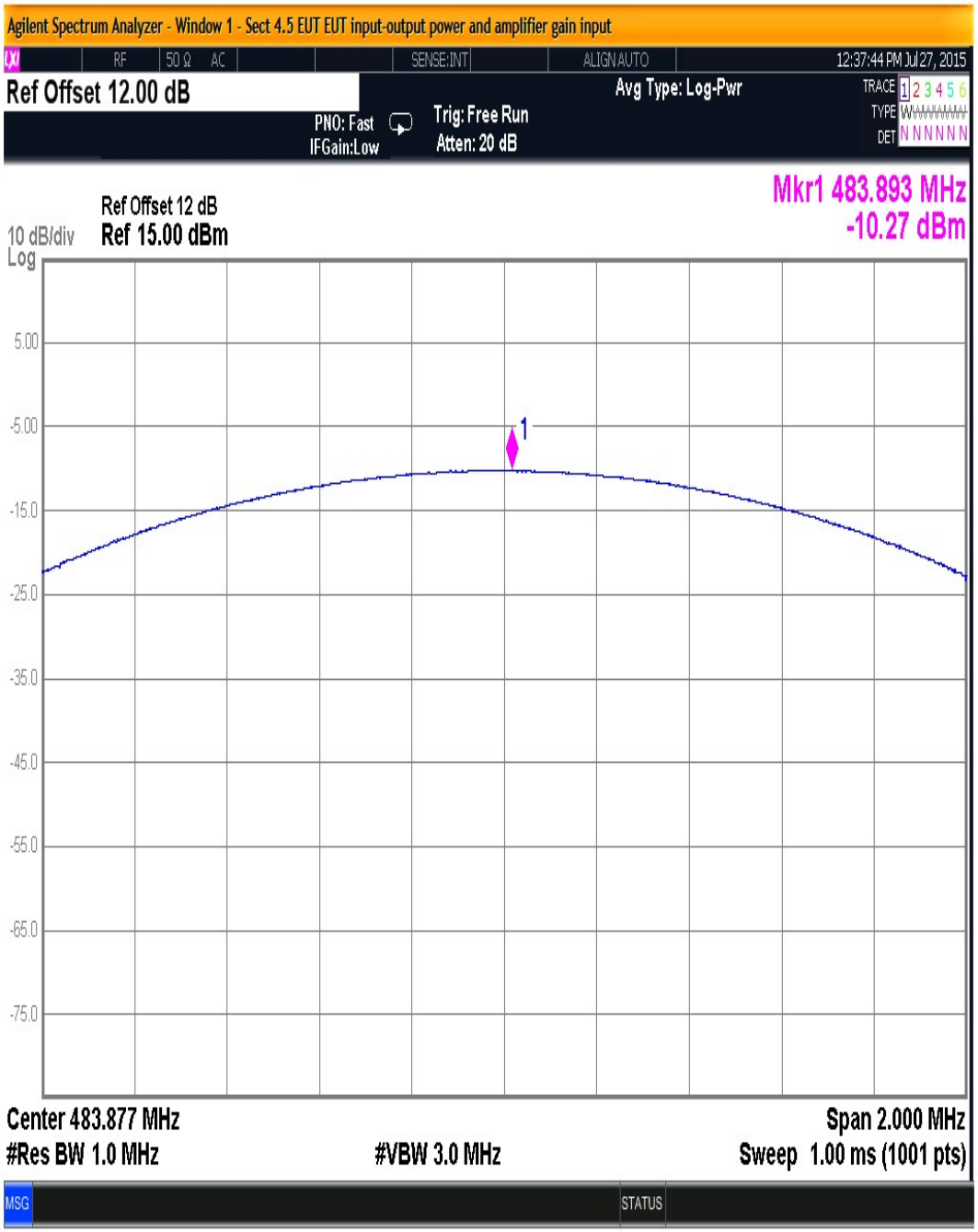

Figure 59. Window 1 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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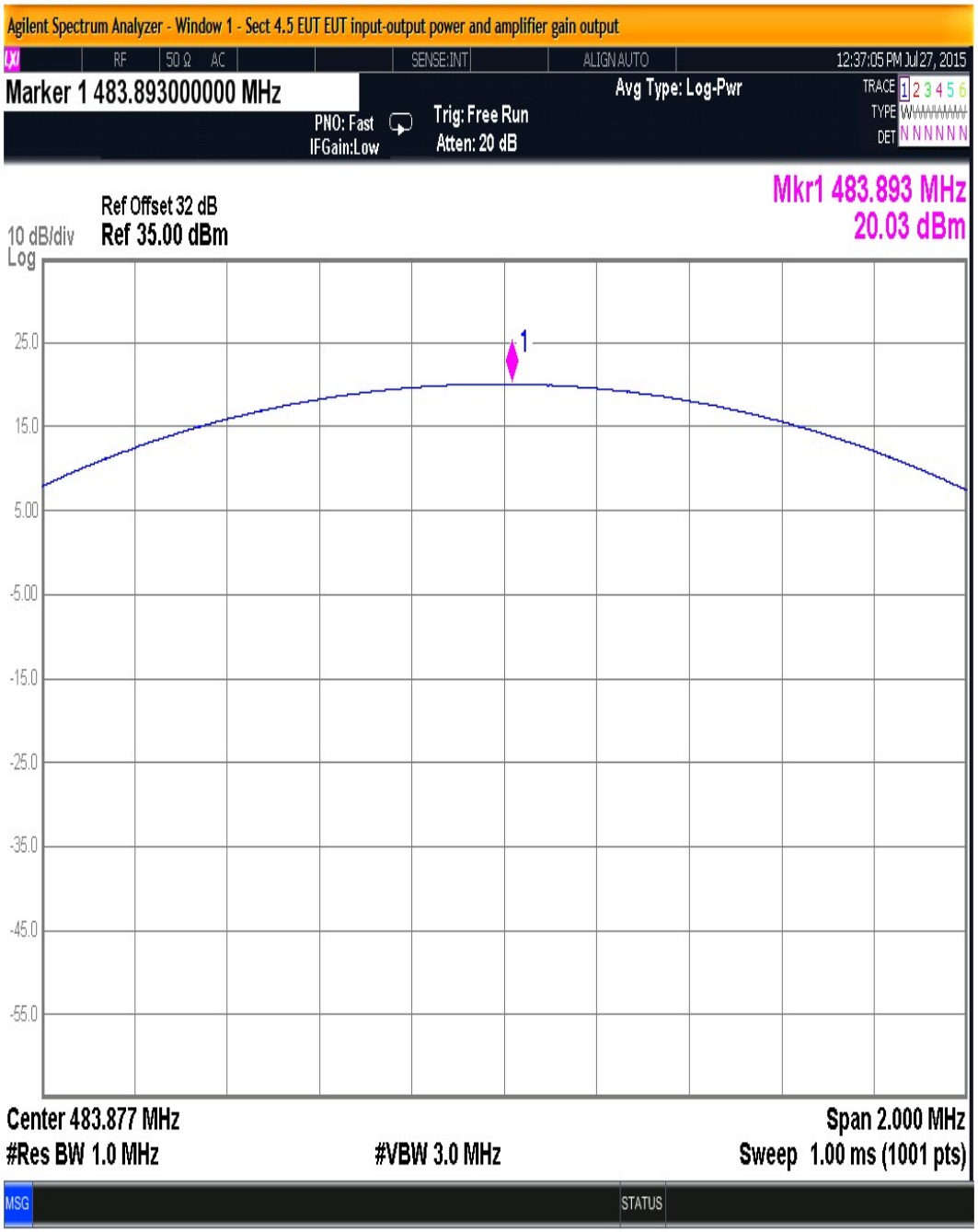

Figure 60. Window 1 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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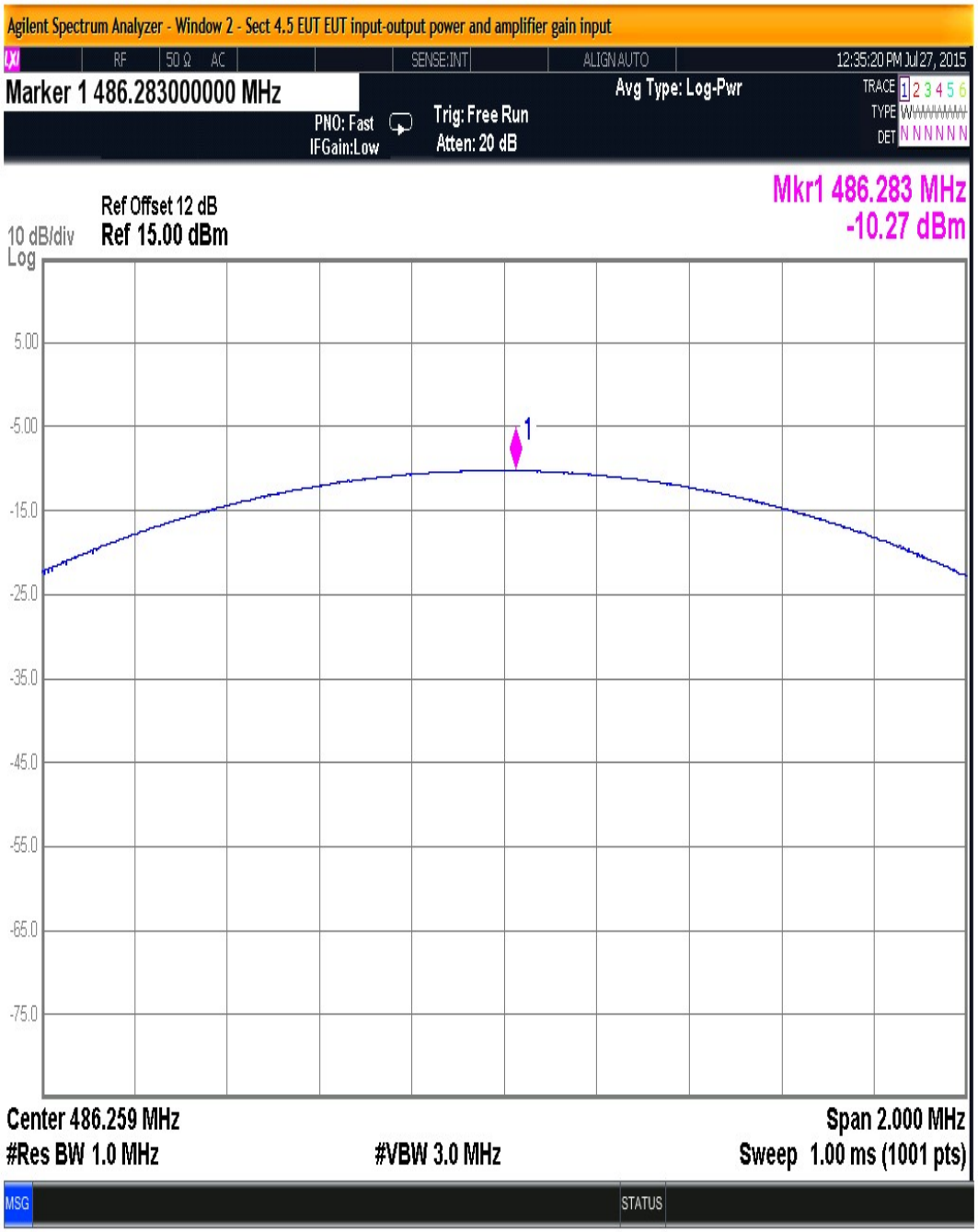

Figure 61. Window 2 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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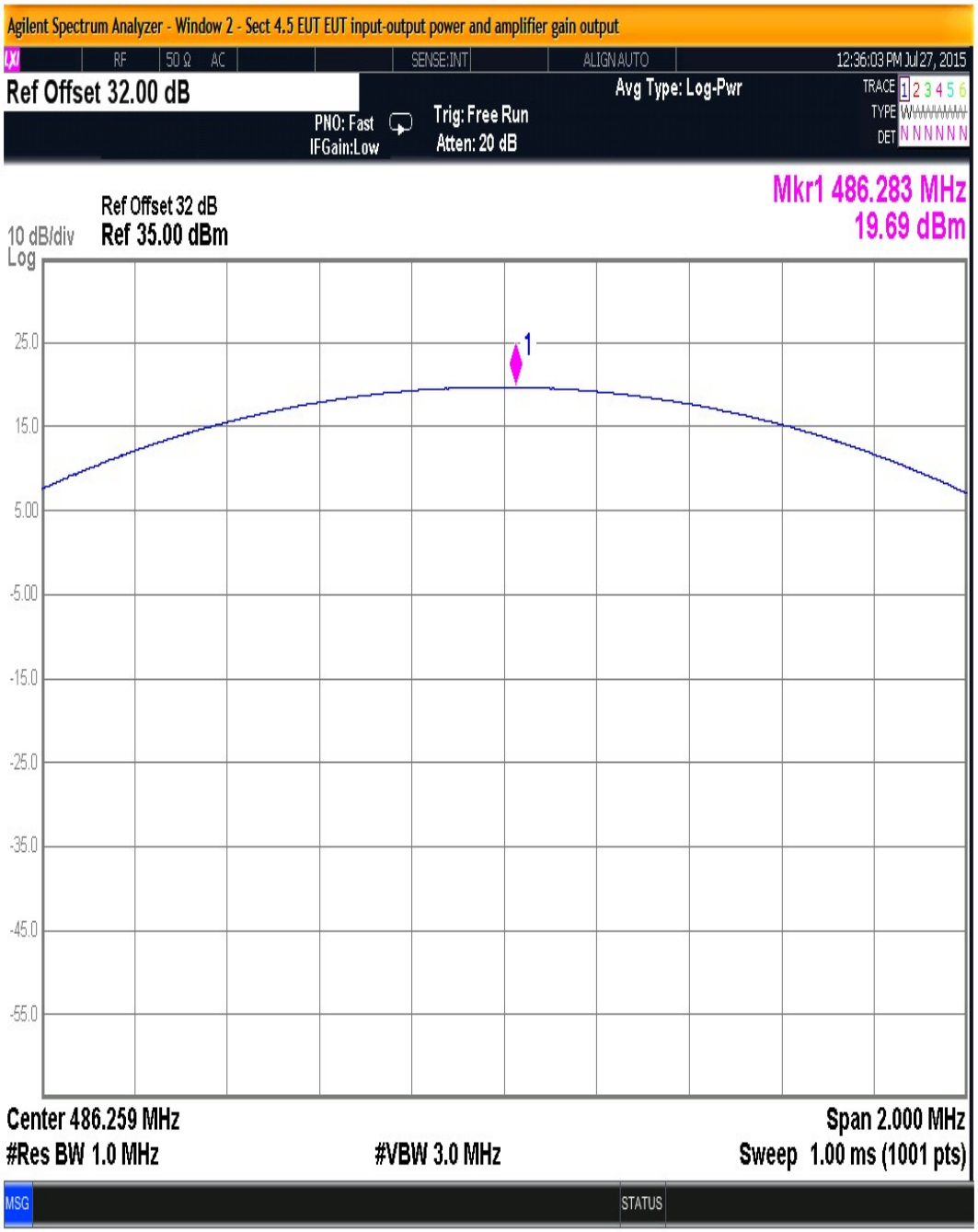

Figure 62. Window 2 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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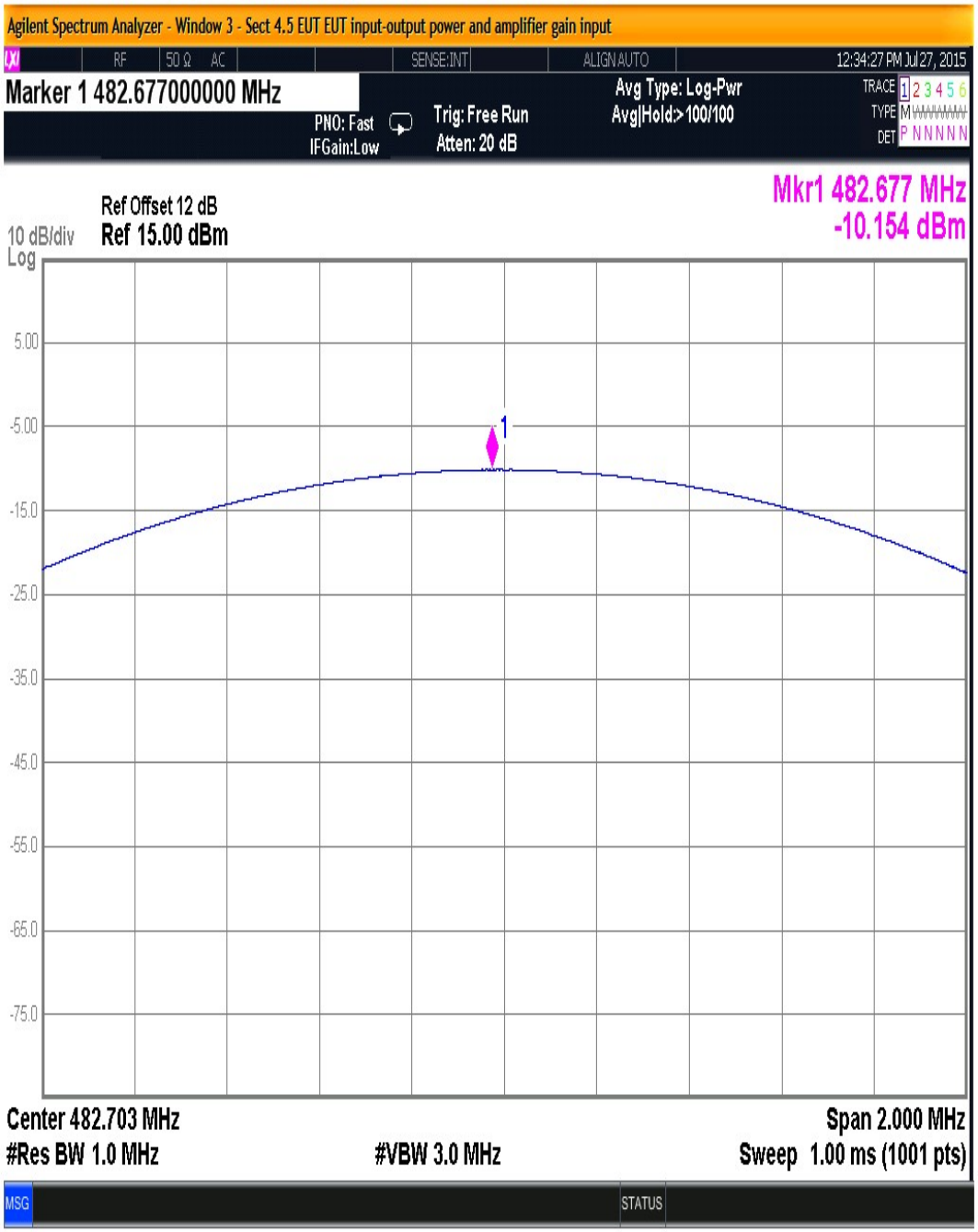

Figure 63. Window 3 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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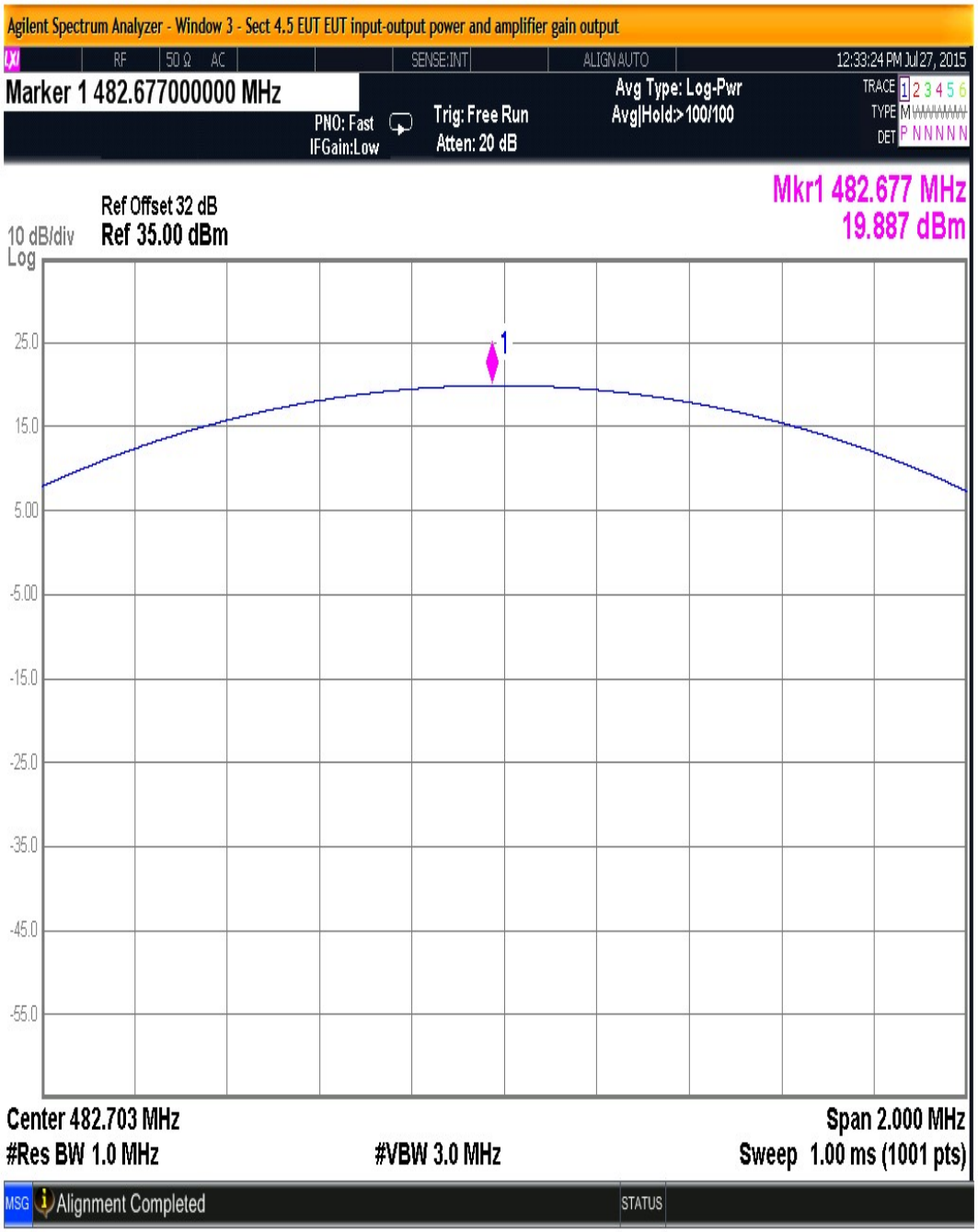

Figure 64. Window 3 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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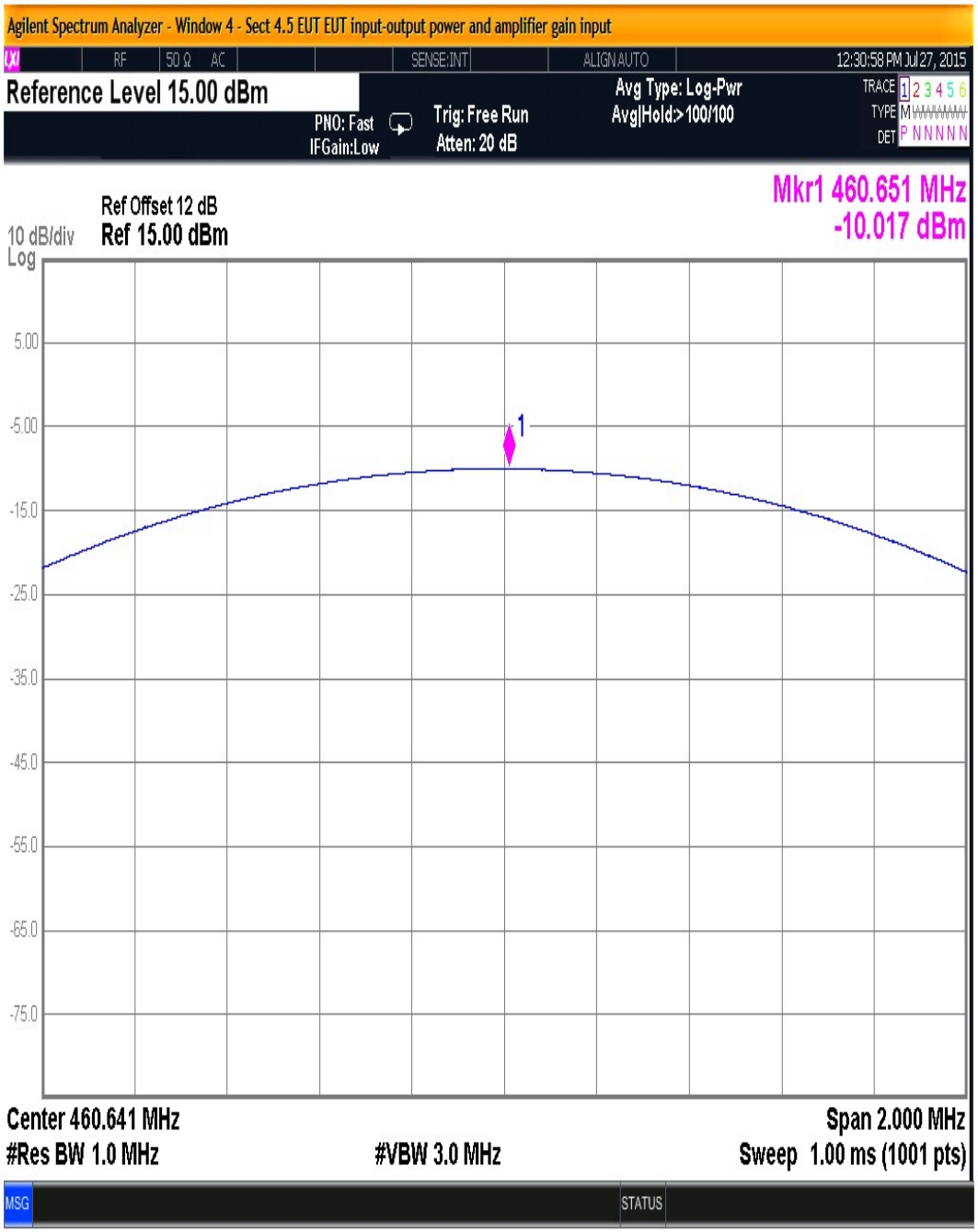

Figure 65. Window 4 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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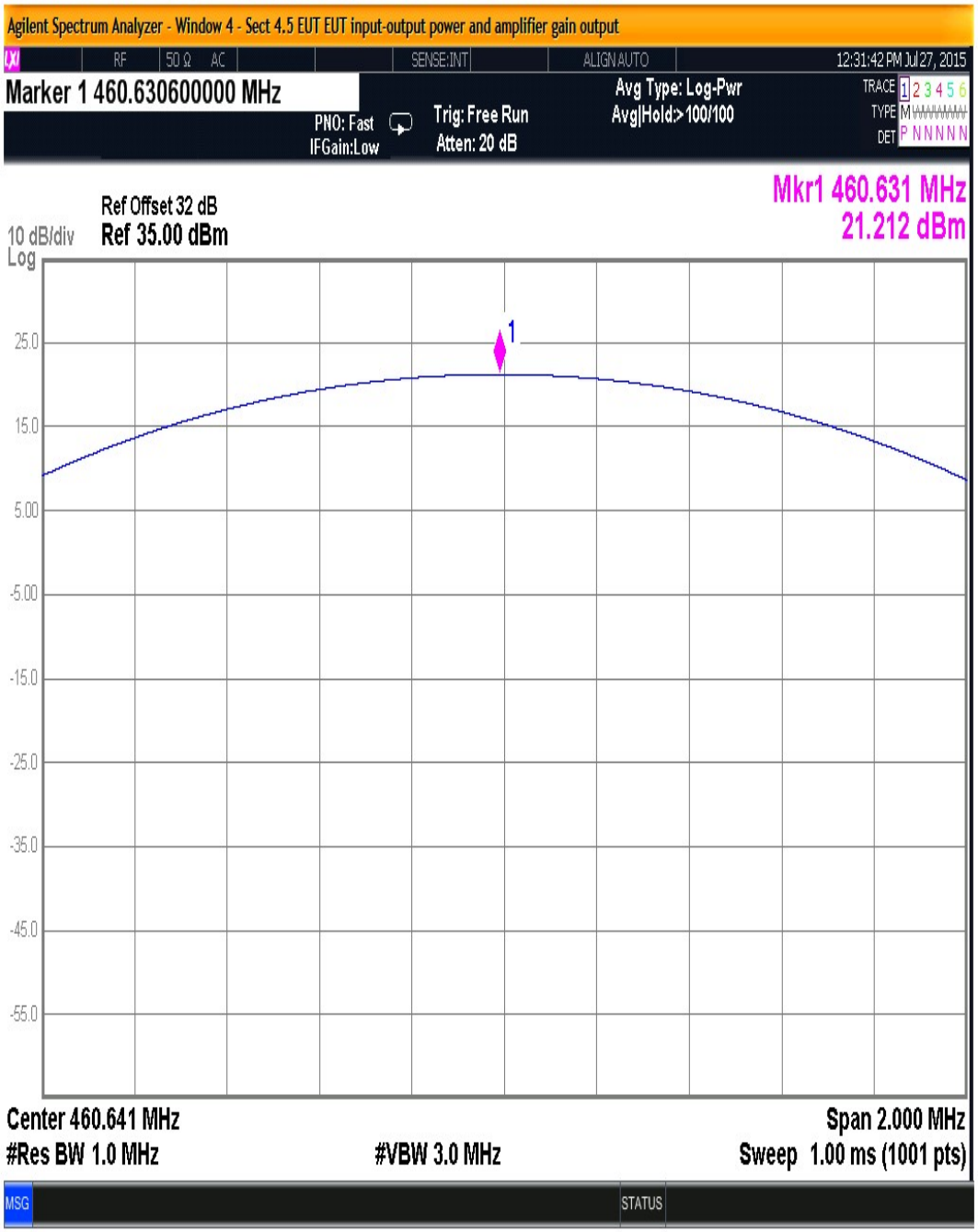

Figure 66. Window 4 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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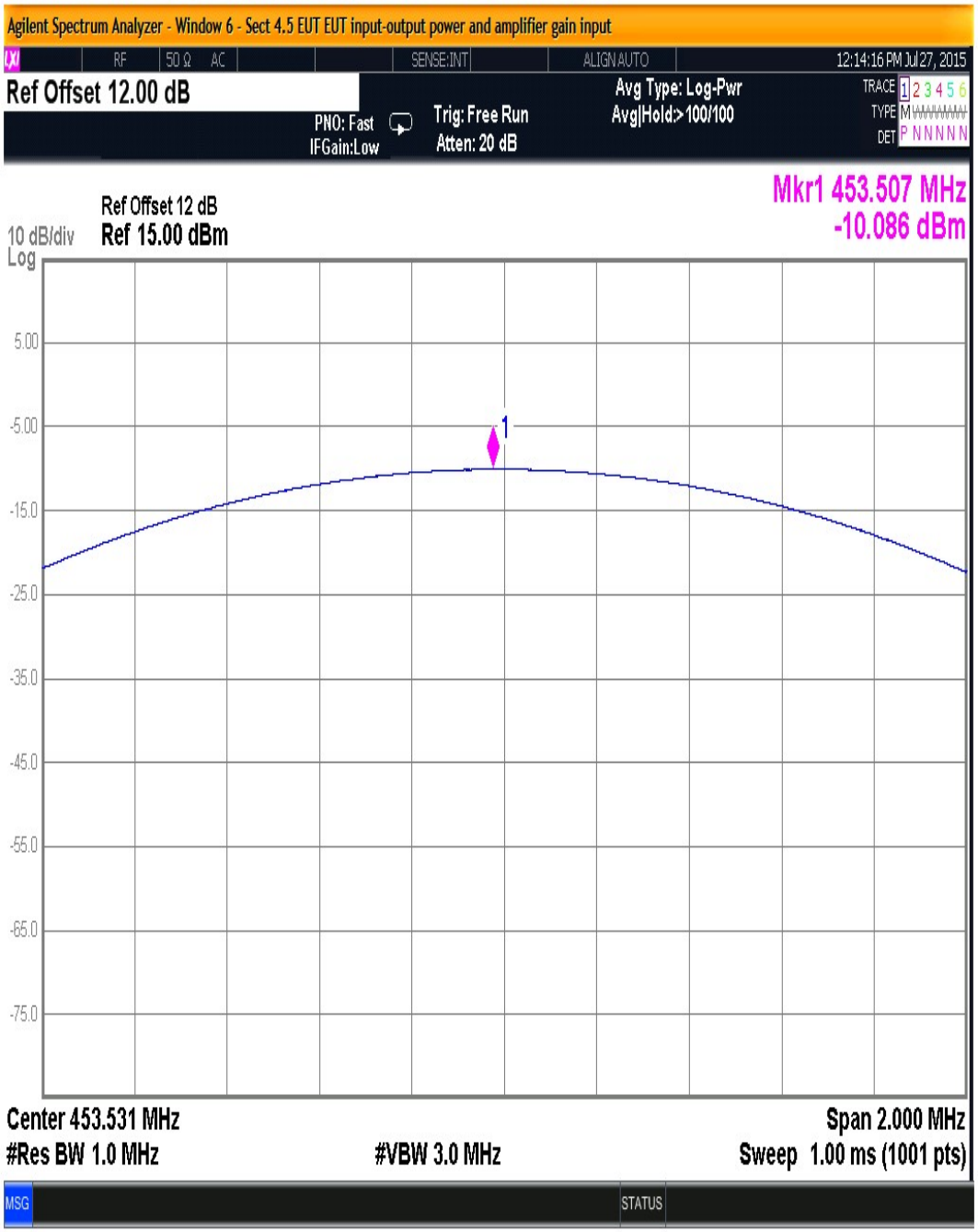

Figure 67. Window 6 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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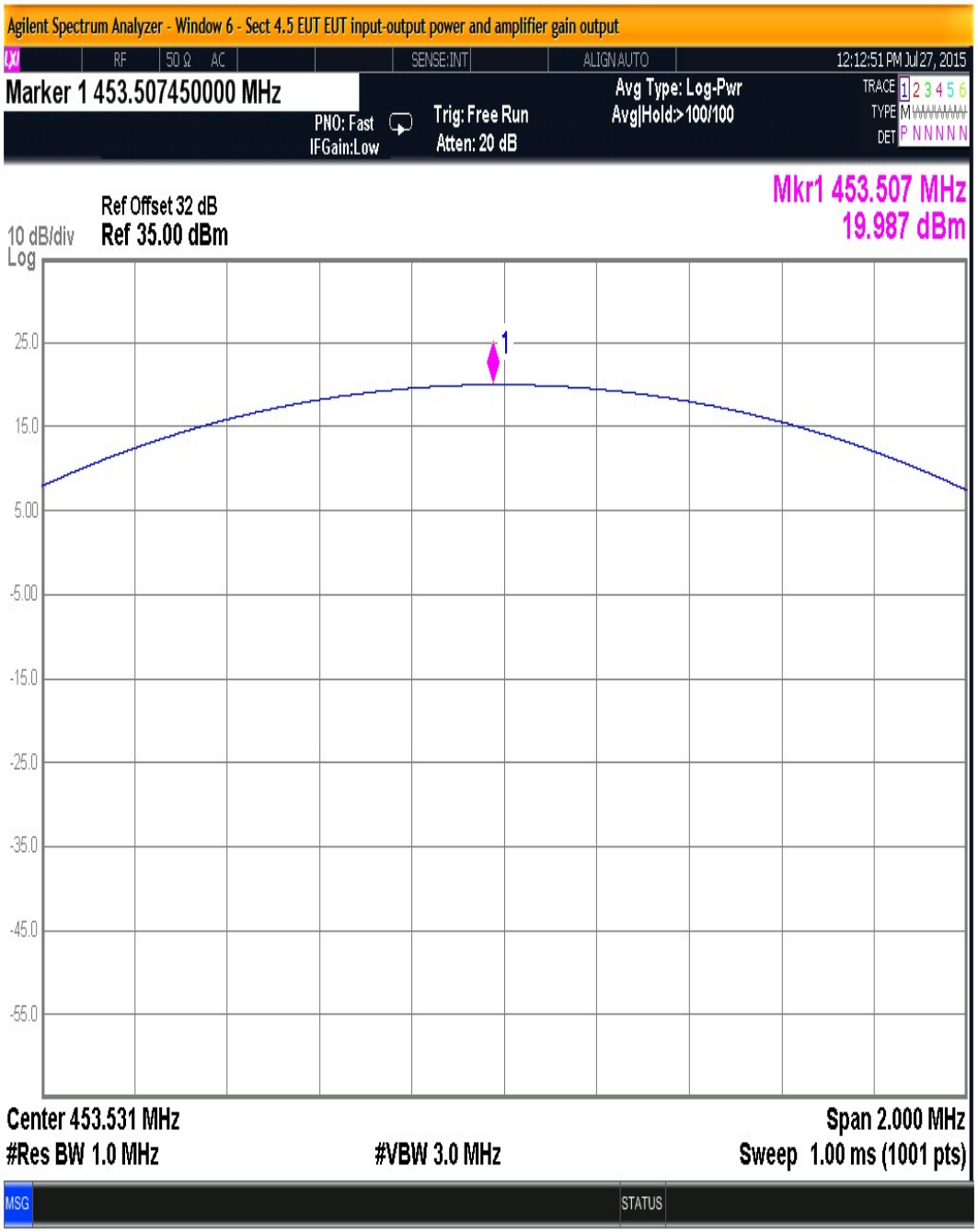

Figure 68. Window 6 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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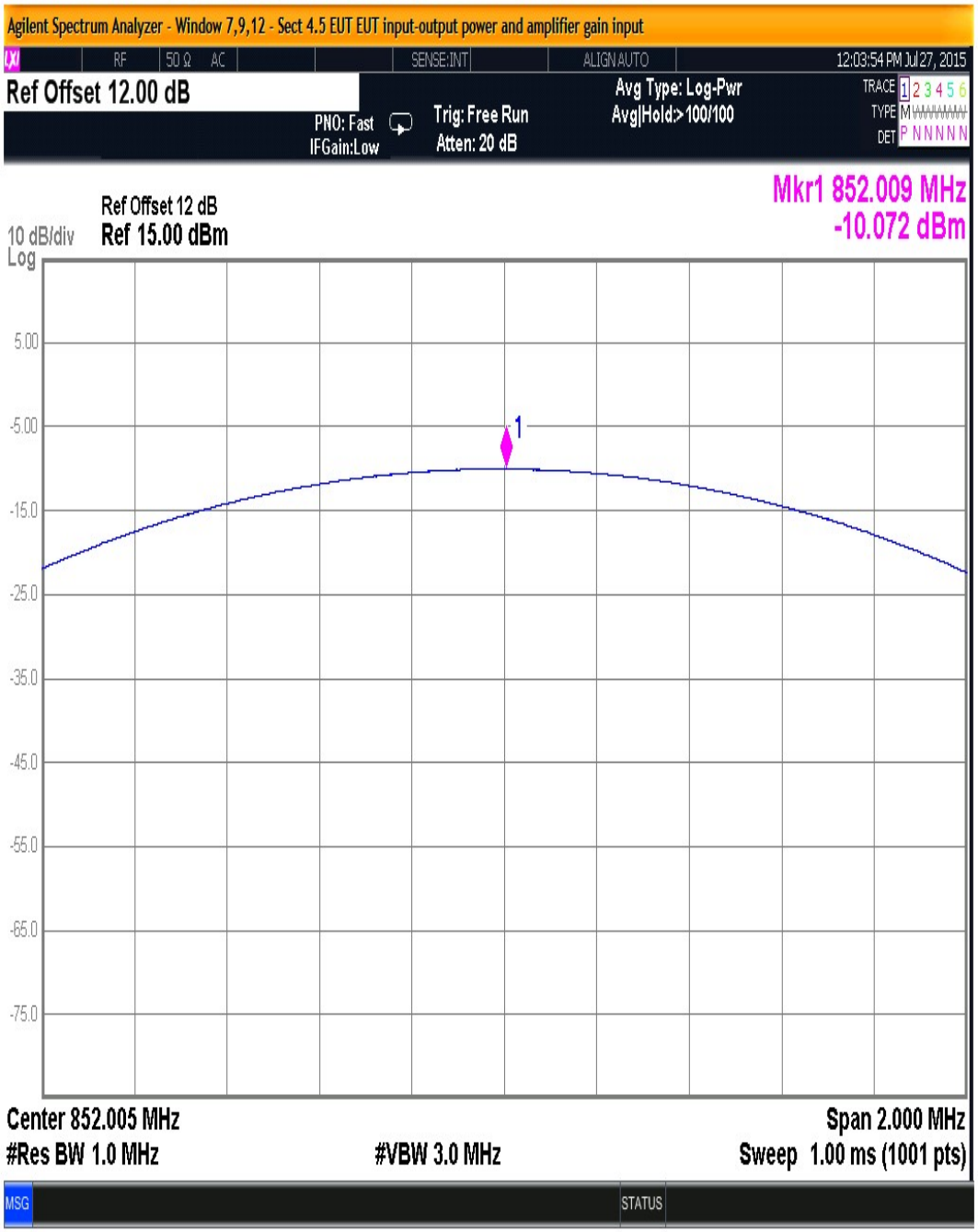

Figure 69. Window 7,9,12 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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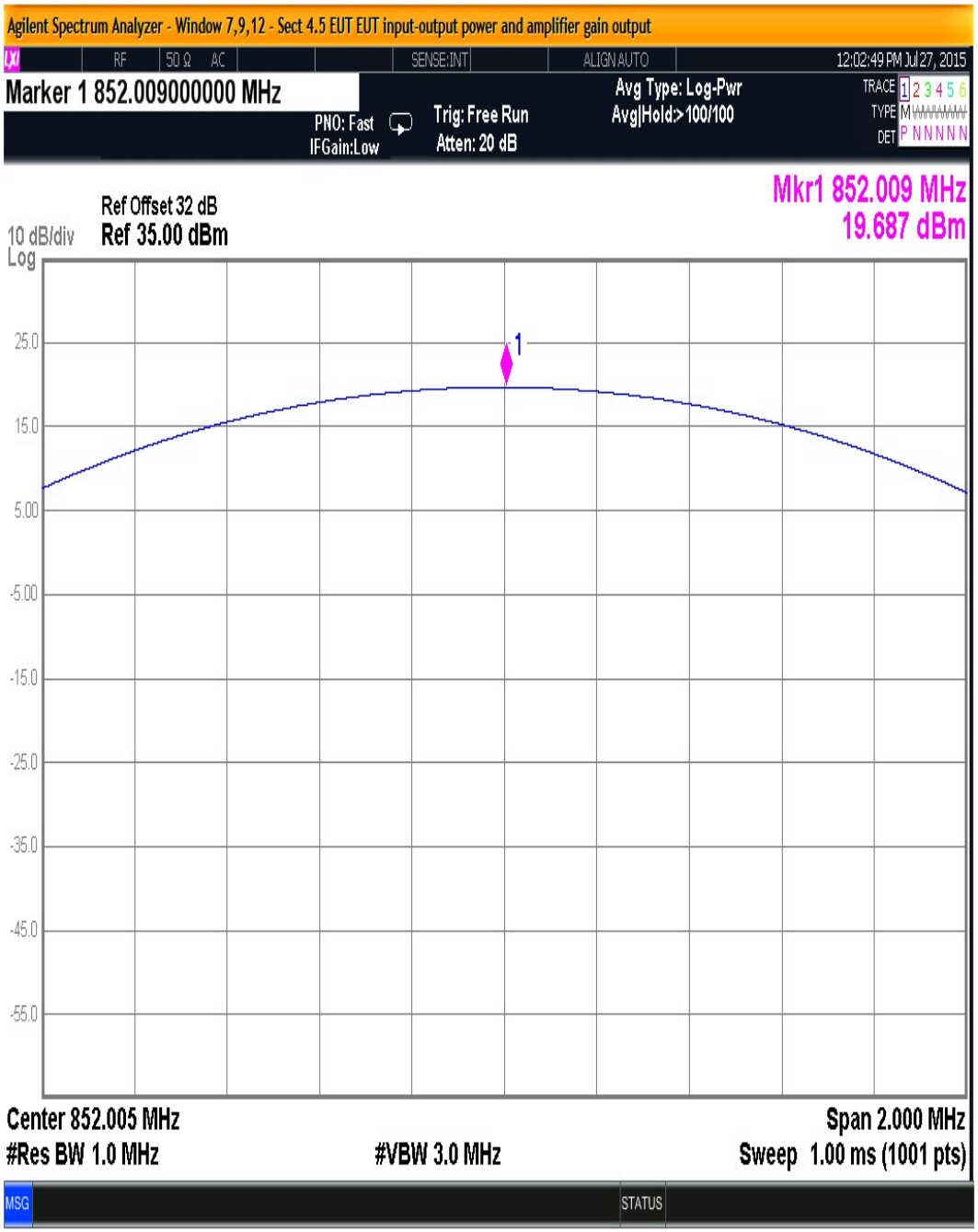

Figure 70. Window 7,9,12 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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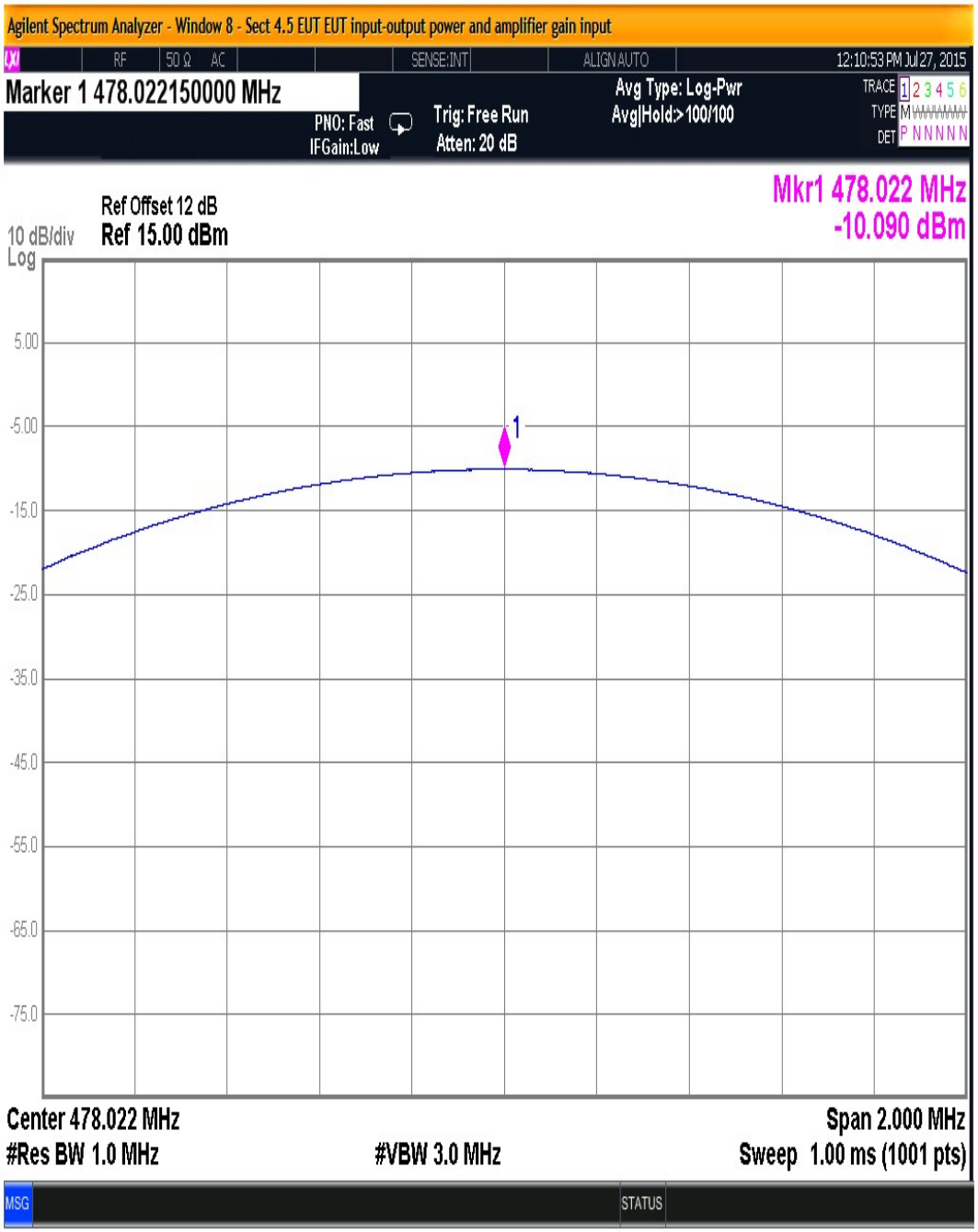

Figure 71. Window 8 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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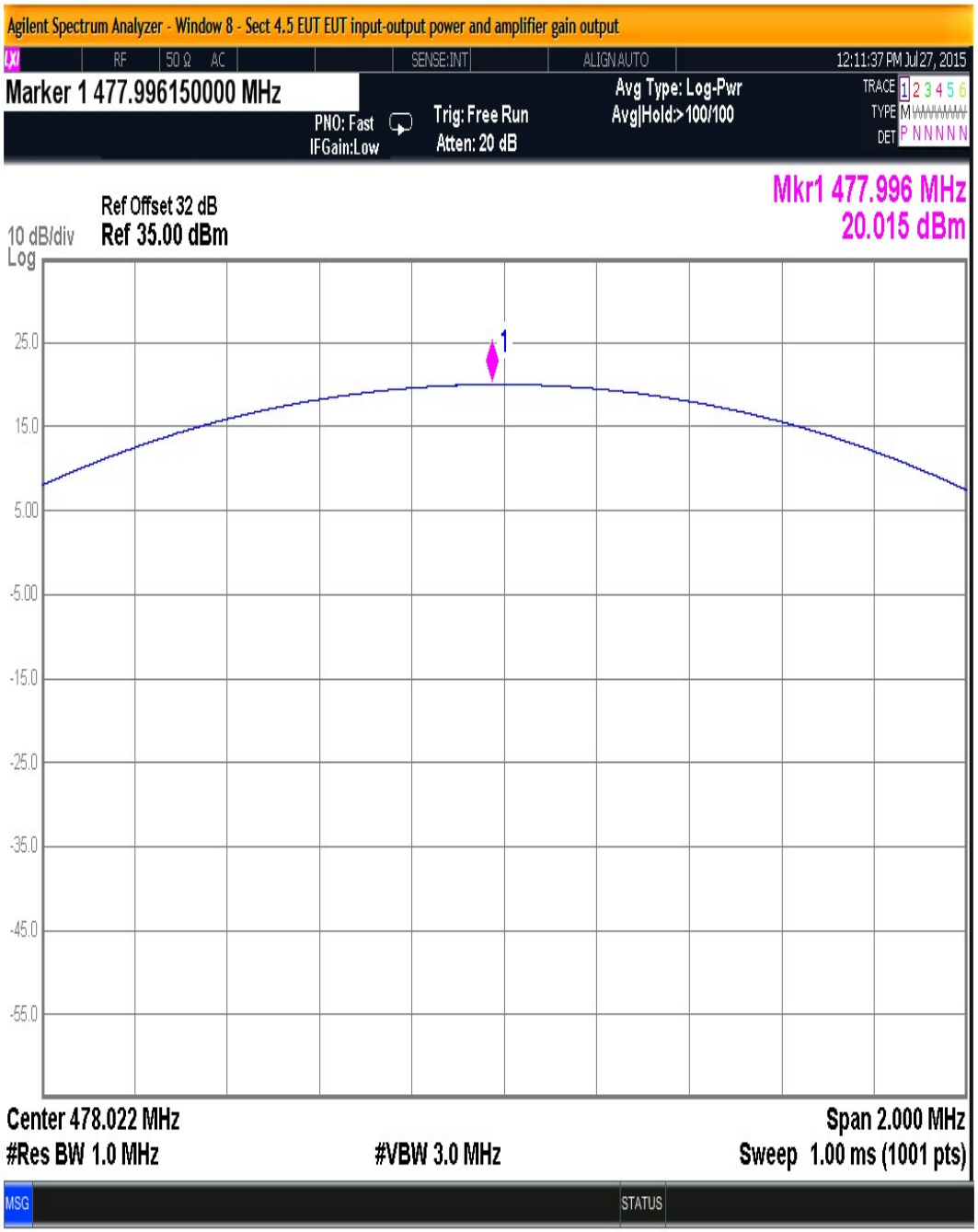

Figure 72. Window 8 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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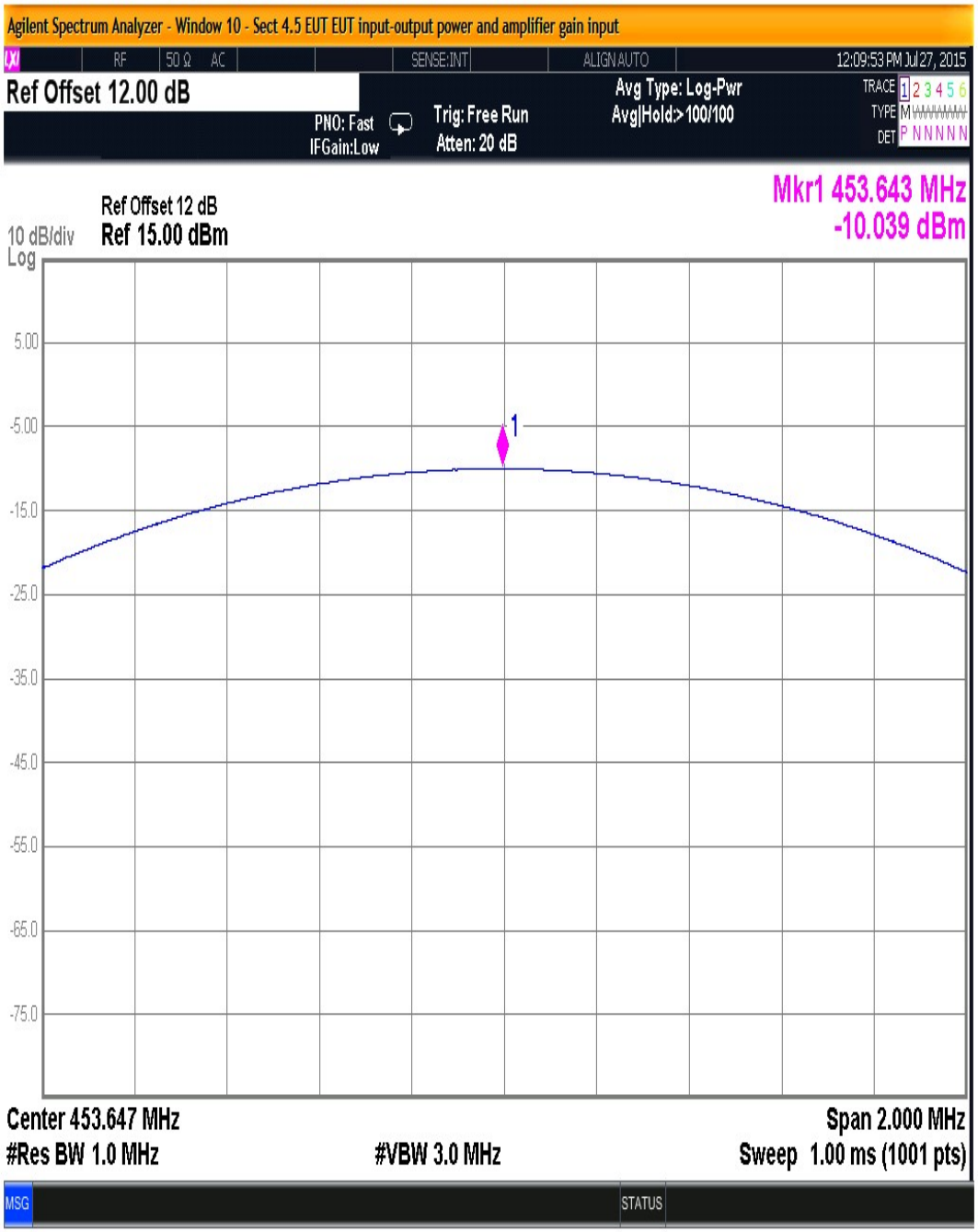

Figure 73. Window 10 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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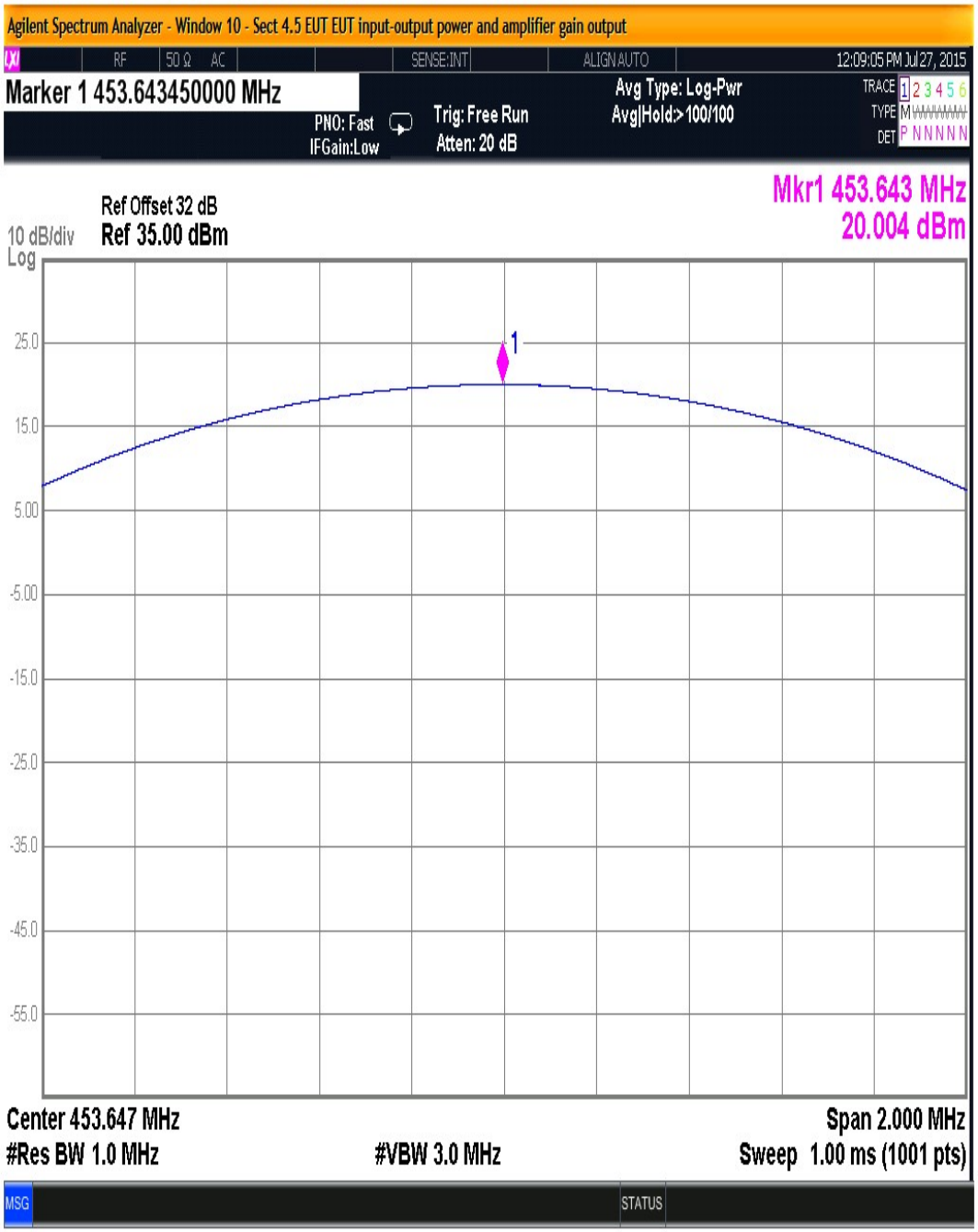

Figure 74. Window 10 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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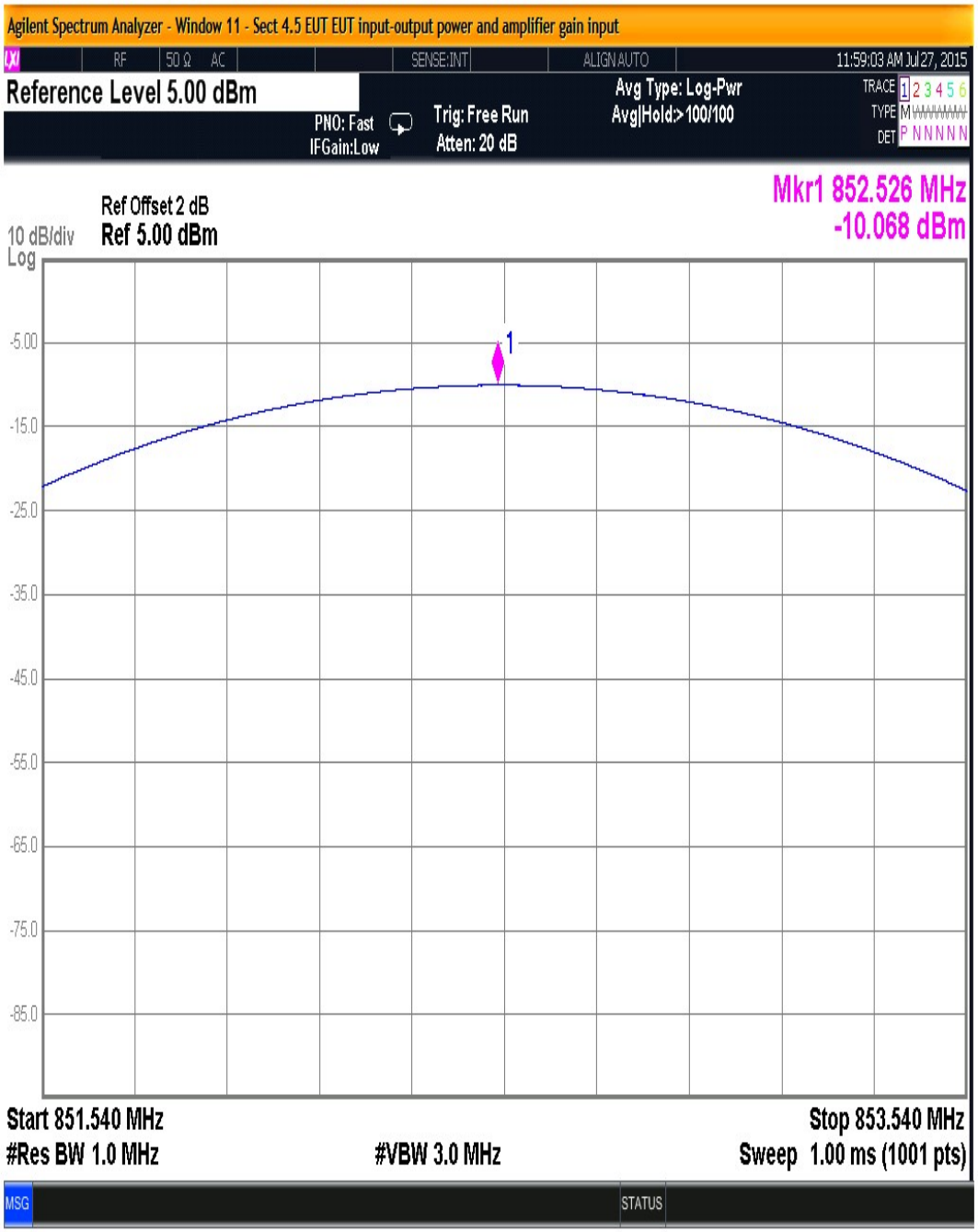

Figure 75. Window 11 - Sect 4.5 EUT EUT input-output power and amplifier gain input

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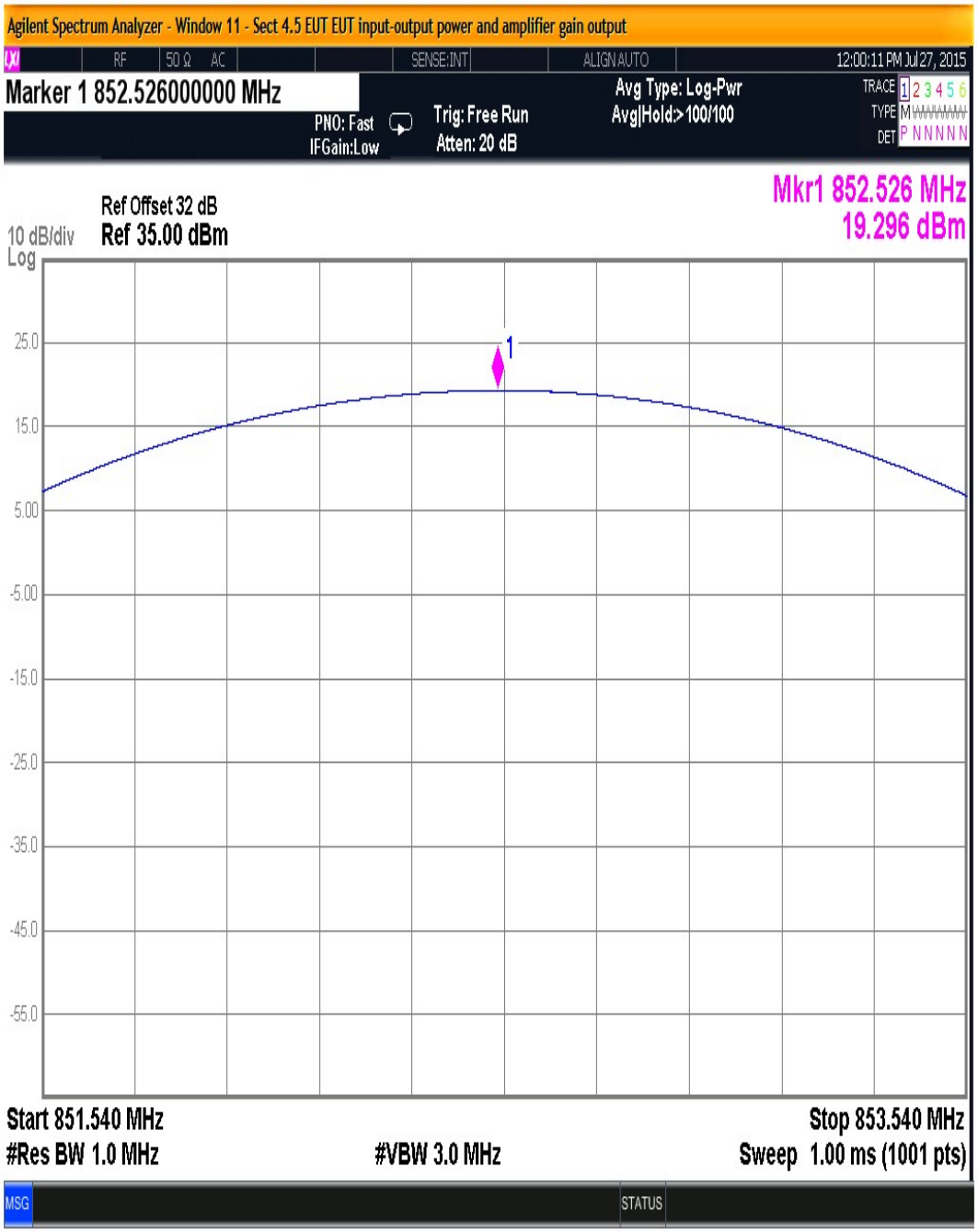

Figure 76. Window 11 - Sect 4.5 EUT EUT input-output power and amplifier gain output

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4.5 EUT noise figure measurement

Procedure: KDB 935210 D05 Indus Booster Basic Meas v01 DR07-42107: Section 4.6

Section 4.6: 90.219(e)(2) limits the noise figure of a signal booster to ≤ 9 dB in either direction. The following guidance is offered with regards to measuring the noise figure to demonstrate compliance to this limitation.

There are several widely recognized methods for performing noise figure measurements. Some require the use of specialized equipment such as a noise figure analyzer and/or an excess noise ratio (ENR) calibrated noise source, while others involve the use of conventional measurement instrumentation such as a spectrum analyzer. The methodology that requires the use of a noise figure analyzer is generally accepted as producing the most accurate results, and thus is considered to be the primary method within this document, while other methods are considered to be acceptable alternatives. Consult the relevant instrumentation application notes for detailed guidance regarding the selection and application of an appropriate methodology for performing noise figure measurements. It should also be noted that noise figure measurements will require that any AGC circuitry be disabled over the duration of the measurement.

Since a Noise figure analyzer was not available, an alternate method utilizing the definition of Noise Figure was utilized.

$$F_n = P_n / (kT_oBG)$$

Equation 3: Noise Factor Equation

Where:

F_n is the Noise Factor

P_n is the power of the channel noise

k is Boltzmann's constant *1.38E-23* J/K

T_0 is 290k

B is the channel bandwidth

G is the gain of the amplifier.

$$NF = 10\text{Log } F_n$$

Equation 4: Noise Figure Equation

Where:

F_n is the Noise Factor

NF is the Noise Figure

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To perform the measurement, each window input was terminated with 50 ohms. The window and amplifier were enabled and the spectrum analyzer was tuned to the center frequency of window. The analyzer was configured to make a channel power measurement with a integration bandwidth of 12.5kHz since this is the typical channel bandwidth and we are interested in the amount of noise introduced to the channel by the amplifier.

4.5.1 Results

Each window met the requirements of $\leq$ 9 dB noise figure. See Table 9 for tabulated results.

Table 9: Noise Figure Results

Window	G(dB)	B (kHz)	P_n (watts)	F_n (dB)
1	27.5	12.8	9.278E-14	5.0
2	28.2	12.8	9.910E-14	3.0
3	27.4	12.8	7.500E-14	2.7
4	26.5	12.8	7.500E-14	3.4
6	26.6	12.8	1.500E-13	6.6
8	27.5	12.8	1.450E-13	5.1
10	26.1	12.8	1.500E-13	7.3
7, 9, 12	26.3	12.8	1.200E-13	5.6
11	25.2	12.8	9.000E-14	5.4

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4.6 Measuring the EUT out-of-band/block (including intermodulation) and spurious emissions

Procedure: KDB 935210 D05 Indus Booster Basic Meas v01 DR07-42107: Section 4.7

Section 4.7 Specifies the limits of §90.210 apply on unwanted (out-of-band/block and spurious) emissions.

There are two requirements in this section: Intermodulation products and Spurious emissions.

4.6.1 KDB 935210 D05 Section 4.7.2 EUT out-of-band/block emissions conducted measurement

Intermodulation products shall be measured while applying two CW tones spaced in frequency ±12.5 kHz relative to the center frequency (f_0) as determined from 4.4.

a) Connect a signal generator to the input of the EUT.
   NOTE—If the signal generator is not capable of producing two independent modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support the two-tone test.
b) Configure the two signal generators to produce CW tones on frequencies spaced at ± 12.5 kHz relative to f_0 with amplitude levels set just below the AGC threshold (see 4.2).
c) Connect a spectrum analyzer to the EUT output.
d) Set the span to 100 kHz.
e) Set the resolution bandwidth to 300 Hz with a video bandwidth ≥ 3 × RBW.
f) Set the detector to power average (rms).
g) Place a marker on highest intermodulation product amplitude.
h) Capture the plot for inclusion in the test report.

4.6.1.1 Results

No intermodulation products exceed the limits. See Table 10 for tabular results. See Figure 77 through Figure 94 for the plots.

Table 10: Intermodulation Products

Window	Intermodulation Frequency (MHz)	Maximum Intermodulation Level (dBm)	Limit (dBm)	Margin (db)
1	483.9146	-35.24	-25	-10.24
2	486.2966	-36.251	-25	-11.251
3	482.7406	-34.541	-25	-9.541
4	460.678	-33.647	-25	-8.647
6	453.494	-36.068	-25	-11.068
8	478.06	-33.437	-25	-8.437
10	453.6101	-36.472	-25	-11.472
7, 9, 12	851.968	-36.675	-22.9	-13.775
11	852.503	-36.372	-22.9	-13.472

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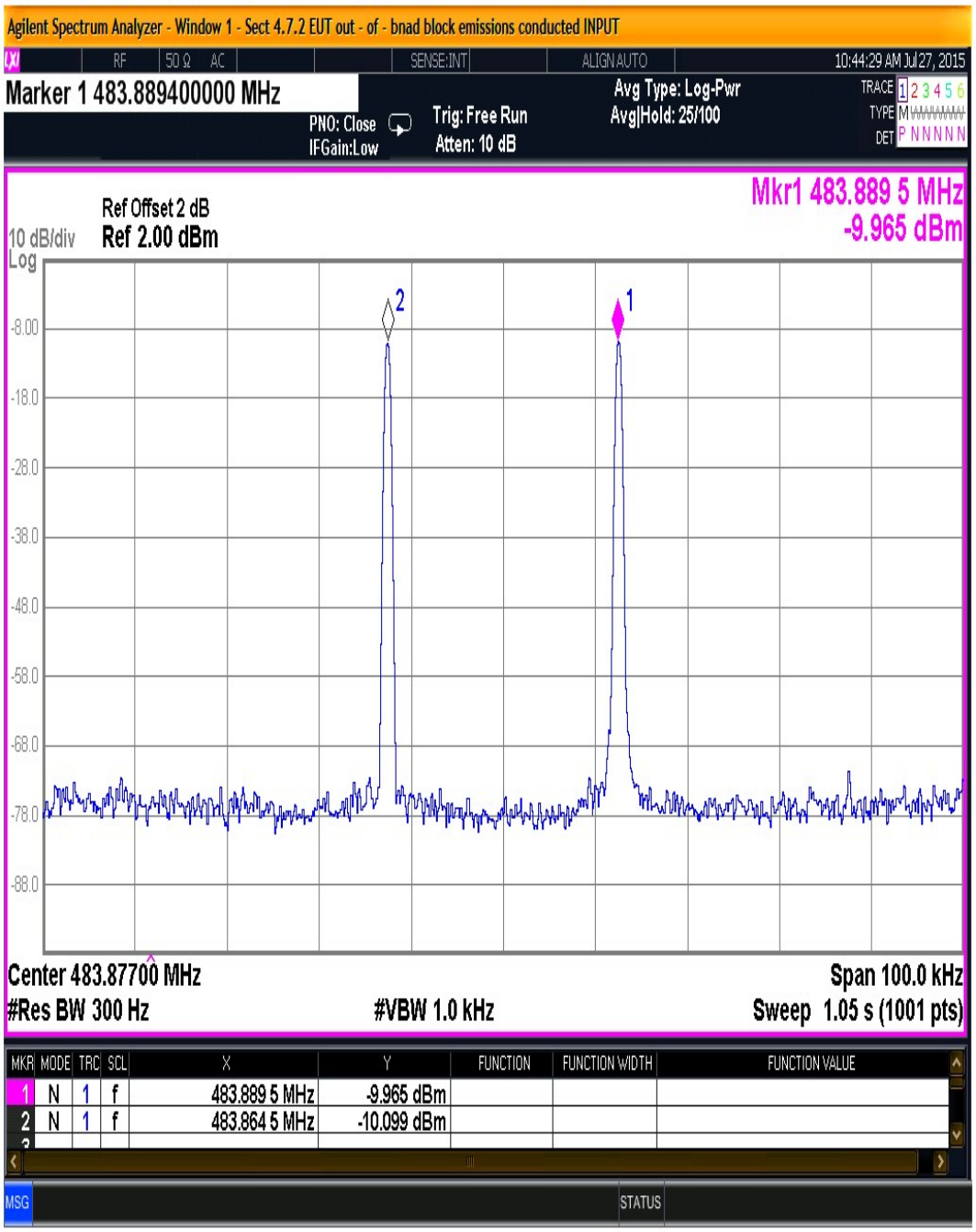

Figure 77. Window 1 - Sect 4.7.2 EUT out - of - band block emissions conducted INPUT

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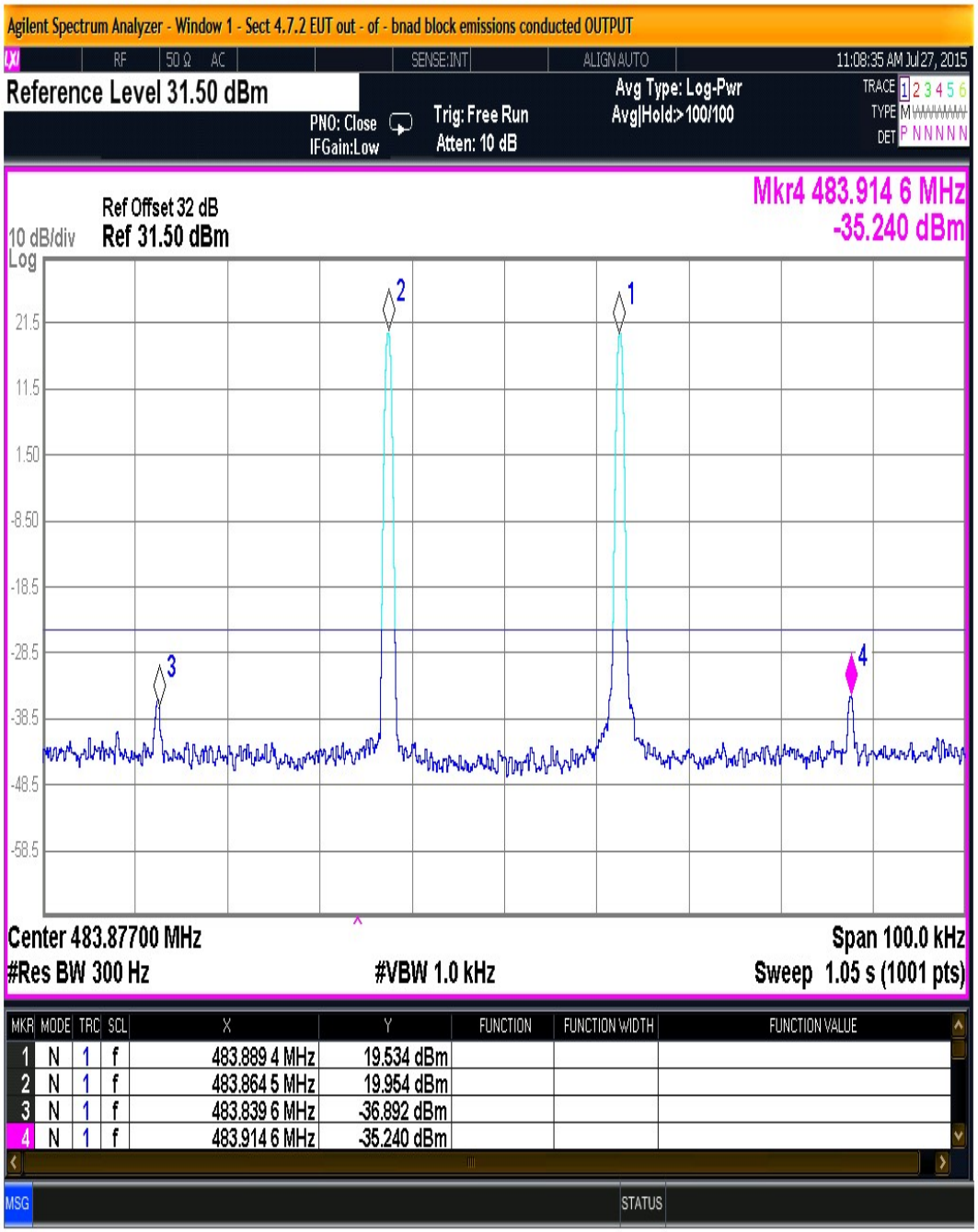

Figure 78. Window 1 - Sect 4.7.2 EUT out - of - band block emissions conducted OUTPUT

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