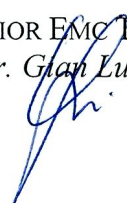




*ELECTROMAGNETIC COMPATIBILITY
ELECTRICAL SAFETY
LASER SPECTROSCOPY
ENVIRONMENTAL PHYSICS*

G.S.D. S.r.l.
Certified in accordance with
UNI EN ISO 9001:2008
by
TÜV Rheinland Italia S.r.l.
Certificate N. 39 00 1850509

G.S.D. Srl PISA - Italy	Test Report n. FCC-17366	Rev. 03
Manufacturer	ISD GEORADAR S.r.l.	
Address	Via Enrica Calabresi, 24 56121 Pisa (PI) Italy	
Test Family Name	IBIS Sensor Ku ETH	
Testing Laboratory Name	G.S.D. S.r.l.	
Address	Via Marmiceto, 8 56121 Pisa (PI) Italy	
Tel/Fax	+39 050 984254 / +39 050 984262	
P.IVA/VAT	01343950505	
http – e-mail	www.gsd.it - info@gsd.it	
FCC Listed. Registration Number: 424037.		
Location and Date of Issue	Pisa, 2017 July 10	
G.S.D. s.r.l. Via Marmiceto, 8 56121 OSPEDALETTO - PISA Tel. 050.984254 - Fax 050.984262 P. IVA 01343950505 SENIOR EMC TEST MANAGER <i>Dr. Gian Luca Genovesi</i>  QUALITY MANAGER <i>Dr. David Pelliccia</i> 		

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Report Revision History

Revision details

<i>Date</i>	<i>Page No.(s)</i>	<i>Details</i>
2017 June 30	86	Rev. 00 First issue
2017 June 30	86	Rev. 01 Second Issue
2017 June 30	77	Rev. 02 Third Issue
2017 July 10	74	Rev. 03 Forth Issue

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1. MANUFACTURER AND EUT IDENTIFICATION ¹	
Manufacturer	ISD GEORADAR S.r.l..
Address	Via Enrica Calabresi, 24 56121 Pisa (PI) Italy
Test Family Name	IBIS Sensor Ku ETH
Date of reception	2017 June 04
Sampling	Laboratory sample for certification
Test Item Description	Interferometric RADAR
Nominal Input Voltage	12-24 Vdc
FCC ID	FCC ID: UFW-IBIS-KU-ETH

¹A detailed documentation is preserved in the internal fascicle.

2. REFERENCE STANDARDS

Tests and measurements are performed accordingly to the reference standards given in the table below:

<i>TEST</i>	<i>STANDARD</i>
Spectrum Emission Mask: 90.210 (c)	FCC Rules ad Regulations, Title 47 Part 90 – Sub part F
RF Output Power: Section 2.1046	FCC Rules ad Regulations, Title 47 Part 2
Occupied Bandwidth: Section 2.1049	FCC Rules ad Regulations, Title 47 Part 2
Conducted Spurious: Section 2.1051	FCC Rules ad Regulations, Title 47 Part 2
Frequency Stability: Section 2.1055	FCC Rules ad Regulations, Title 47 Part 2
Measurements required: Field strength of spurious radiation / Spurious emissions (radiated)	FCC 47 CFR § 2.1053 § 90.210
Antenna Requirement: §15.203	FCC Rules ad Regulations, Title 47 Part 15 – Sub part C

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3. RESULT, CONDITION, MEASUREMENT UNCERTAINTYSummary of Test Results

<i>TEST</i>	<i>RESULT</i>
<i>Emissions: conducted</i>	<i>N/A</i>
<i>Emissions: radiated</i> <i>Section 90.210</i> <i>Section 2.1053</i>	<i>Pass</i>
<i>RF Output Power</i> <i>Section 2.1046</i>	<i>Pass</i>
<i>Occupied bandwidth</i> <i>Section 2.1049</i>	<i>Pass</i>
<i>Spectrum Emission Mask</i> <i>Section 90.210 (c)</i>	<i>Pass</i>
<i>Conducted Spurious Emissions</i> <i>Section 2.1051</i>	<i>Pass</i>
<i>Radiated Spurious Emissions</i> <i>Section 2.1053</i>	<i>Pass</i>
<i>Frequency Stability</i> <i>Section 2.1055</i>	<i>Pass</i>

Measurement uncertainty

<i>TEST</i>	<i>EXPANDED UNCERTAINTY</i>
Conducted Emission – 50Ω/50μH (150 kHz - 30 MHz)	± 3.5 dB
Radiated Emission – (Semianechoic Room) (30 MHz - 18 GHz)	± 4.7 dB

Climatic Conditions

<i>PARAMETER</i>	<i>VALUE</i>
Temperature	(293 ± 3) K
Relative humidity	(50 ± 5) %

Auxiliary apparatus

Equipment uses two different antenna: 13.3 dBi and 22 dBi gains.

Extensions

The results refer only to the sampled EUT and under the specified conditions.

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4. CONDUCTED EMISSIONS

In the following table you can find the limits established by the reference standard:

<i>FREQUENCY RANGE</i> (MHz)	<i>QUASI-PEAK LIMIT</i> [dB(μV)]	<i>AVERAGE LIMIT</i> [dB(μV)]
0.15 – 0.50	66 – 56 (*)	56 – 46 (*)
0.50 – 5	56	46
5 – 30	60	50

(*) Decreases with the logarithm of the frequency.

Test Equipment

EQUIPMENT	MANUFACTURER	MODEL	NEXT CALIBRATION
EMI Receiver	Agilent	E4440	01/2018
LISN	GSD	GSDA01	01/2018
Screened Room	GSD	CSC01	01/2018

Method

The EUT was switched on and allowed to warm up to its normal operating condition.

All possible modes of operation were investigated.

Only the 6 worst case emissions measured, using the correct CISPR and Average detectors, are reported. All other emissions were relatively insignificant.

Result:

Not applicable. The EUT was powered by battery.

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5. RADIATED EMISSIONS

In the following table you can find the limits established by the reference standard:

FREQUENCY RANGE (MHz)	Field Strength QUASI-PEAK LIMITS [dB (μV/m)]
0.009 – 0.490	48.15 – 13.8 @ 300m
0.490 – 1.705	33.8 – 23 @ 30m
1.705 – 30	29.5 @ 30m
30 – 88	40
88 – 216	43.5
216 – 960	46
Above 960	54

Test Equipment

EQUIPMENT	MANUFACTURER	MODEL	CAL. DUE
MXE EMI Receiver	Agilent/Keysight	N9038A	01/2018
EMI Receiver	Agilent	E4440	01/2018
Harmonic mixer	HP	11971A	01/2018
Harmonic mixer	Keysight	11970U	07/2020
EXA Signal Analyzer	Keysight	N9010B	01/2018
Waveguide Harmonic Mixer	Keysight	M1970E	11/2017
Anechoic Chamber	Comtest	CSA01	01/2018
Bilog Antenna	Schaffner	CBL6112B	01/2018
Horn Antenna	EMCO	3115	01/2018
Horn Antenna	Alpha Industries	61932500	01/2018
Standard Gain Horn Antenna	A-INFOMW	LB-19-20-A	01/2018
Standard Gain Horn Antenna	A-INFOMW	LB-12-20-A	01/2018
Controller	Deisel	HD100	01/2018
Turn Table	Deisel	MA240	01/2018
LISN	GSD	NTW06	01/2018

Test procedure: RE22R02

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<u>Notes</u>
Azimuth position EUT-Antenna corresponding to 0° identifies the rotating table orientation (TT) in which the instrument to be tested shows the front part turned towards the antenna. Positive grades individuate clockwise rotations of TT when this one is observed from the top. For negative degrees, TT rotation is counter-clockwise. Antenna height respect to the mass plane is conventionally individuated with: MA=XXX where XXX indicates the height (always positive and greater than 100) expressed in cm. Antenna horizontal polarisation is indicated by POL=H. Antenna vertical polarisation is indicated by POL=V. EUT was tested in the three orthogonal planes.
Note:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))
<u>Results and conclusions</u>
In all the operative conditions, equipment complied with the standard limits. Graphics in following figures show the most significant registrations of the performed measurements.

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Job Number FCC-17366
 Test Name Radiated Emissions - FCC 15C
 EUT Name ISD GEORADAR S.r.l. - IBIS Sensor Ku ETH

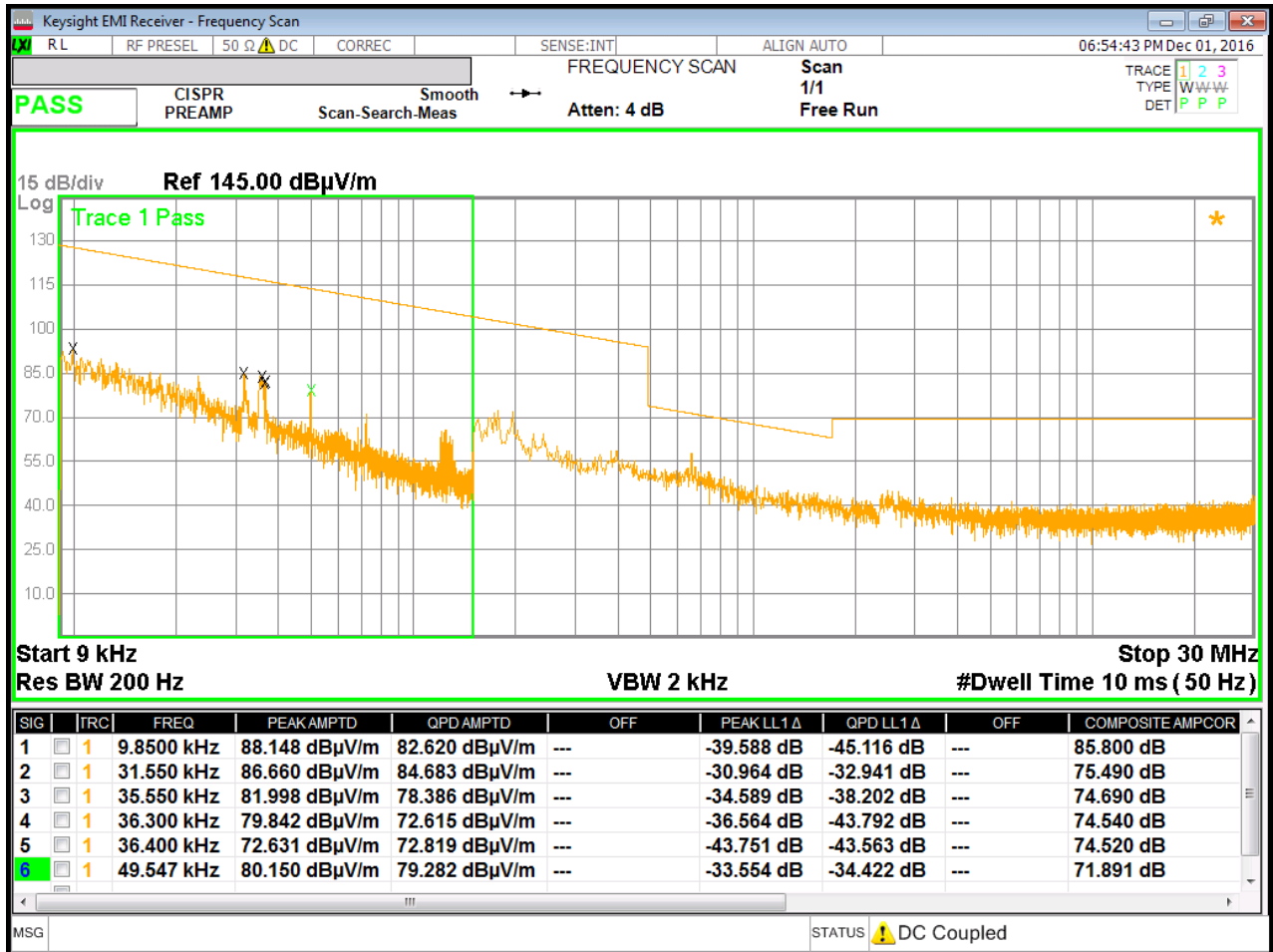


Fig. 5.1

Maximum disturbance determined in the frequency range 150 kHz – 30 MHz.
 Loop Antenna Parallel Polarization

Job Number FCC-17366
 Test Name Radiated Emissions - FCC 15C
 EUT Name ISD GEORADAR S.r.l. - IBIS Sensor Ku ETH

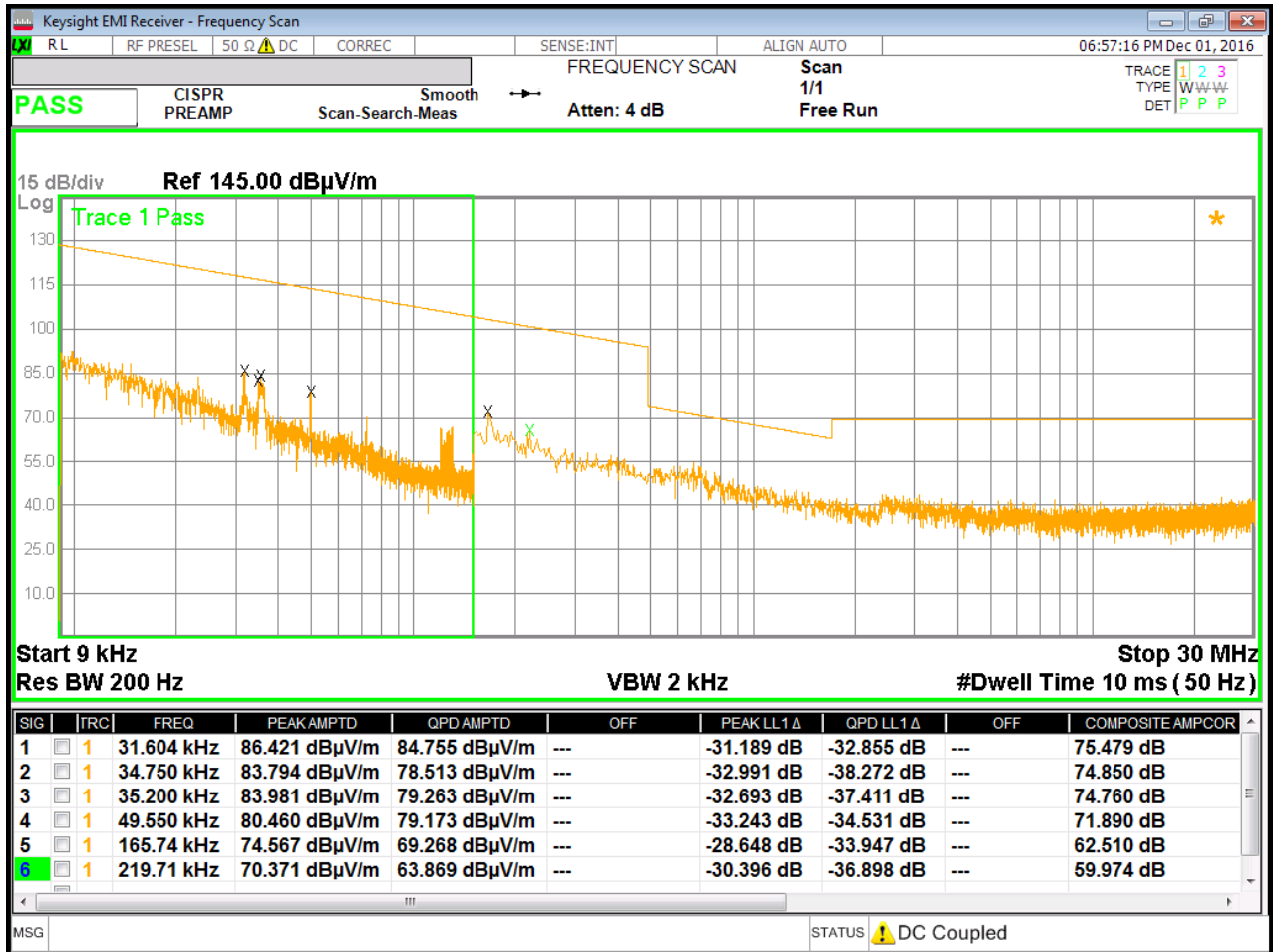
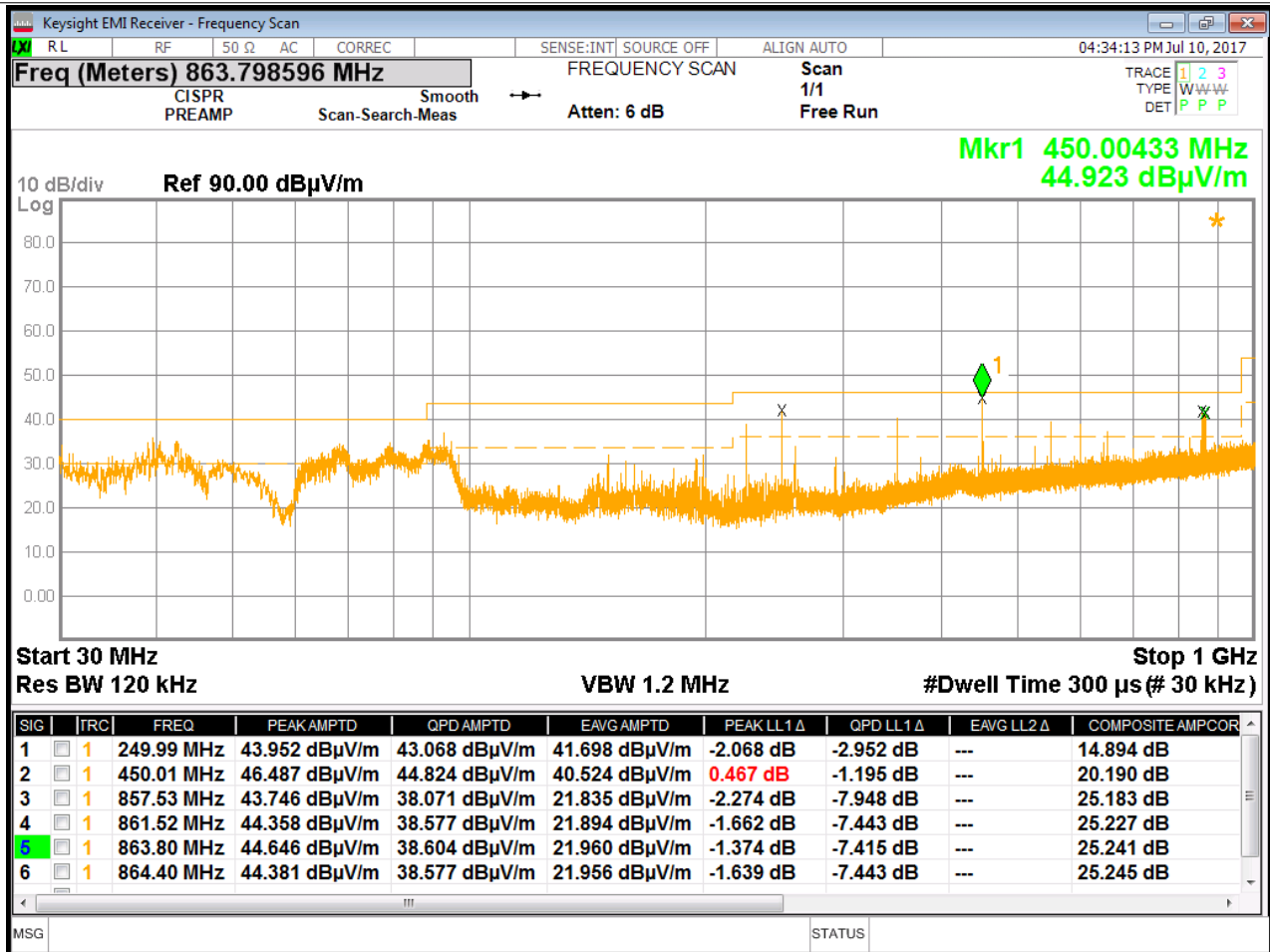


Fig. 5.2

Maximum disturbance determined in the frequency range 150 kHz – 30 MHz.
 Loop Antenna Orthogonal Polarization

Job Number FCC-17366
 Test Name Radiated Emissions - FCC 15C
 EUT Name ISD GEORADAR S.r.l. - IBIS Sensor Ku ETH

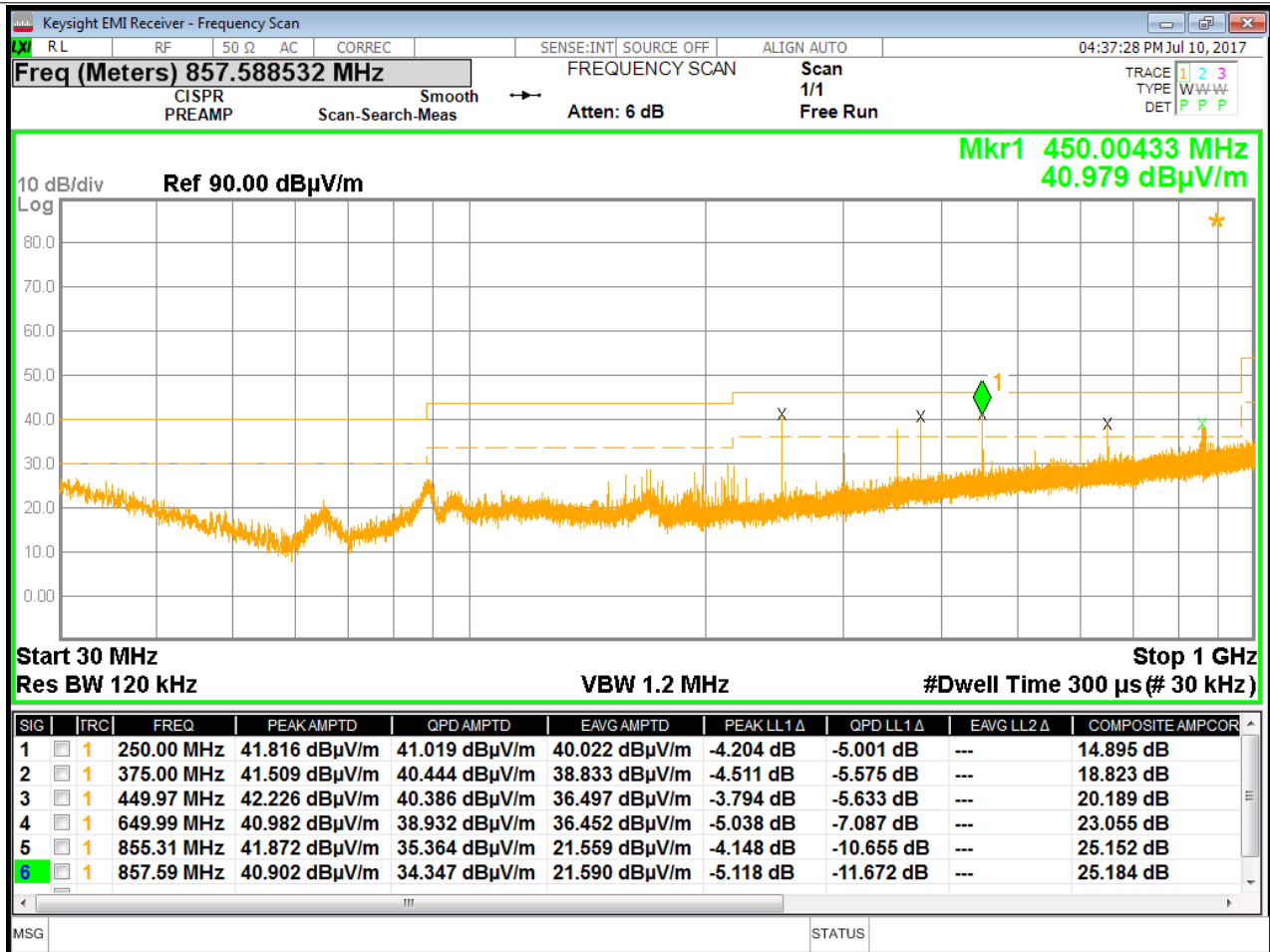


POL V

Fig. 5.3

Record of the measurement of radiated emissions (PK in orange, AVG in blu)
 Maximum disturbance determined in the frequency range 30 MHz – 1000 MHz.

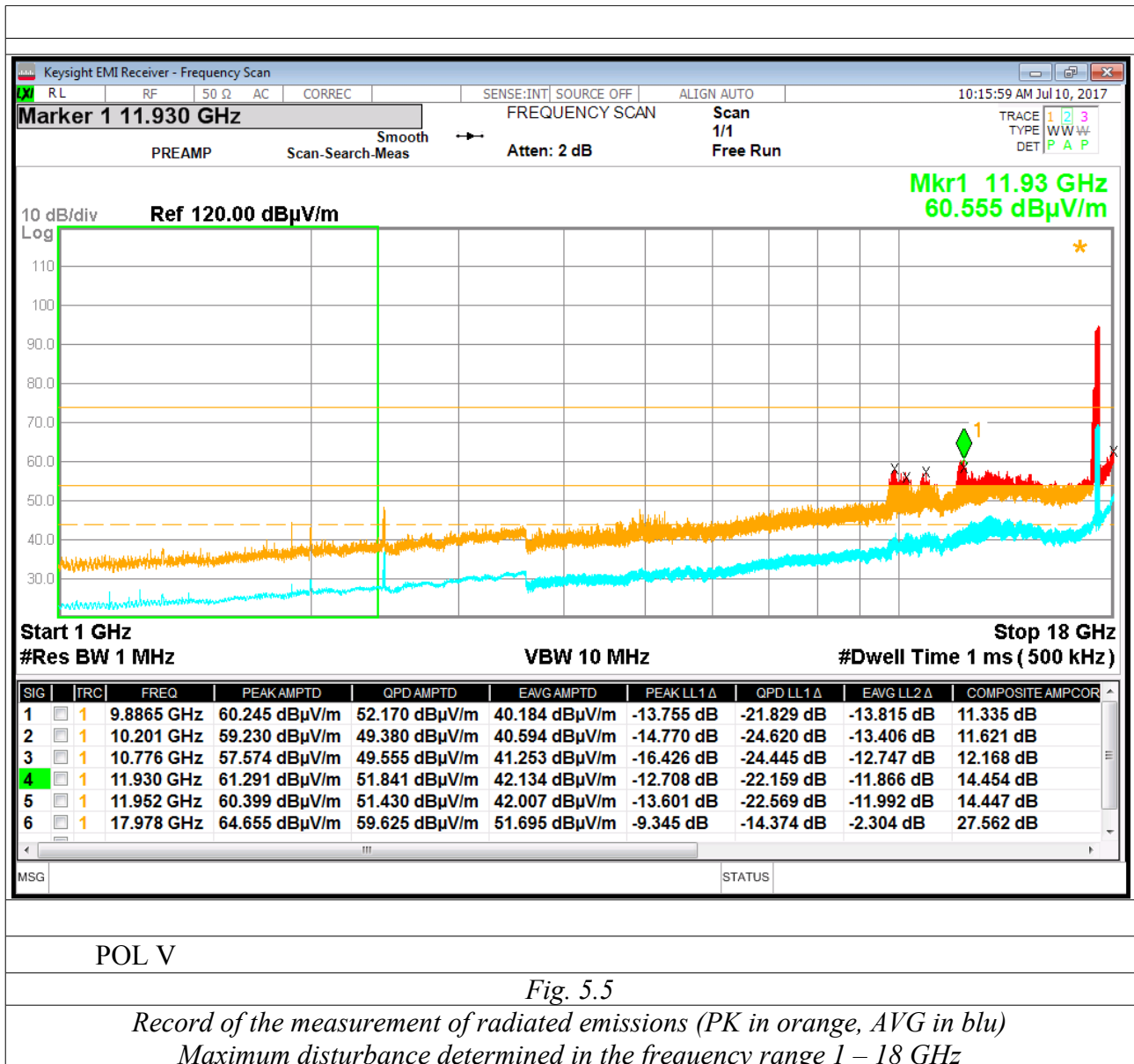
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 Test Name Radiated Emissions - FCC 15C
 EUT Name ISD GEORADAR S.r.l. - IBIS Sensor Ku ETH



POL H

Fig. 5.4

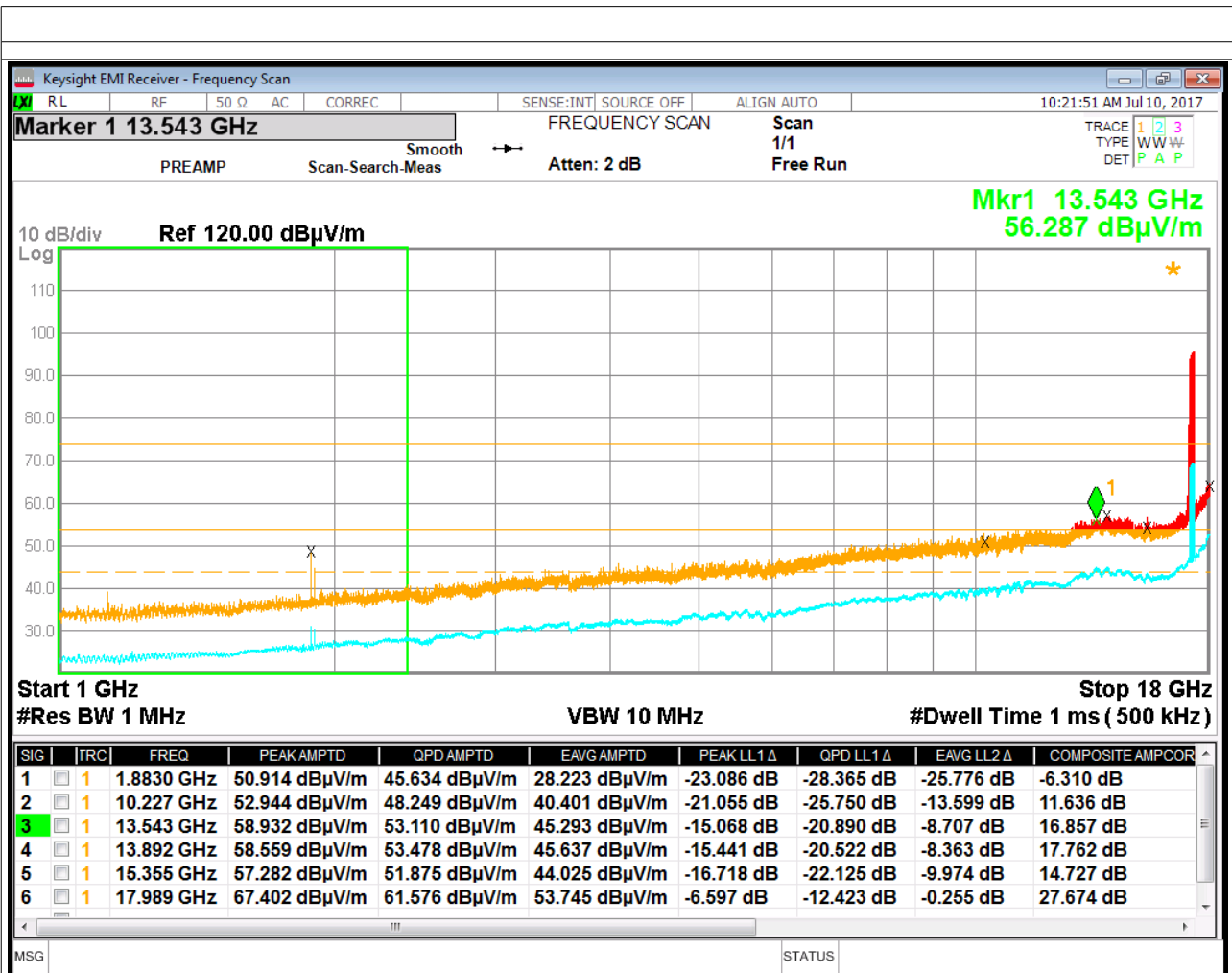
Record of the measurement of radiated emissions (PK in orange, AVG in blu)
 Maximum disturbance determined in the frequency range 30 MHz – 1000 MHz.



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POL H

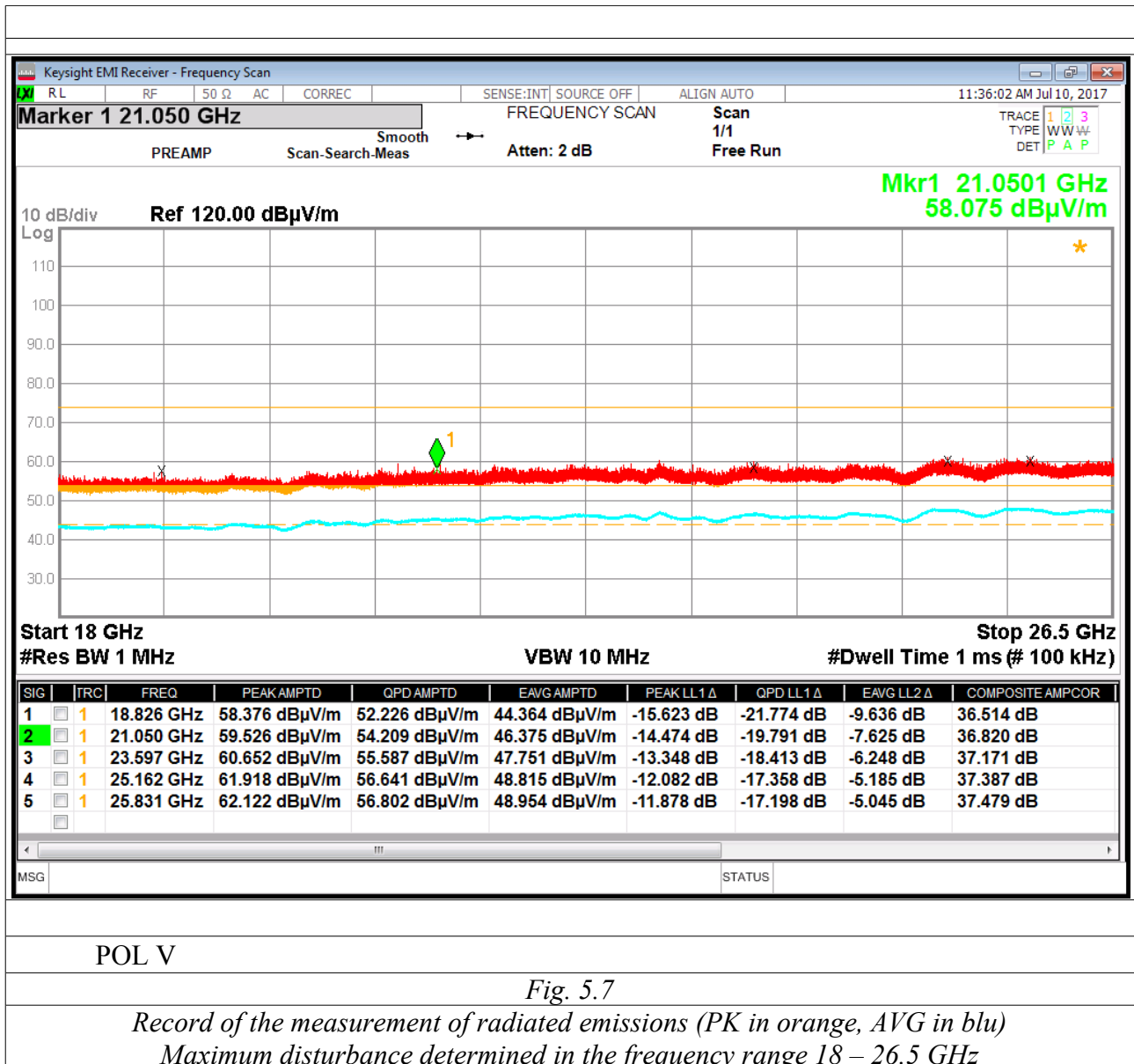
Fig. 5.6

Record of the measurement of radiated emissions (PK in orange, AVG in blu)
Maximum disturbance determined in the frequency range 1 – 18 GHz

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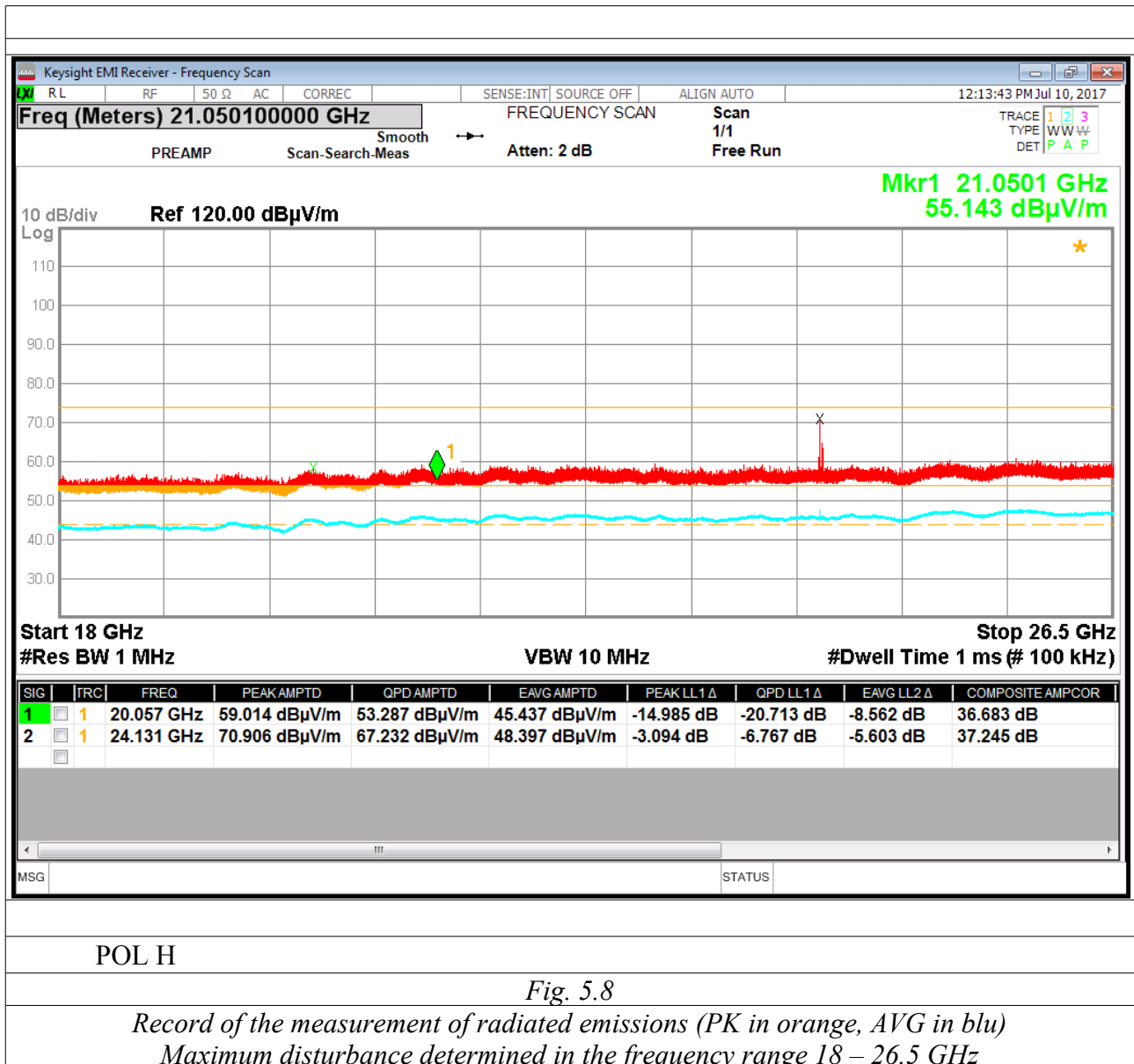
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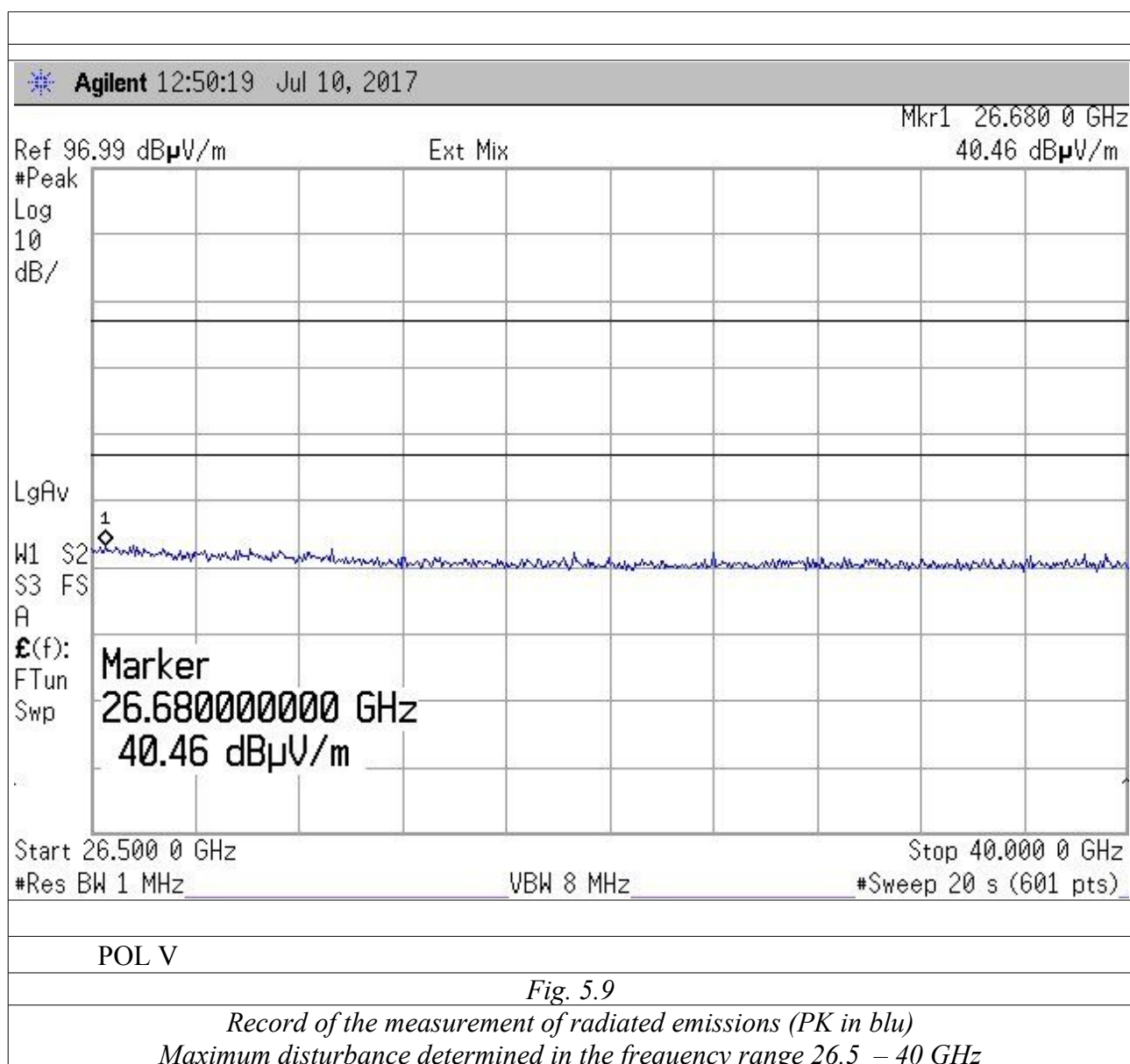


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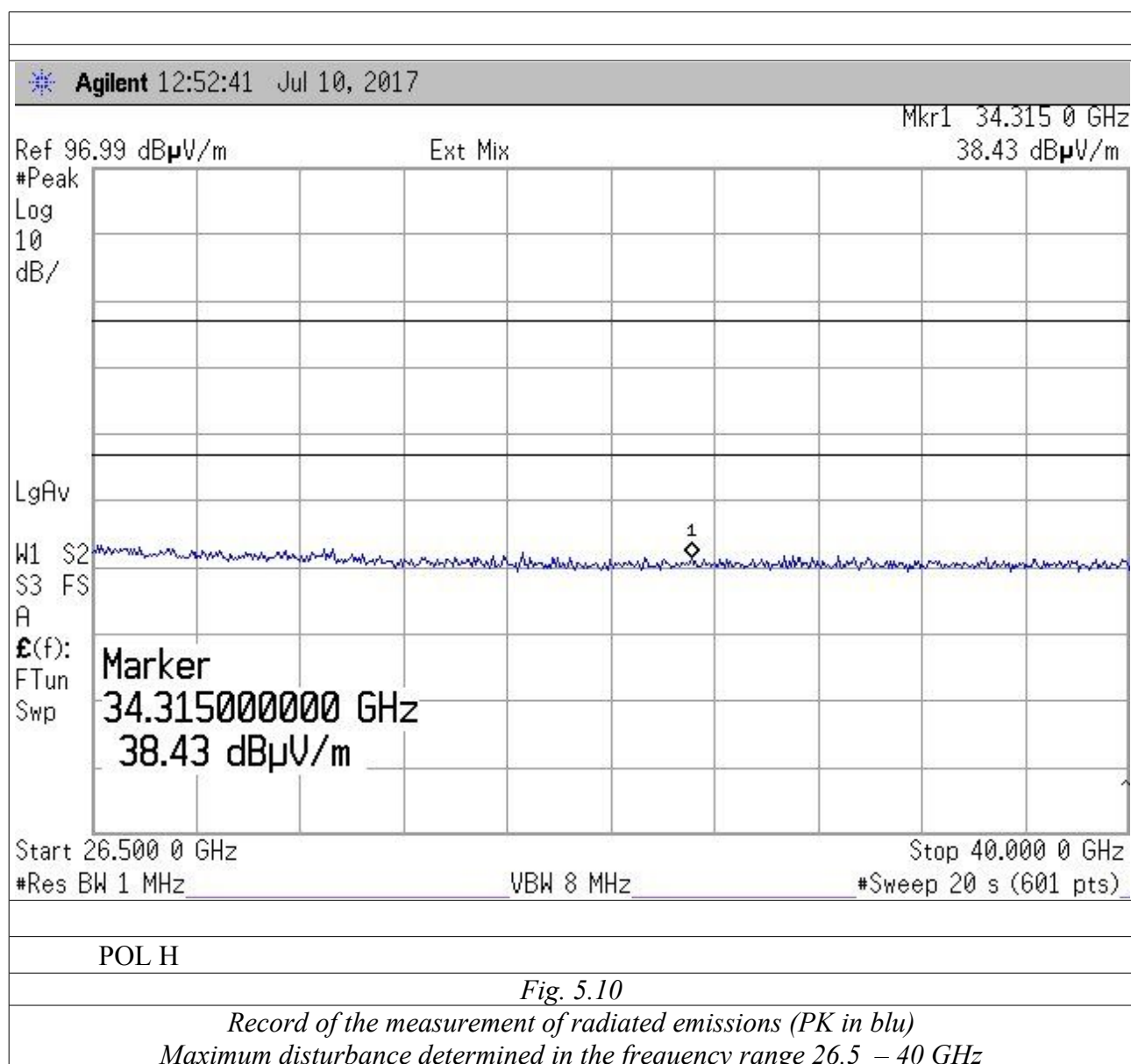




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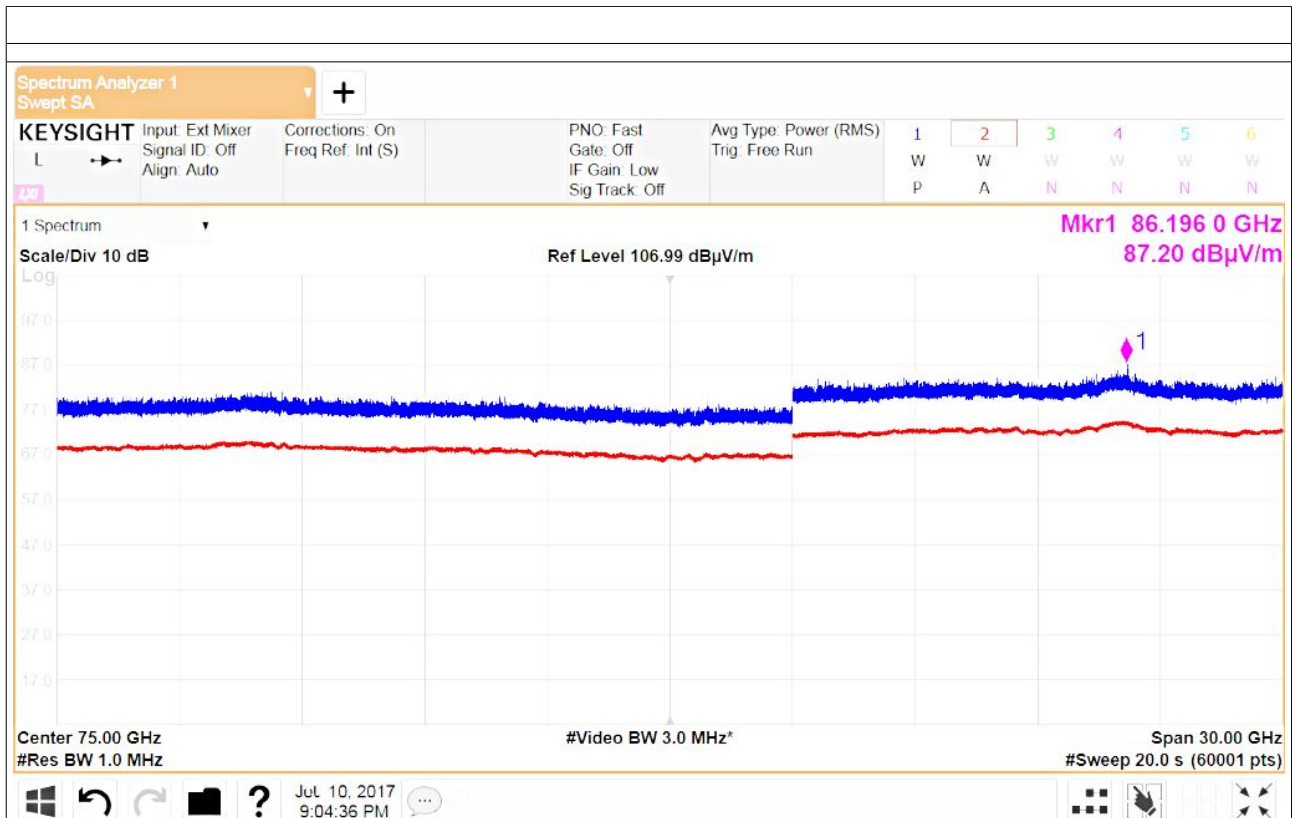
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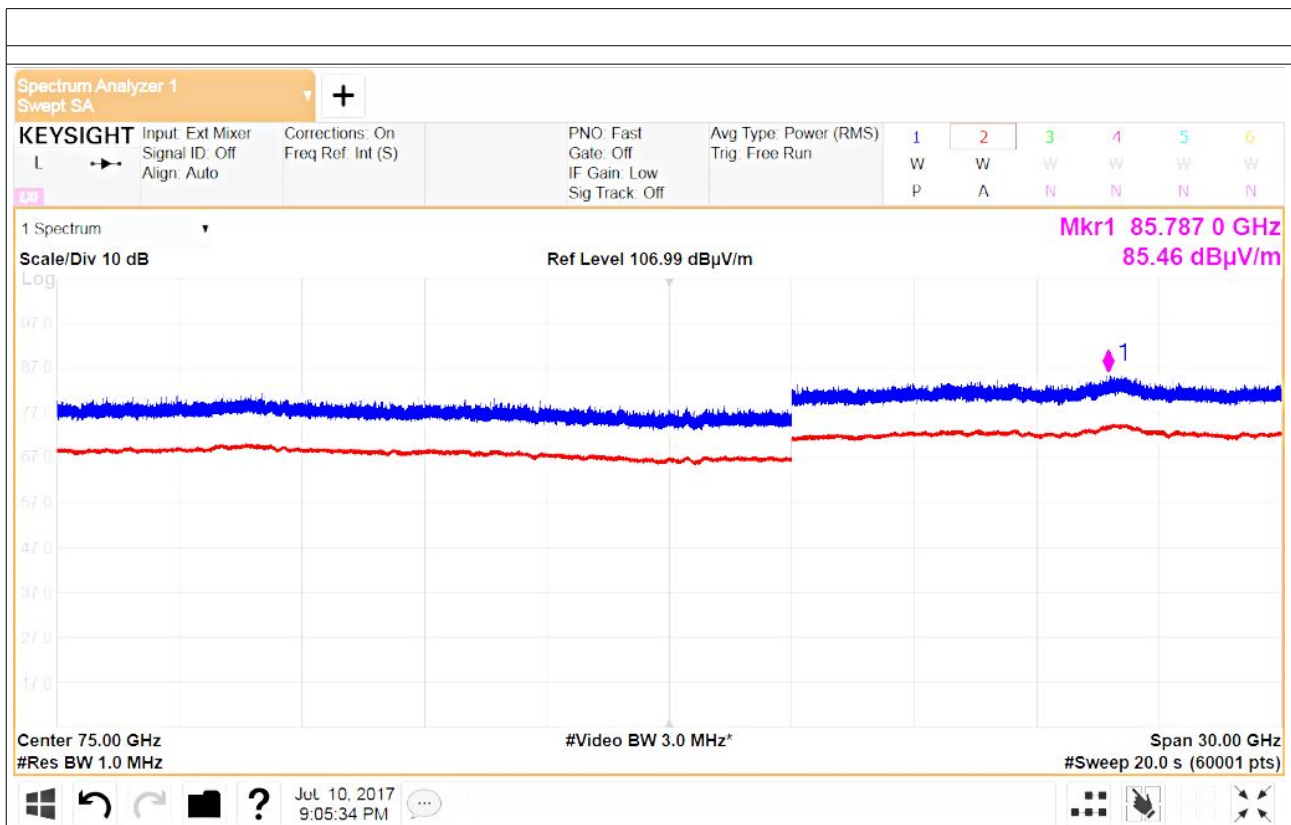
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POL V

Fig. 5.11

Record of the measurement of radiated emissions (PK in orange, AVG in blu)
Maximum disturbance determined in the frequency range 60 – 90 GHz



POL H

Fig. 5.12

Record of the measurement of radiated emissions (PK in orange, AVG in blu)
Maximum disturbance determined in the frequency range 60 – 90 GHz

6. TRANSMISSION REQUIREMENTS

An intentional radiator must be designed to guarantee specific requirements.

6.1. ANTENNA REQUIREMENT

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna requirement must meet at least one of the following:

- Antenna must be permanently attached to the device.
- Antenna must use a unique type of connector to attach to the device.
- Device must be professionally installed. Installer shall be responsible for ensuring that the correct antenna is employed with the device.

Note:

Antenna use a wave guide port to attach to the device.

Result

Pass

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6.2. *PEAK OUTPUT POWER*

EUT was set for low, mid, and high channel with modulated mode and highest RF output power. Two antennas with lowest and highest gains was imposed.

The spectrum analyzer was connected to the antenna terminal.

Measurement (conducted)

The measured values are:

Channel Output A

<i>FREQUENCY</i>	Output Power (dBm)	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Low (17.1 GHz)	19.9	13.6
Mid (17.2 GHz)	20.5	13.9
High (17.3 GHz)	19.1	12.3

Channel Output B

<i>FREQUENCY</i>	Output Power (dBm)	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Low (17.1 GHz)	20.4	13.8
Mid (17.2 GHz)	19.6	12.9
High (17.3 GHz)	19.7	12.9

Procedures:

The peak output power was measured conducted using a spectrum analyzer at low, mid, and hi frequency channels. Peak detector was set to measure the power output. The lowest antenna gain is 13.3 dBi, and highest antenna gain is 22 dBi.

Result

Pass

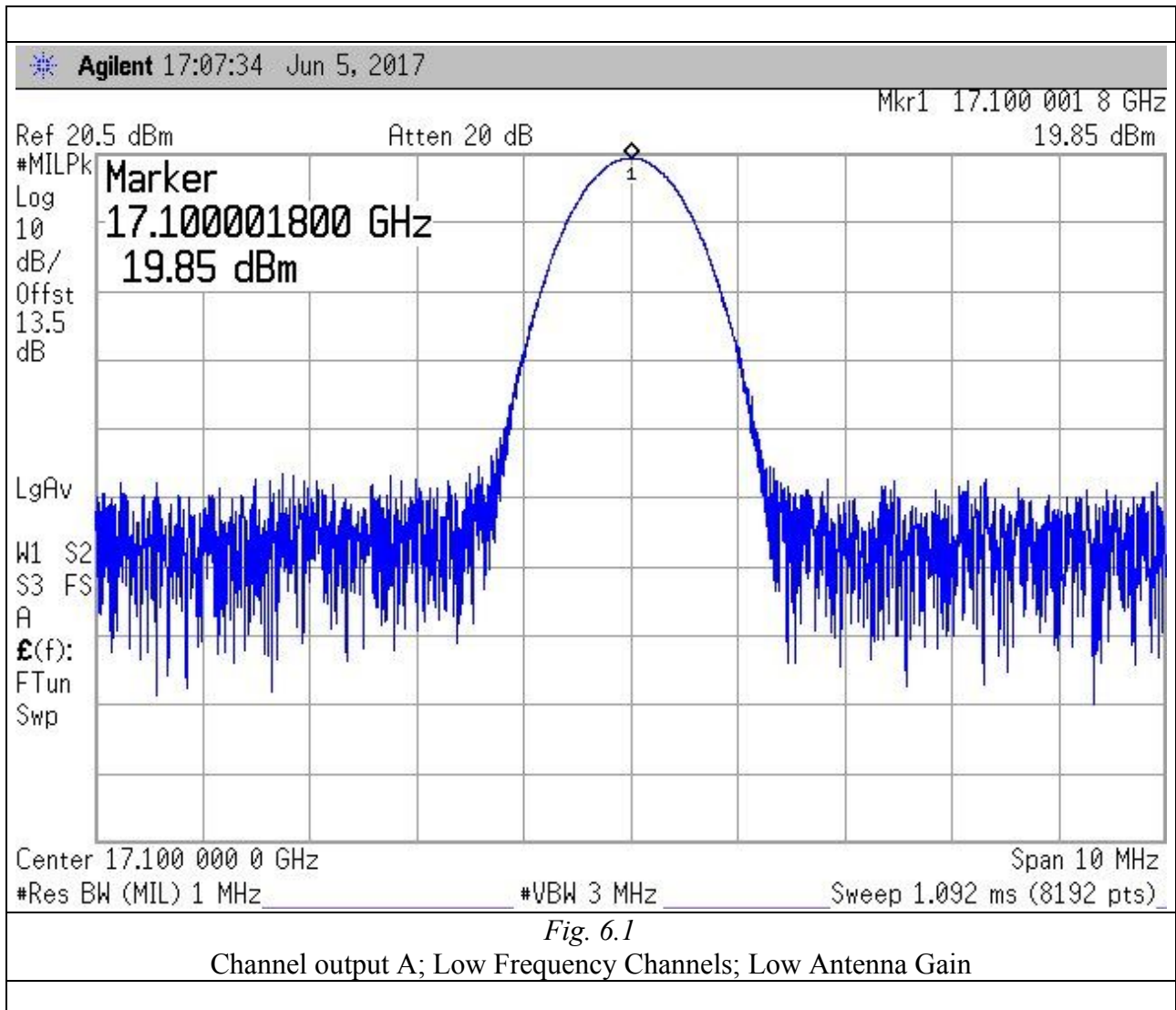
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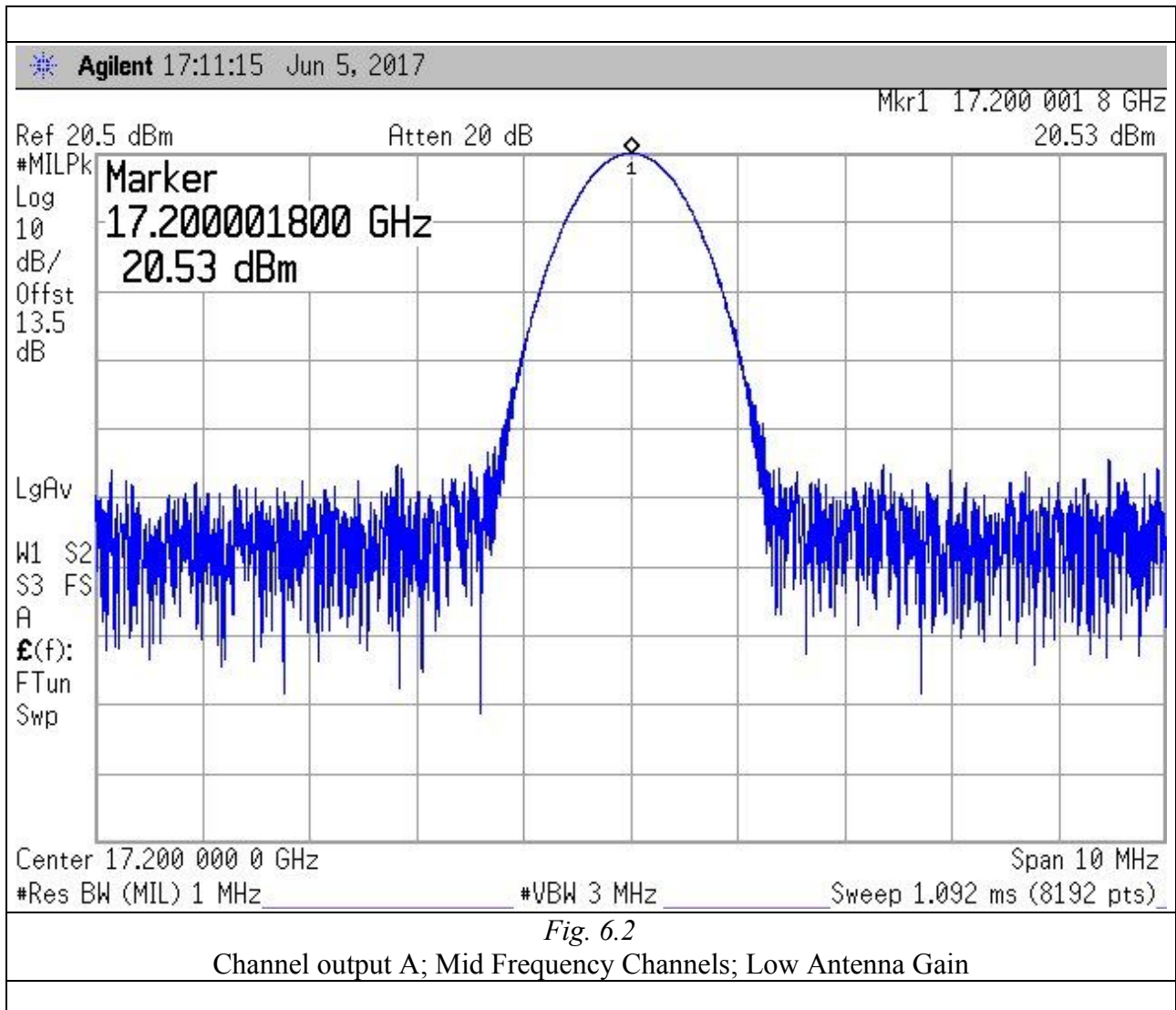
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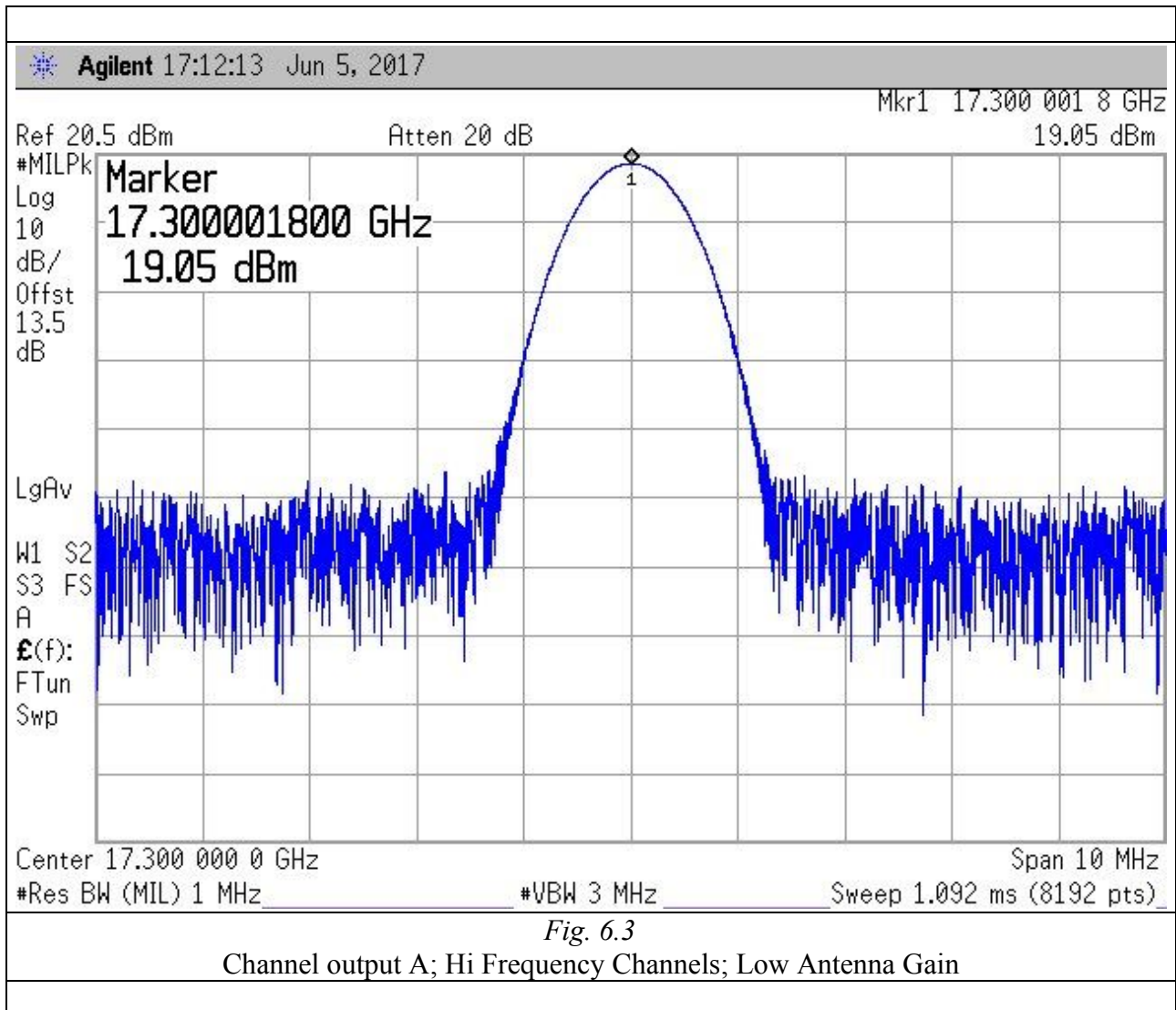
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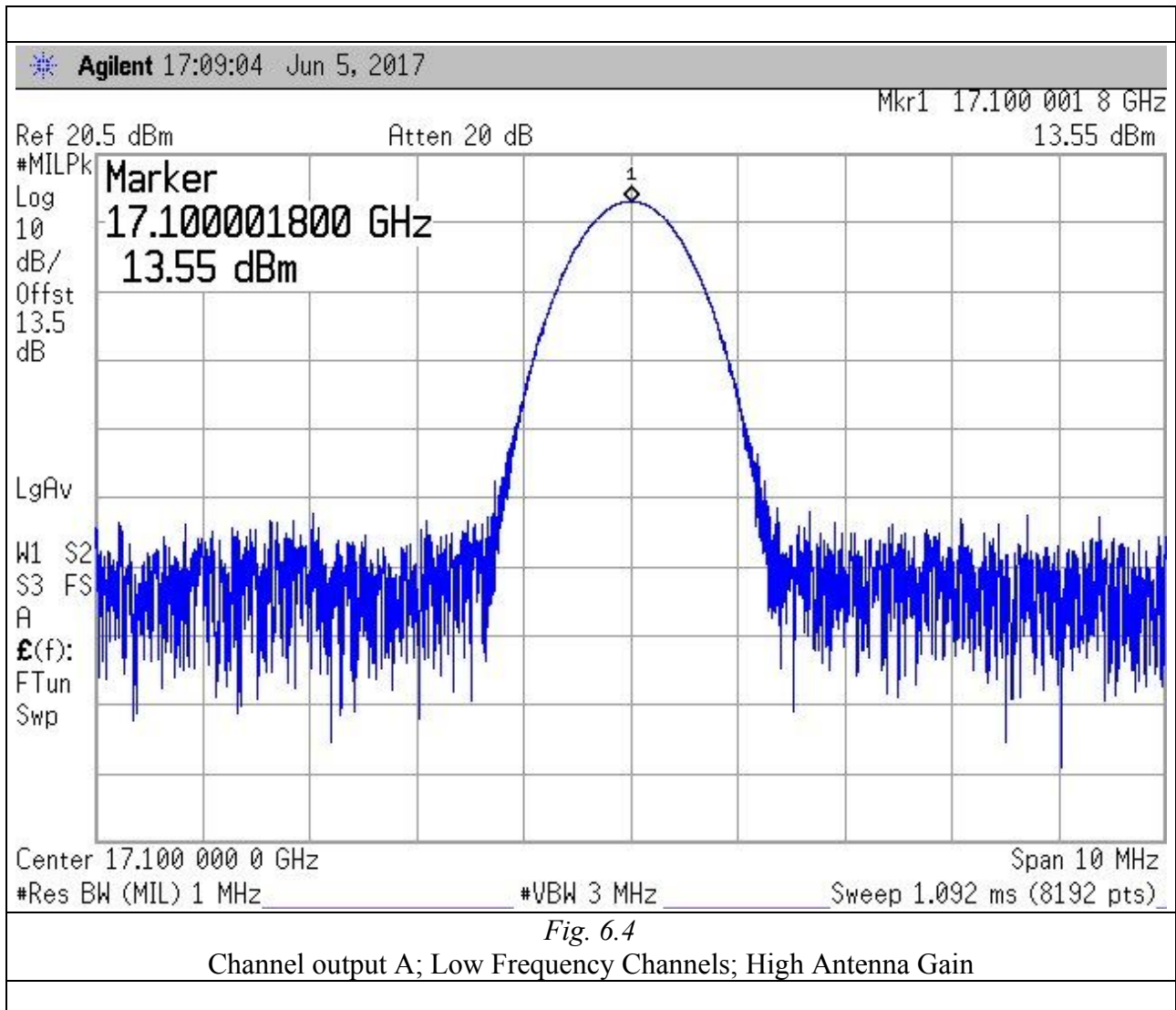
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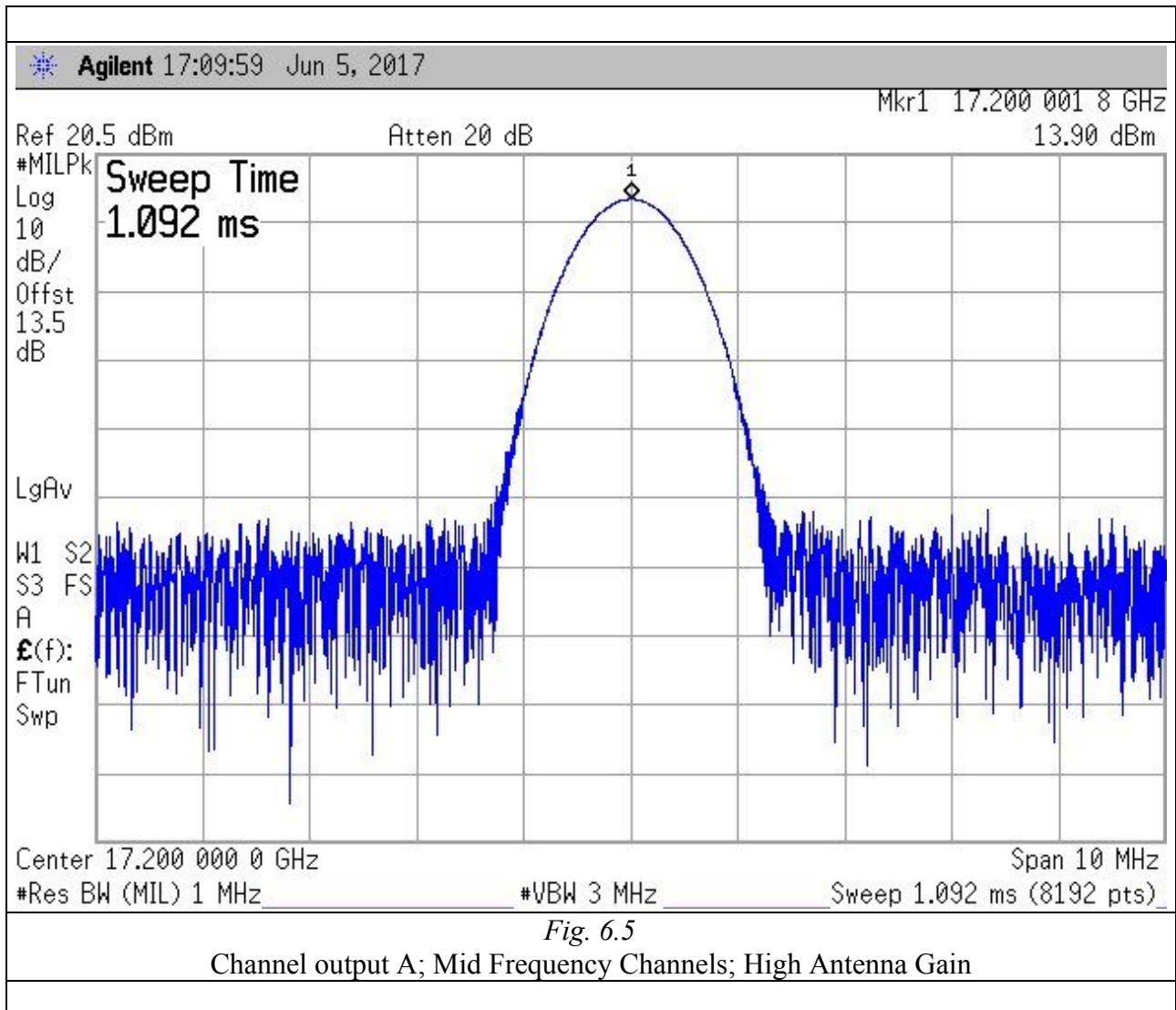
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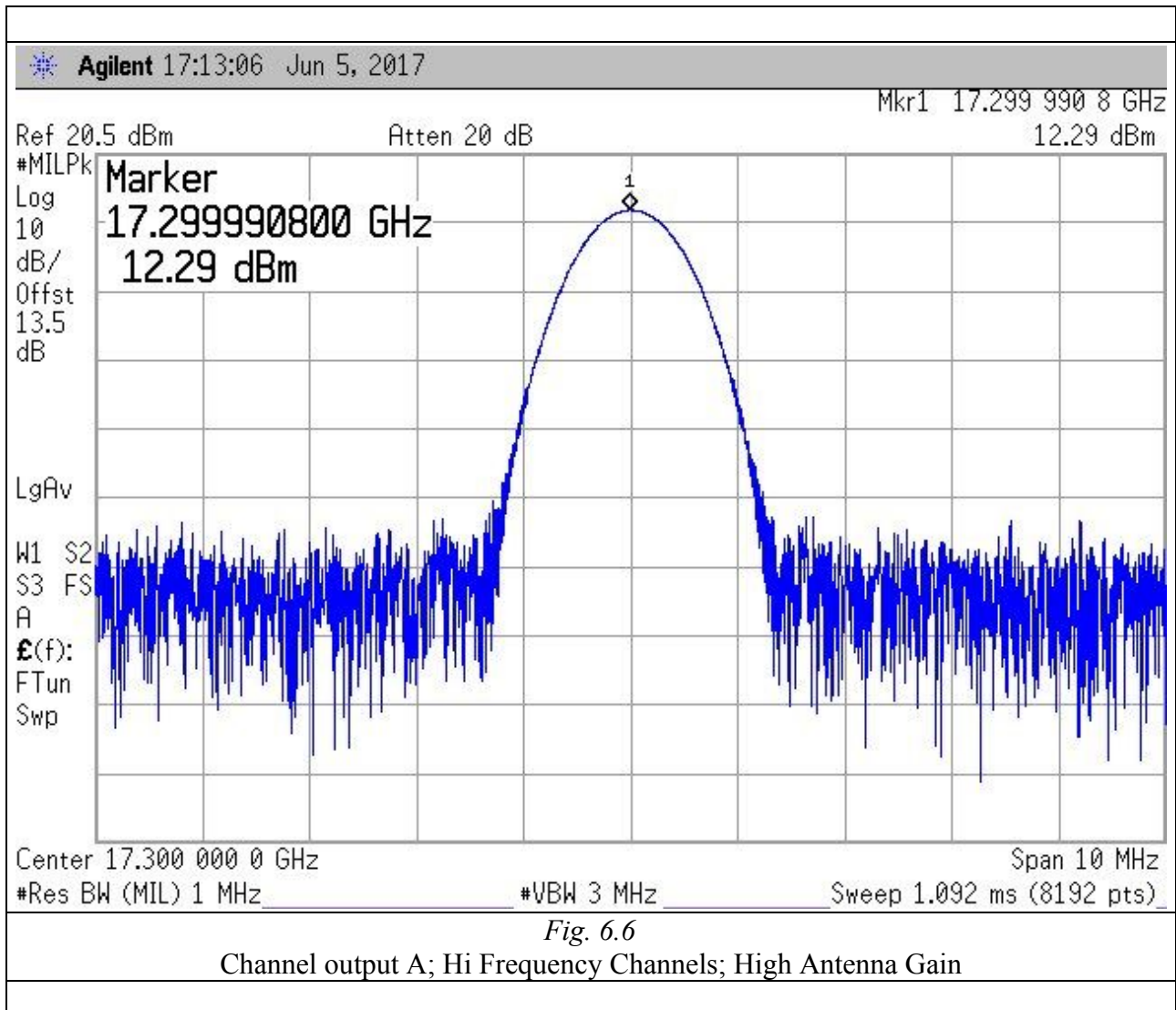
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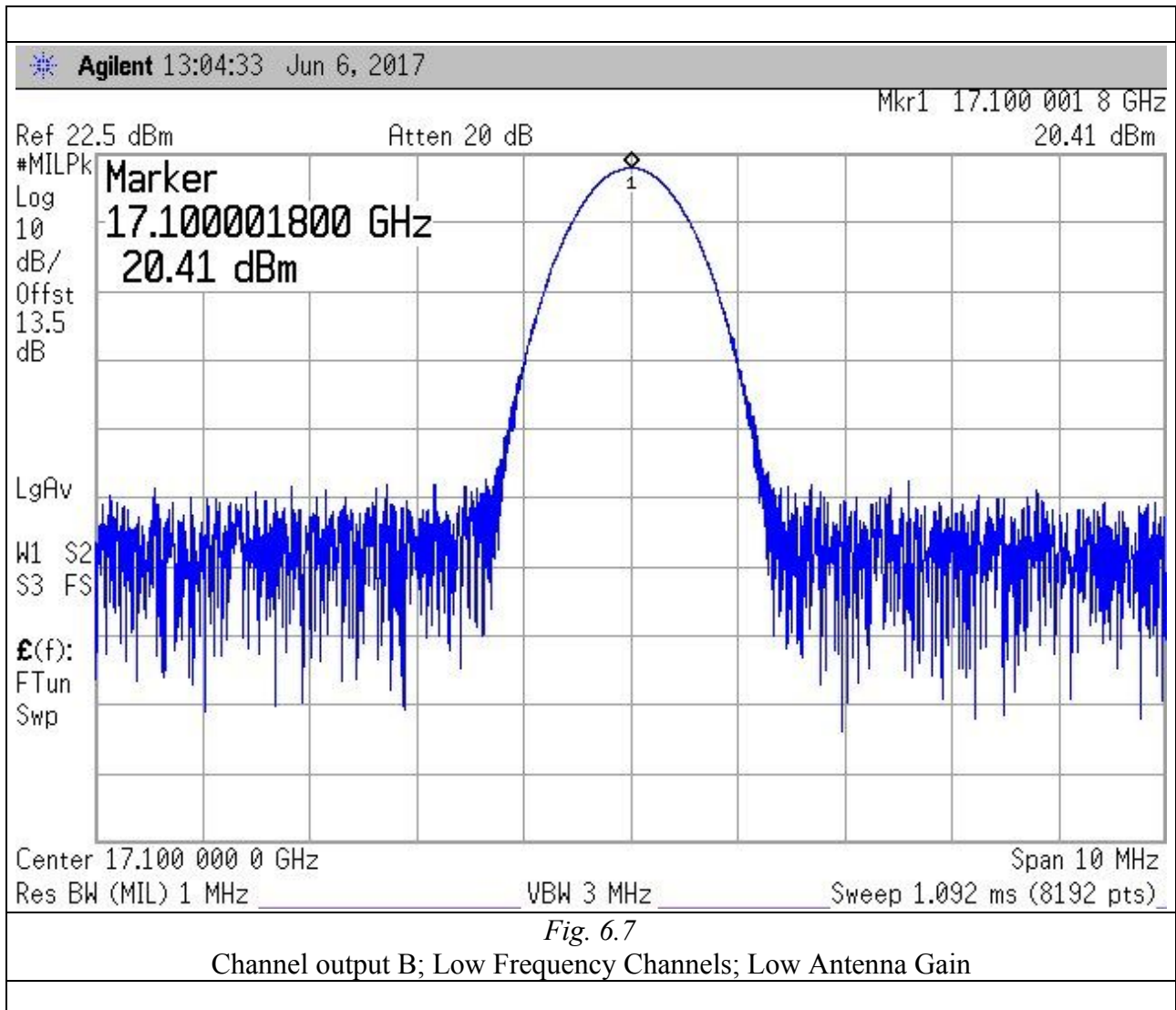
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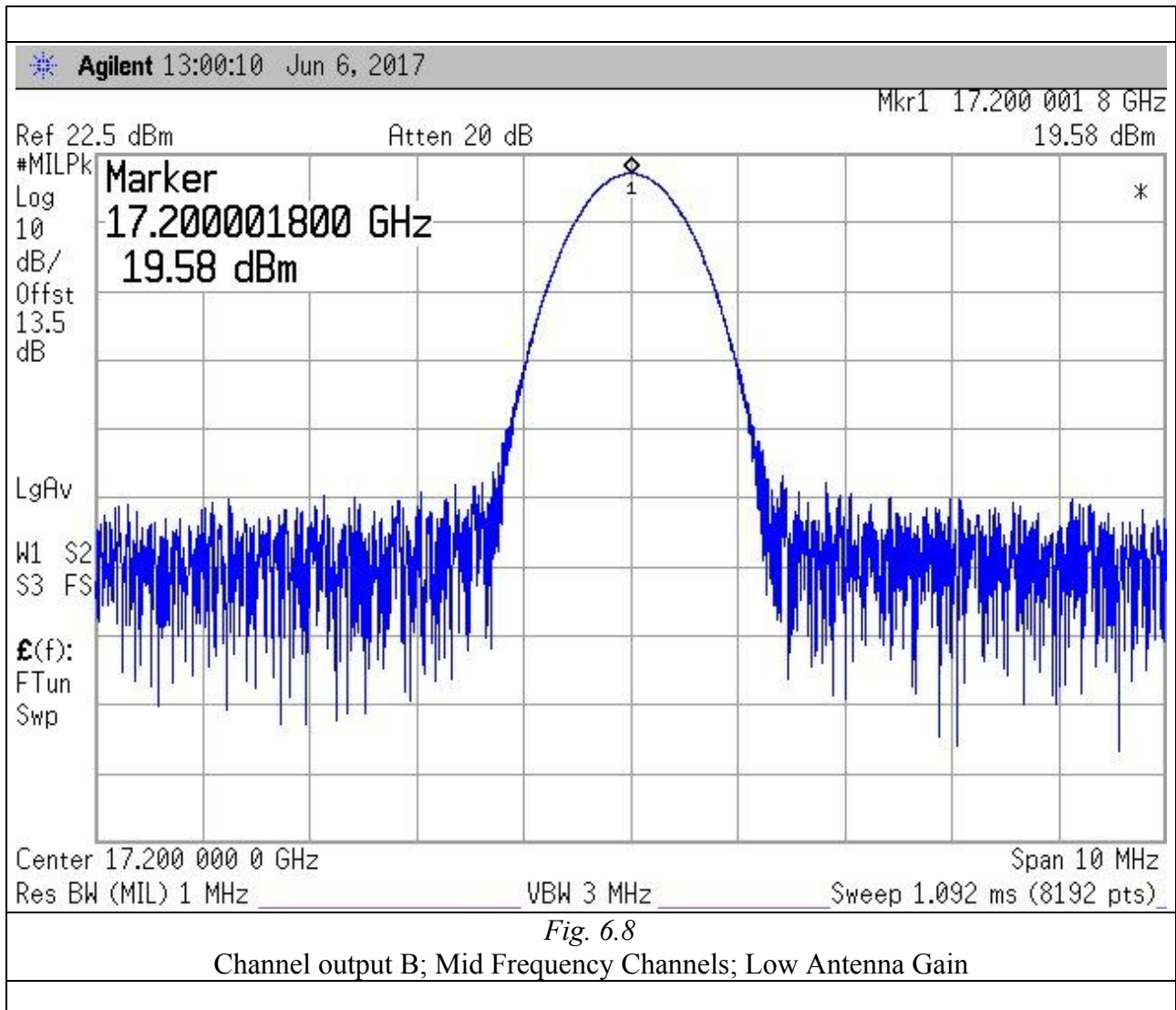
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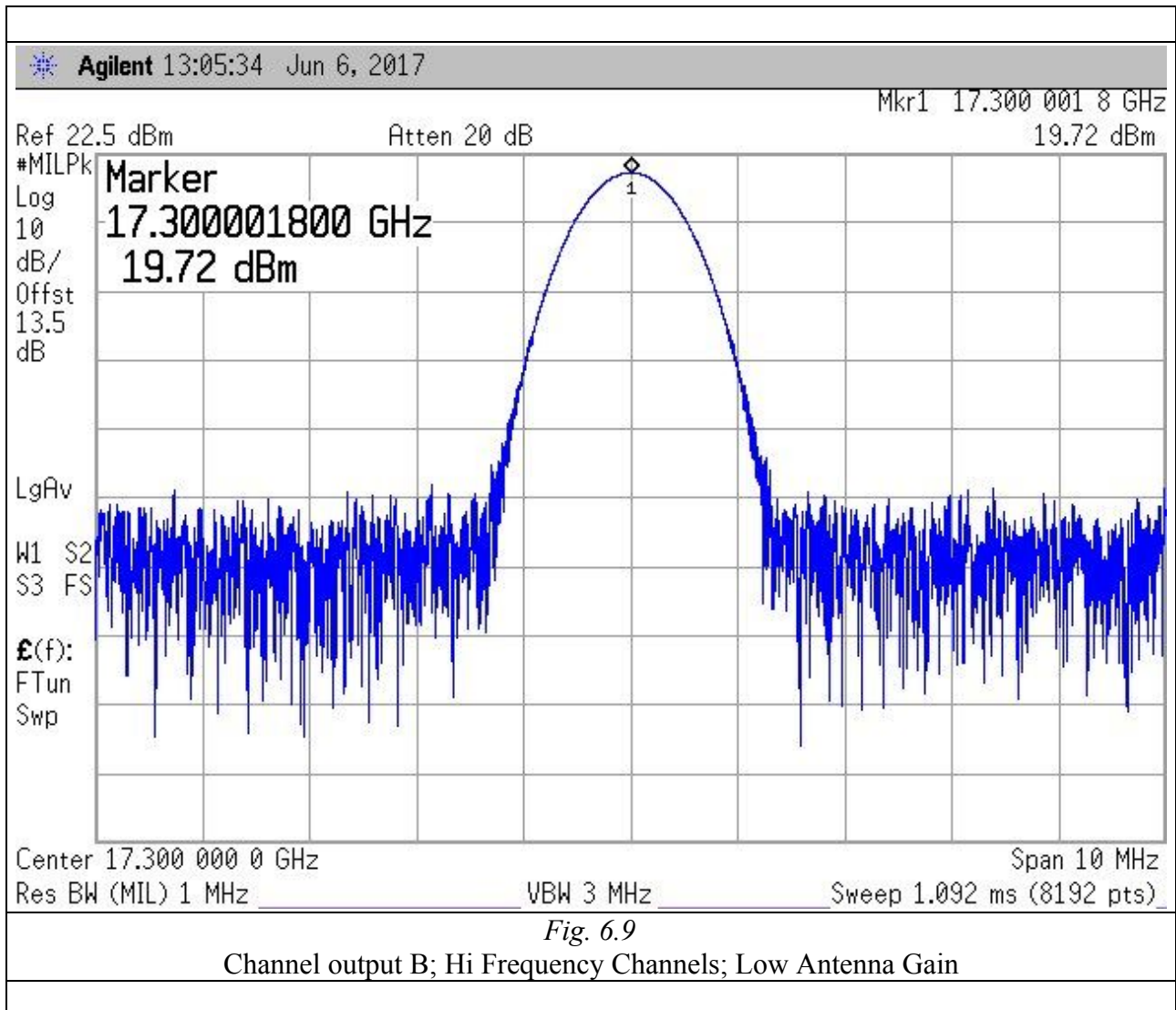
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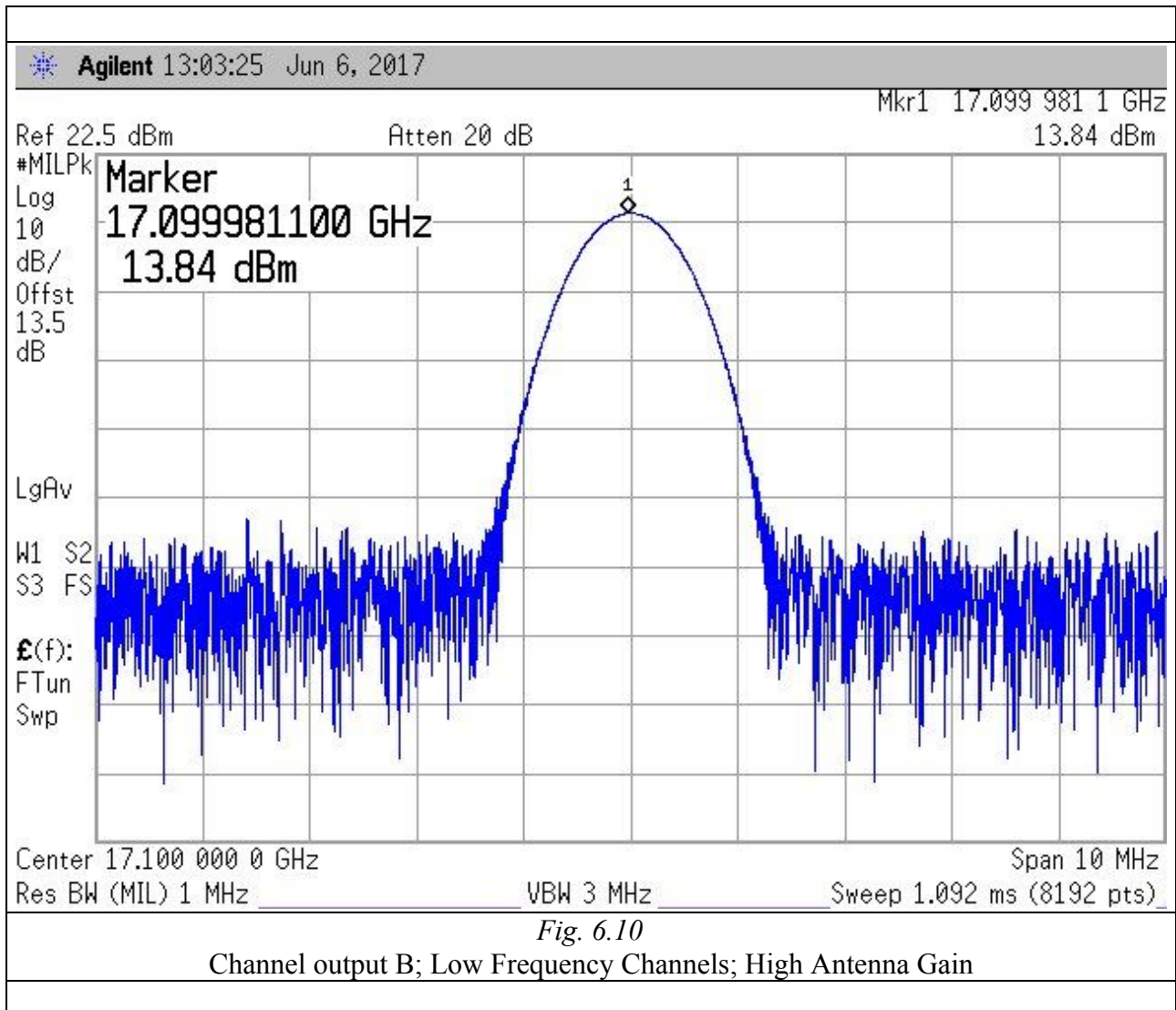


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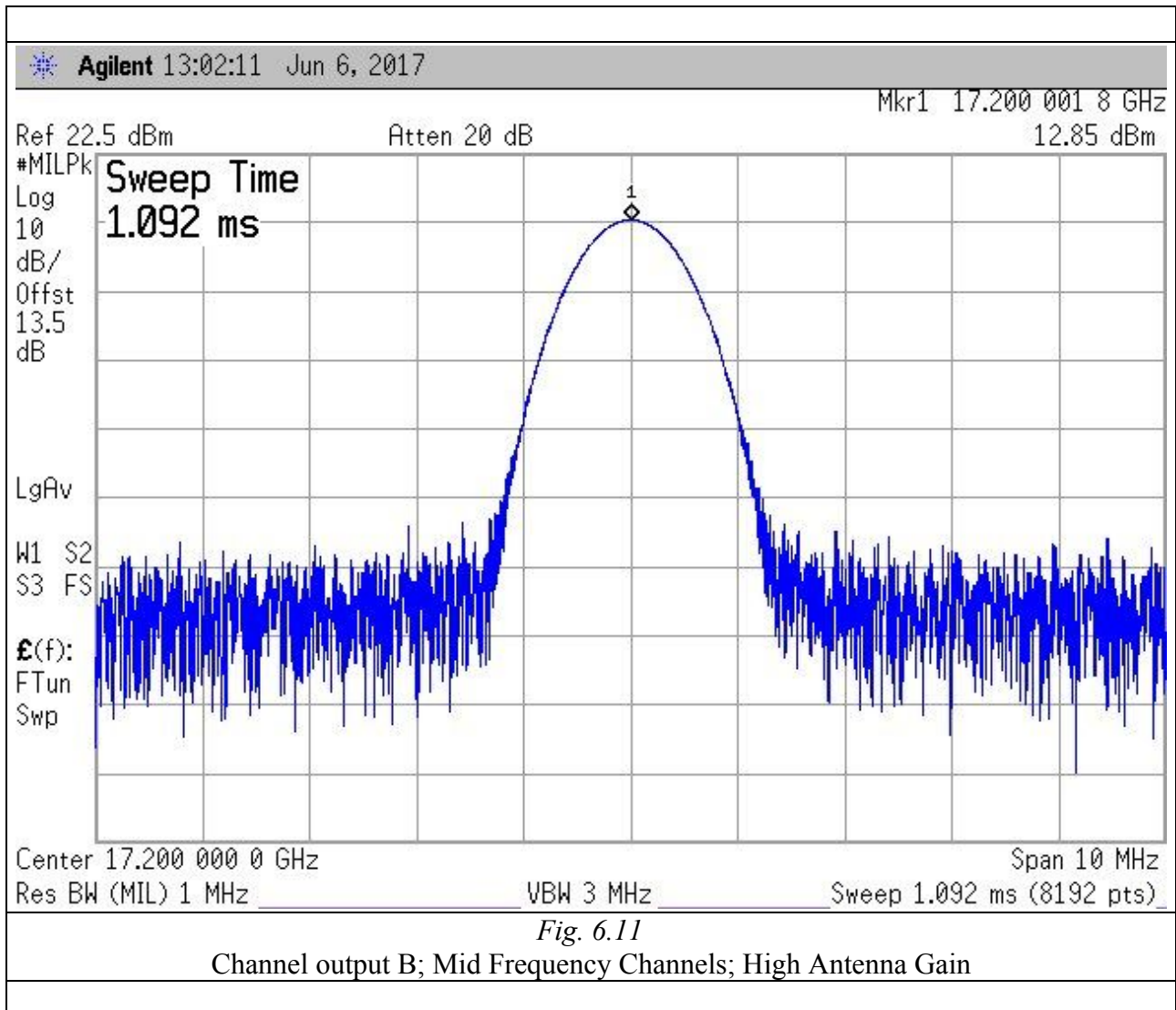




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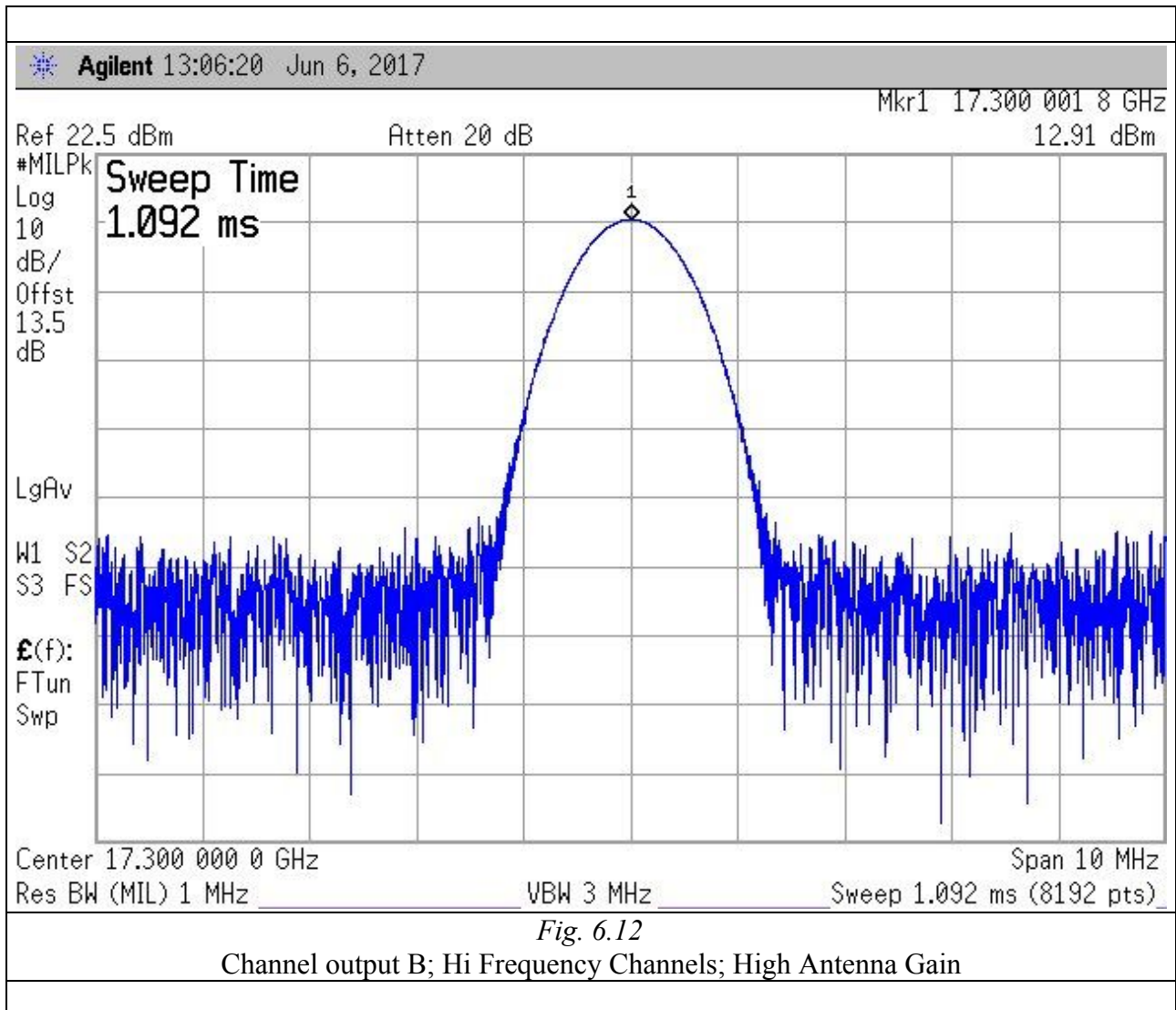
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6.3. 99% OCCUPIED BANDWIDTH

EUT was set for chirp sweep with modulated mode and highest RF output power.

Two antennas with lowest and highest gains was imposed.

The spectrum analyzer was connected to the antenna terminal.

The lowest antenna gain is 13.3 dBi, and highest antenna gain is 22 dBi.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

Measurement (conducted)

The measured values are:

CHANNELS	Bandwidth (MHz)	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Output A	198.4	198.1
Output B	198.6	198.6

Result

Pass

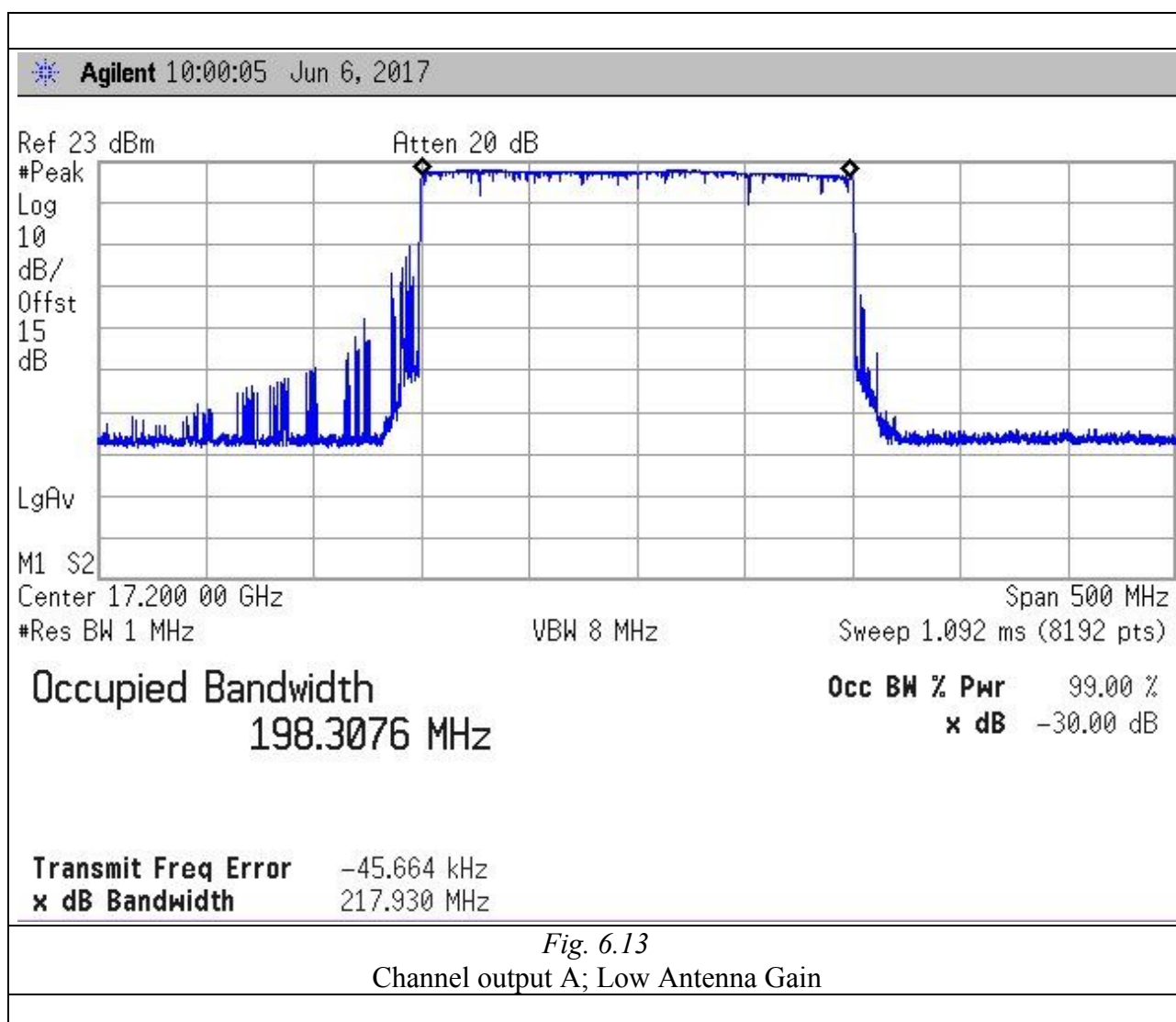
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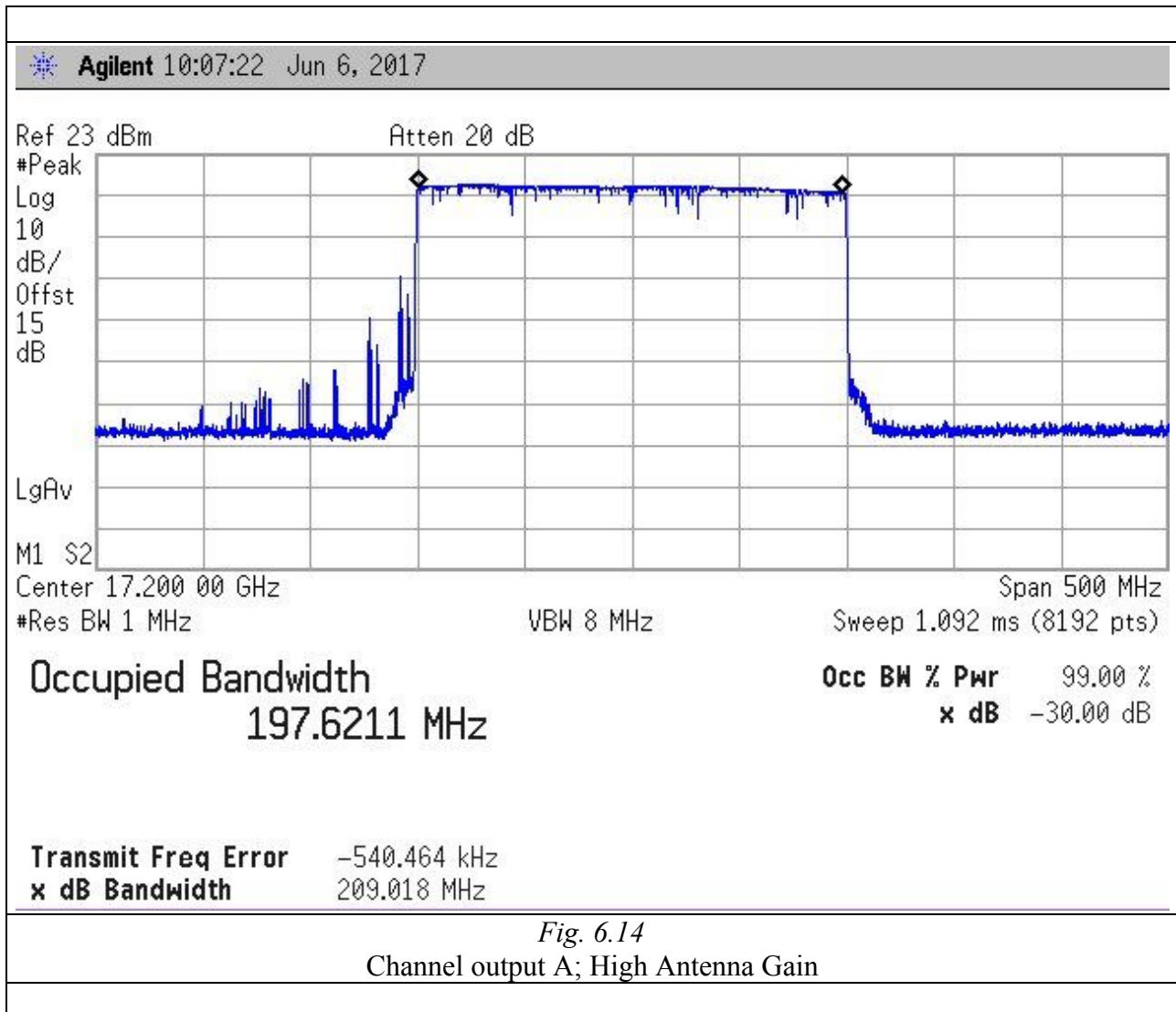
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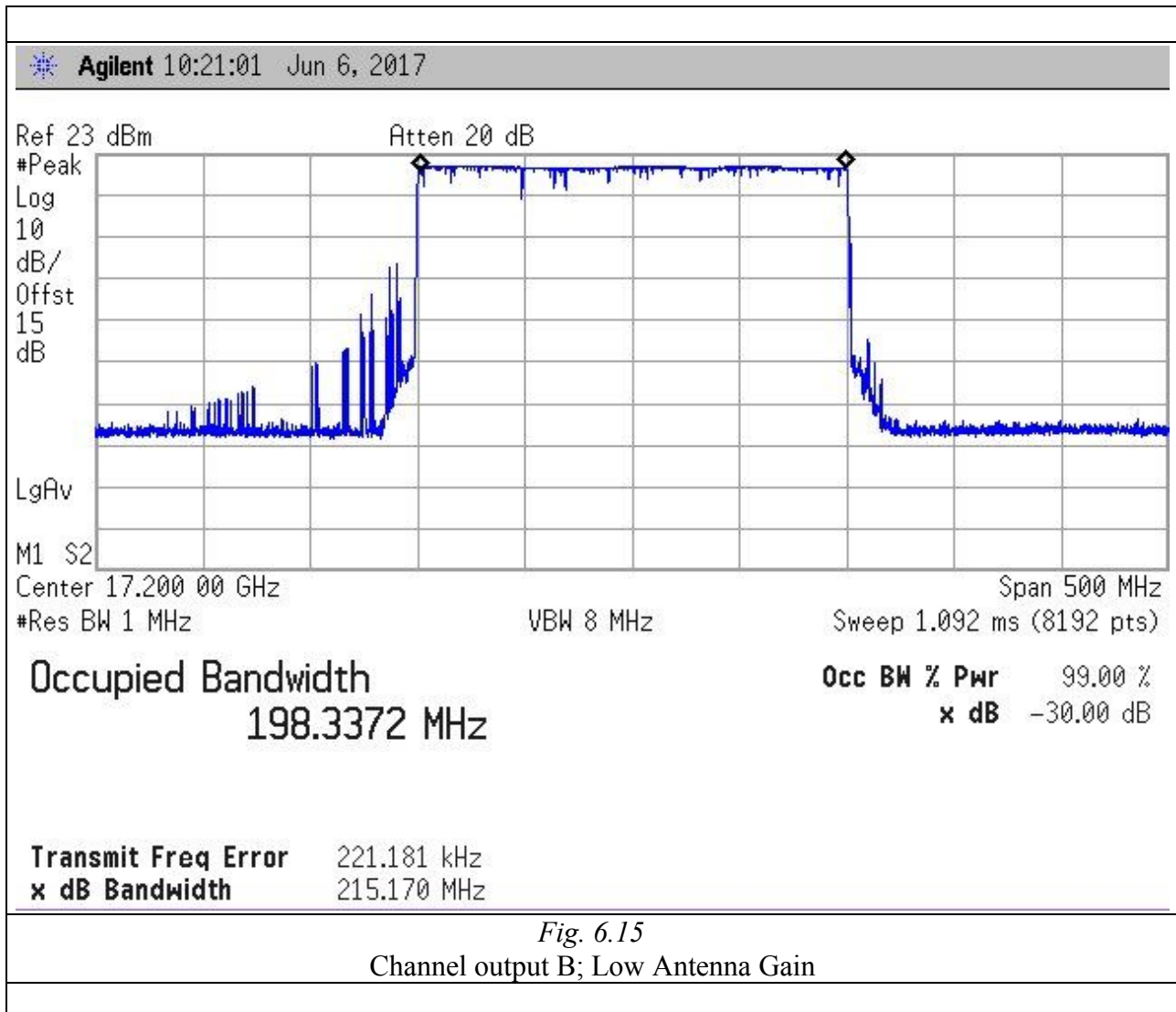
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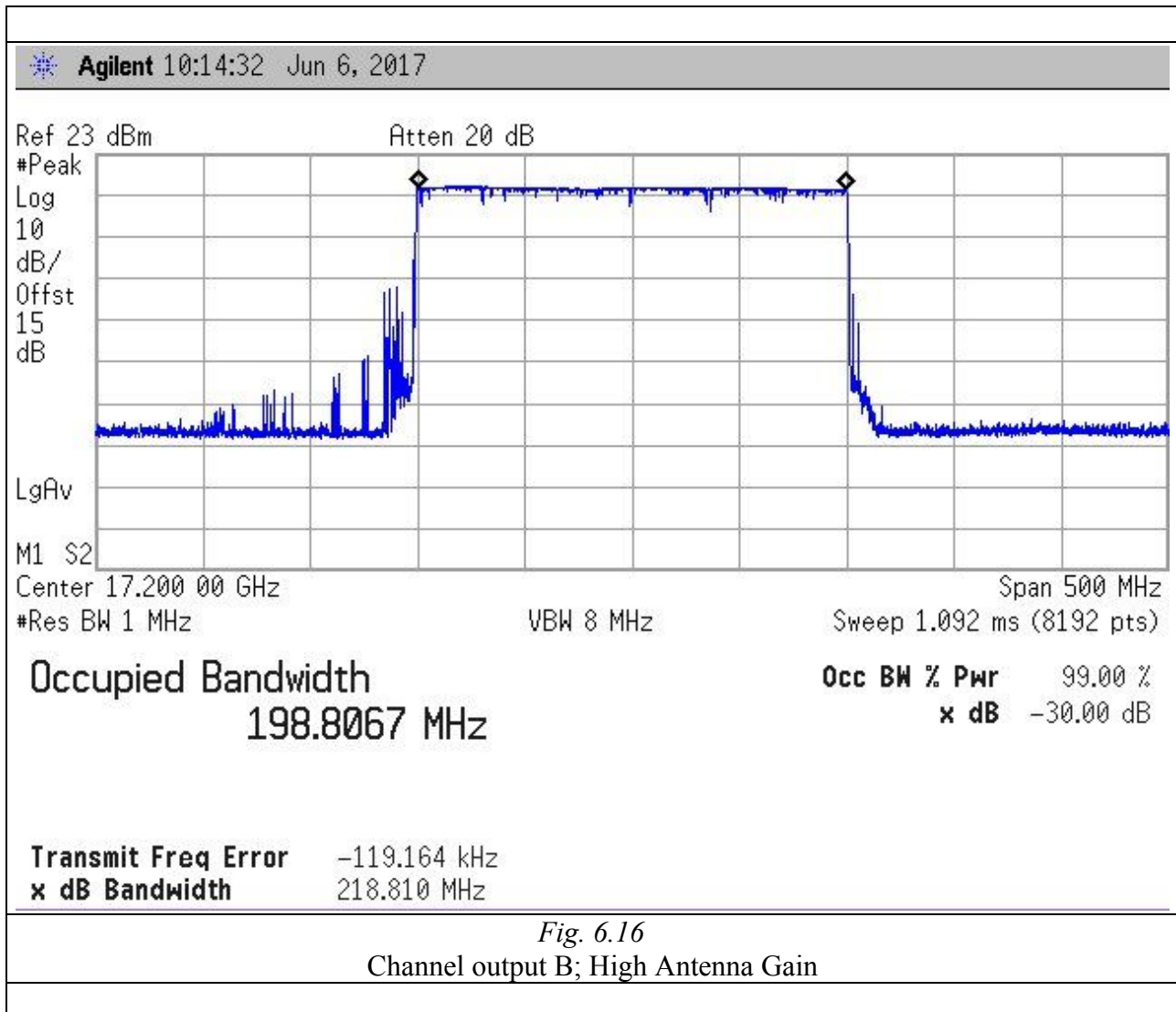
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6.4. SPECTRUM EMISSION MASK

EUT was set for low, mid, high channel with modulated mode and highest RF output power
Two antennas with lowest and highest gains was imposed.

The spectrum analyzer was connected to the antenna terminal.

The lowest antenna gain is 13.3 dBi, and highest antenna gain is 22 dBi.

Requirements

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: at least $83 \log(f_d/5)$ dB;
- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: at least $29 \log(f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation;
- On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least $43 + 10 \log(P)$ dB.

Measurement (conducted)

The single result are:

Channel Output A

FREQUENCY	Results	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Low (17.1 GHz)	<i>Pass</i>	<i>Pass</i>
Mid (17.2 GHz)	<i>Pass</i>	<i>Pass</i>
High (17.3 GHz)	<i>Pass</i>	<i>Pass</i>

Channel Output B

FREQUENCY	Results	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Low (17.1 GHz)	<i>Pass</i>	<i>Pass</i>
Mid (17.2 GHz)	<i>Pass</i>	<i>Pass</i>
High (17.3 GHz)	<i>Pass</i>	<i>Pass</i>

Result

Pass

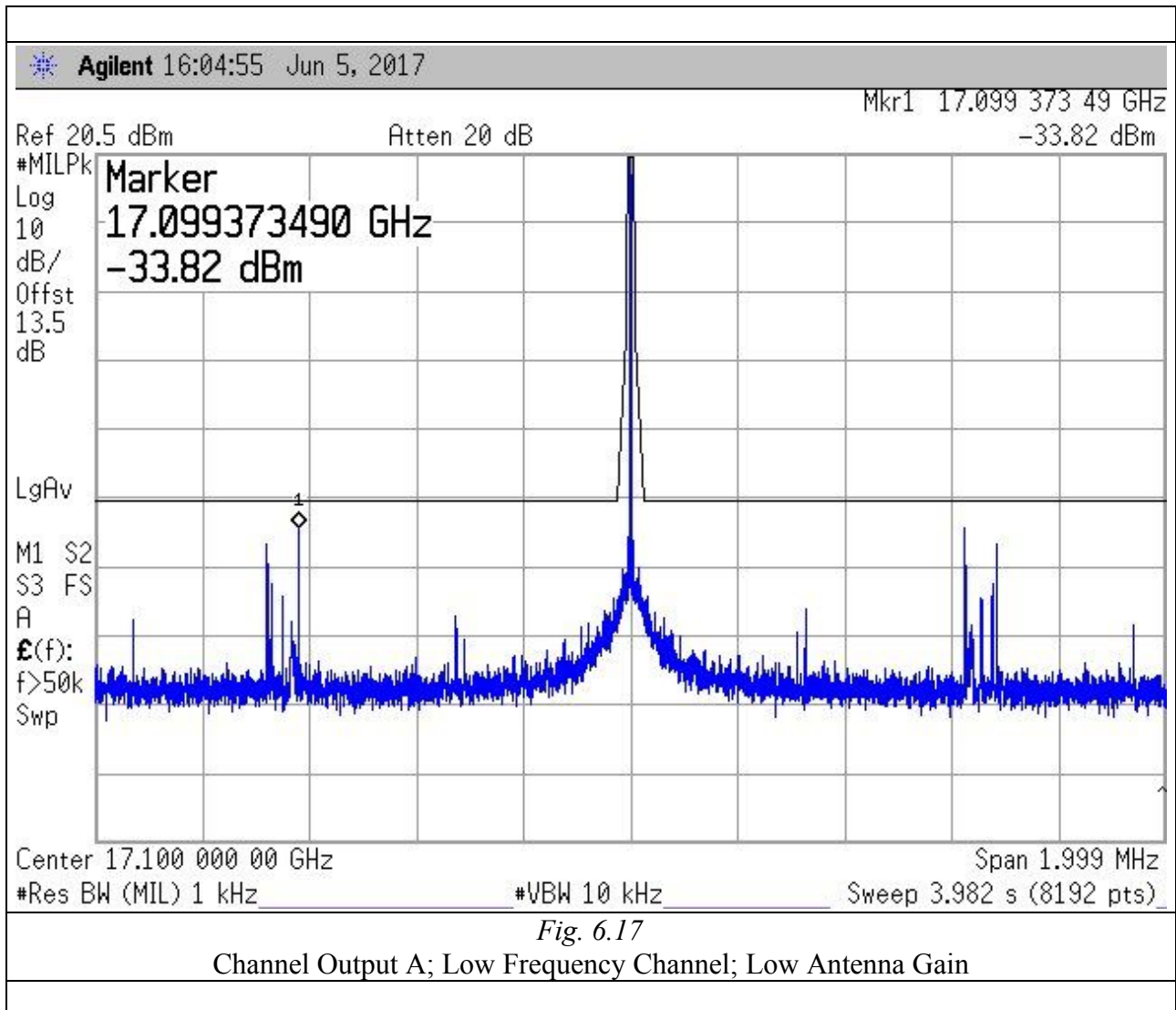
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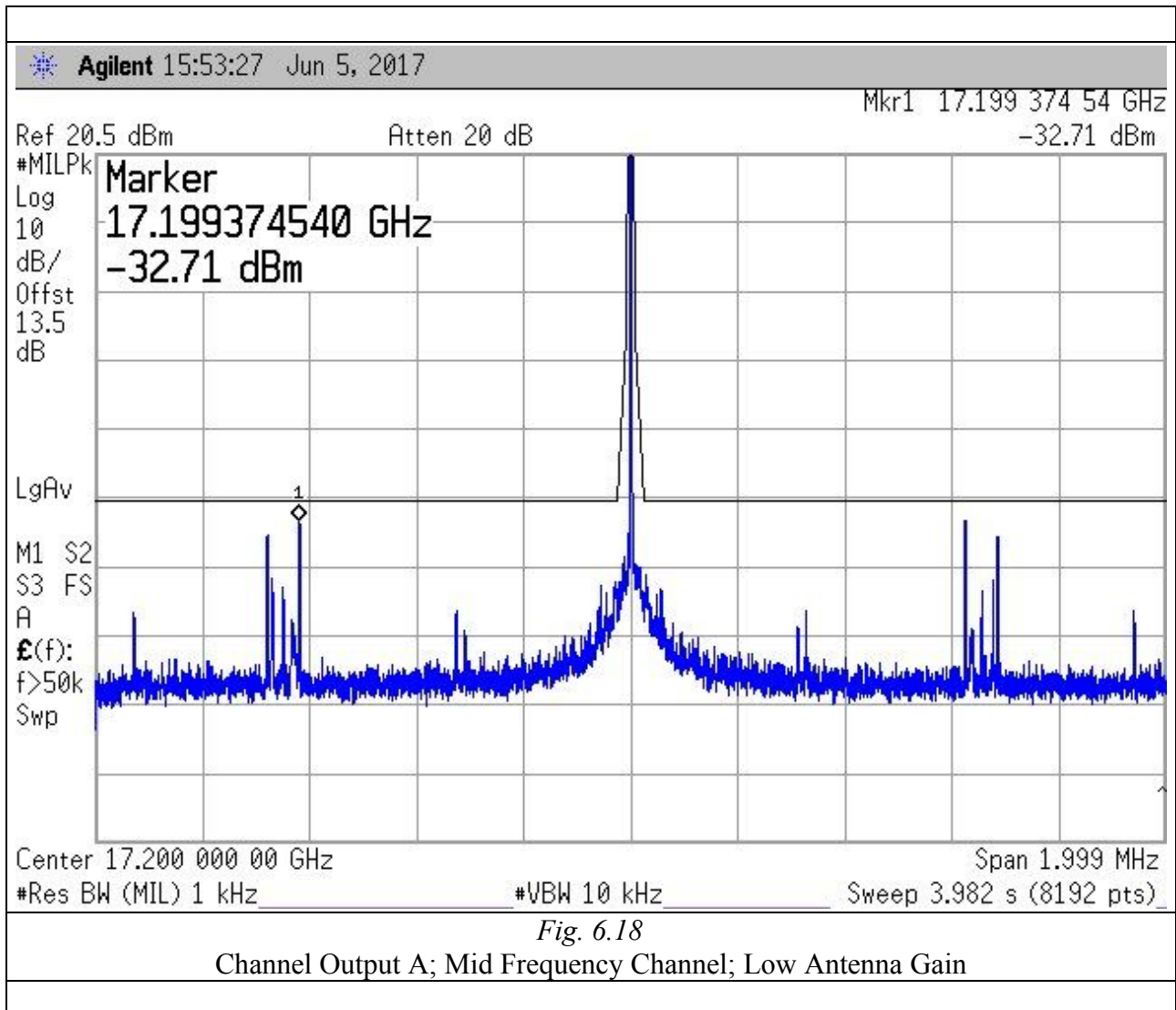
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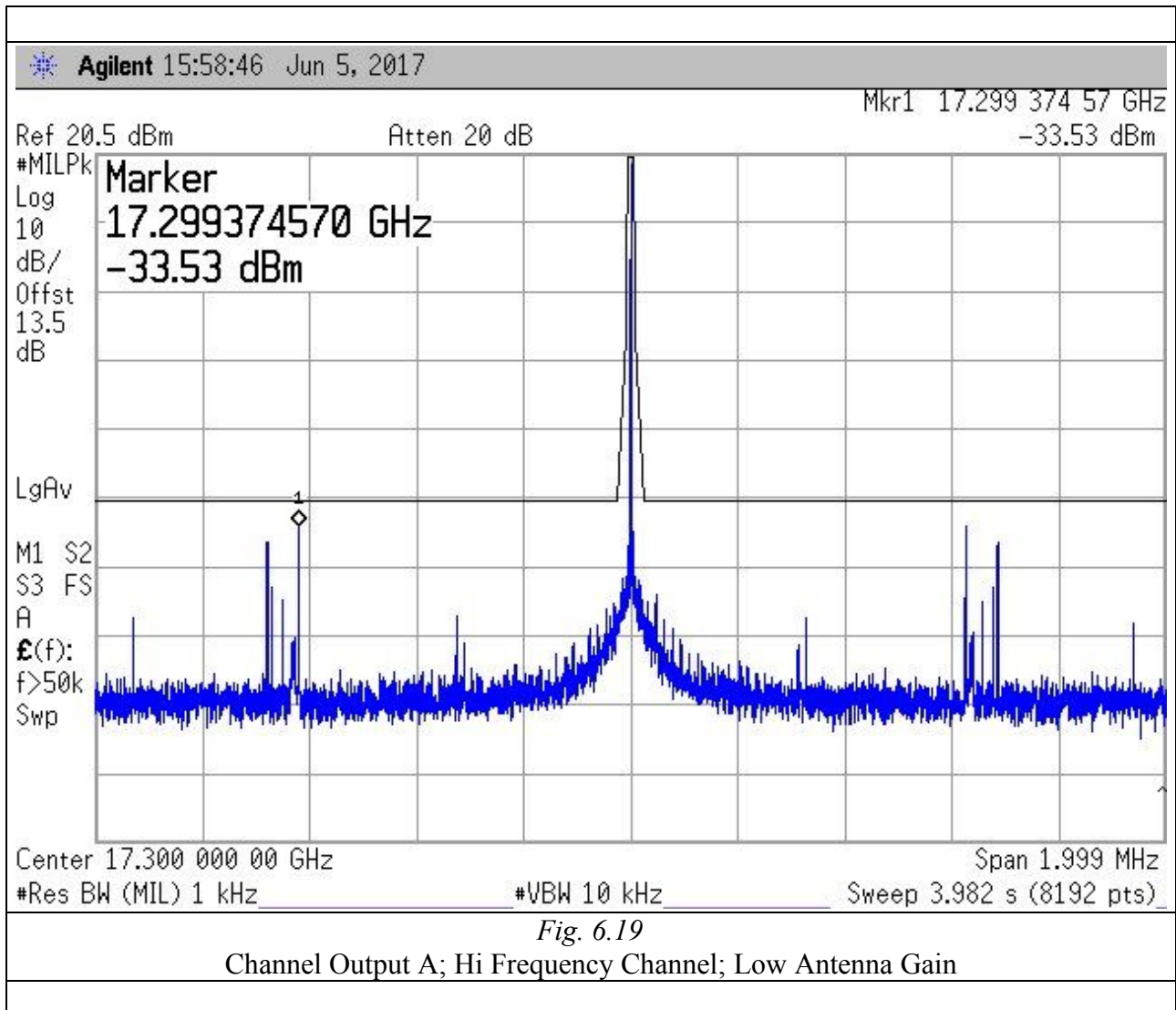
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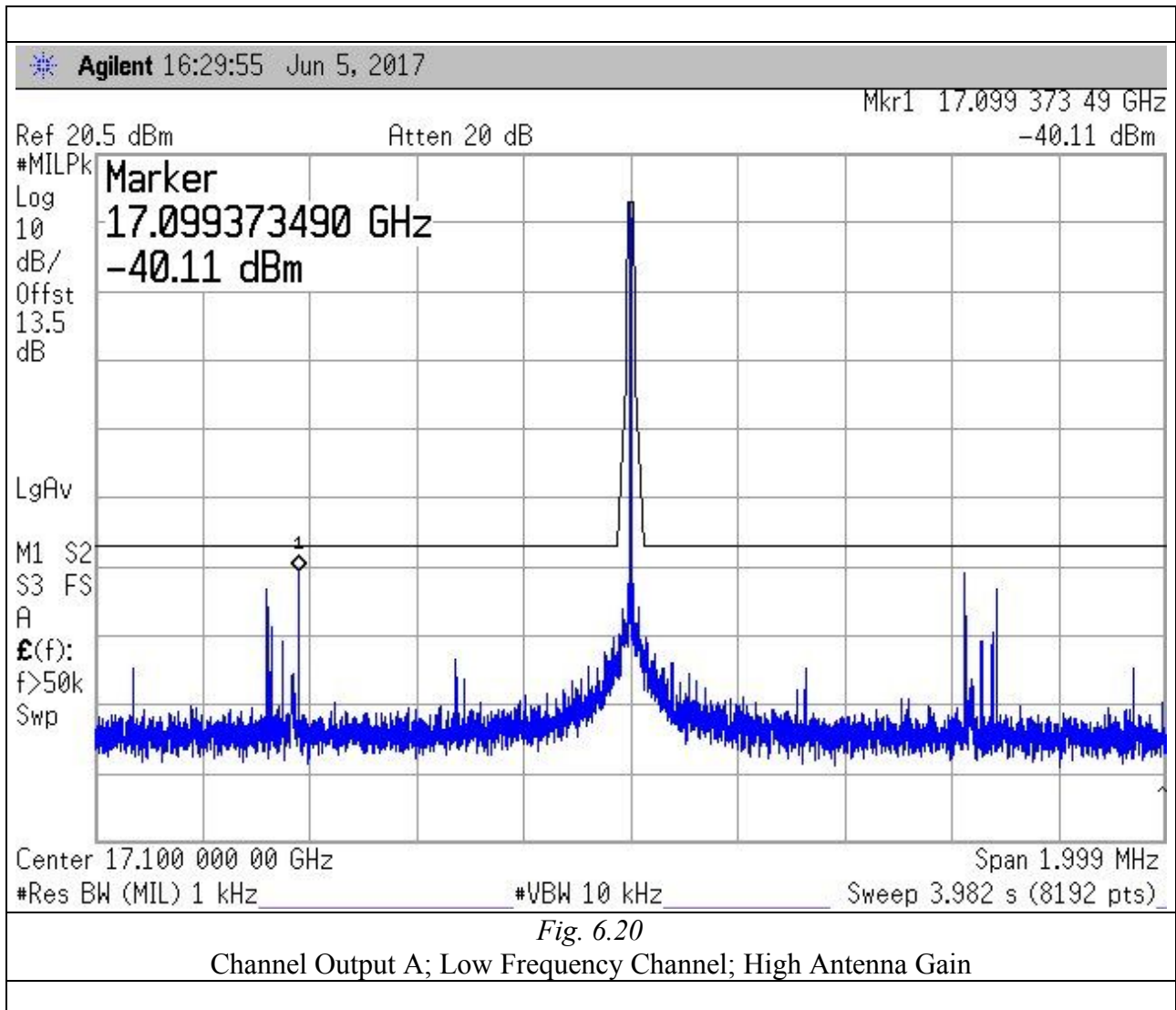
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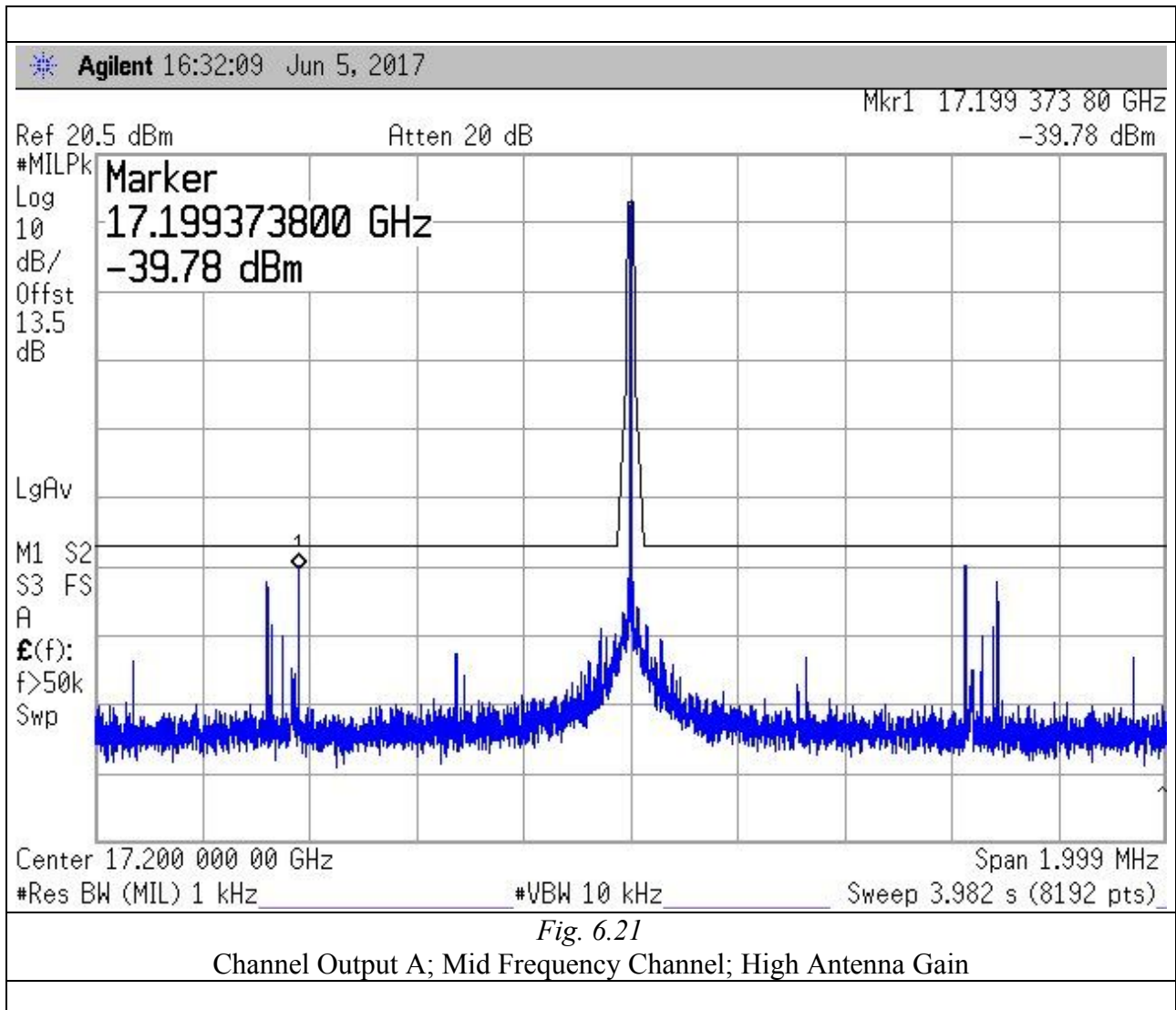
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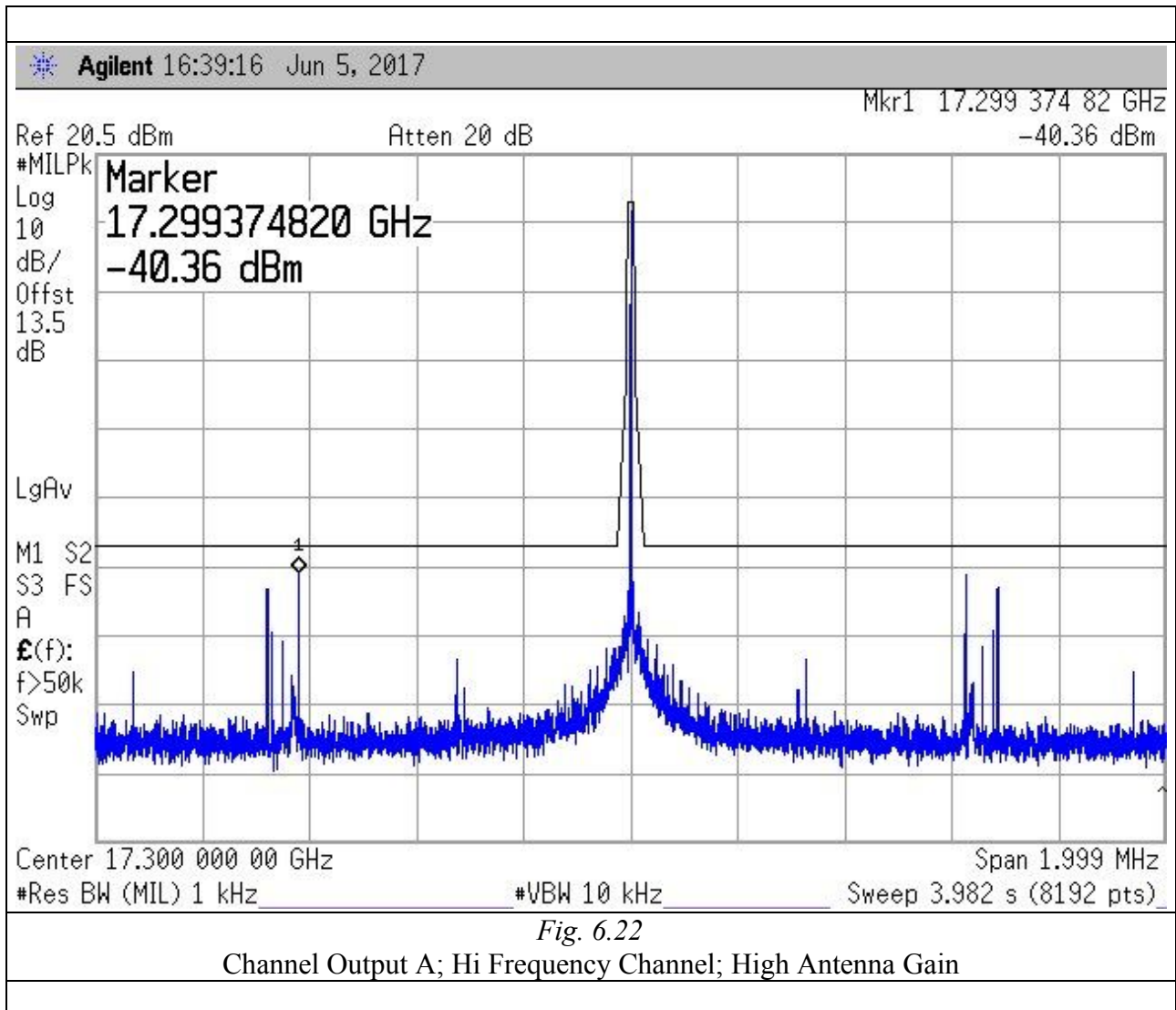
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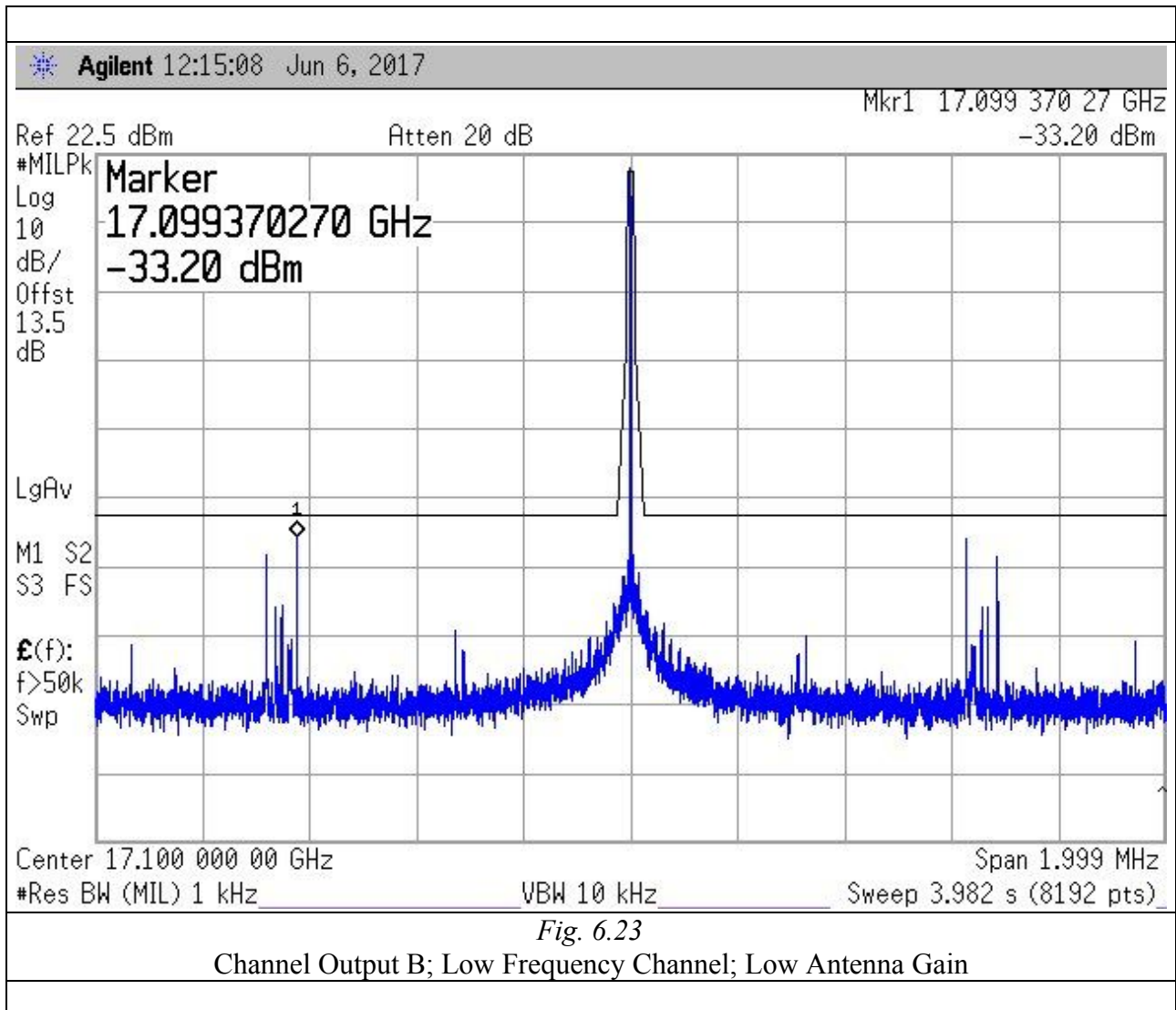
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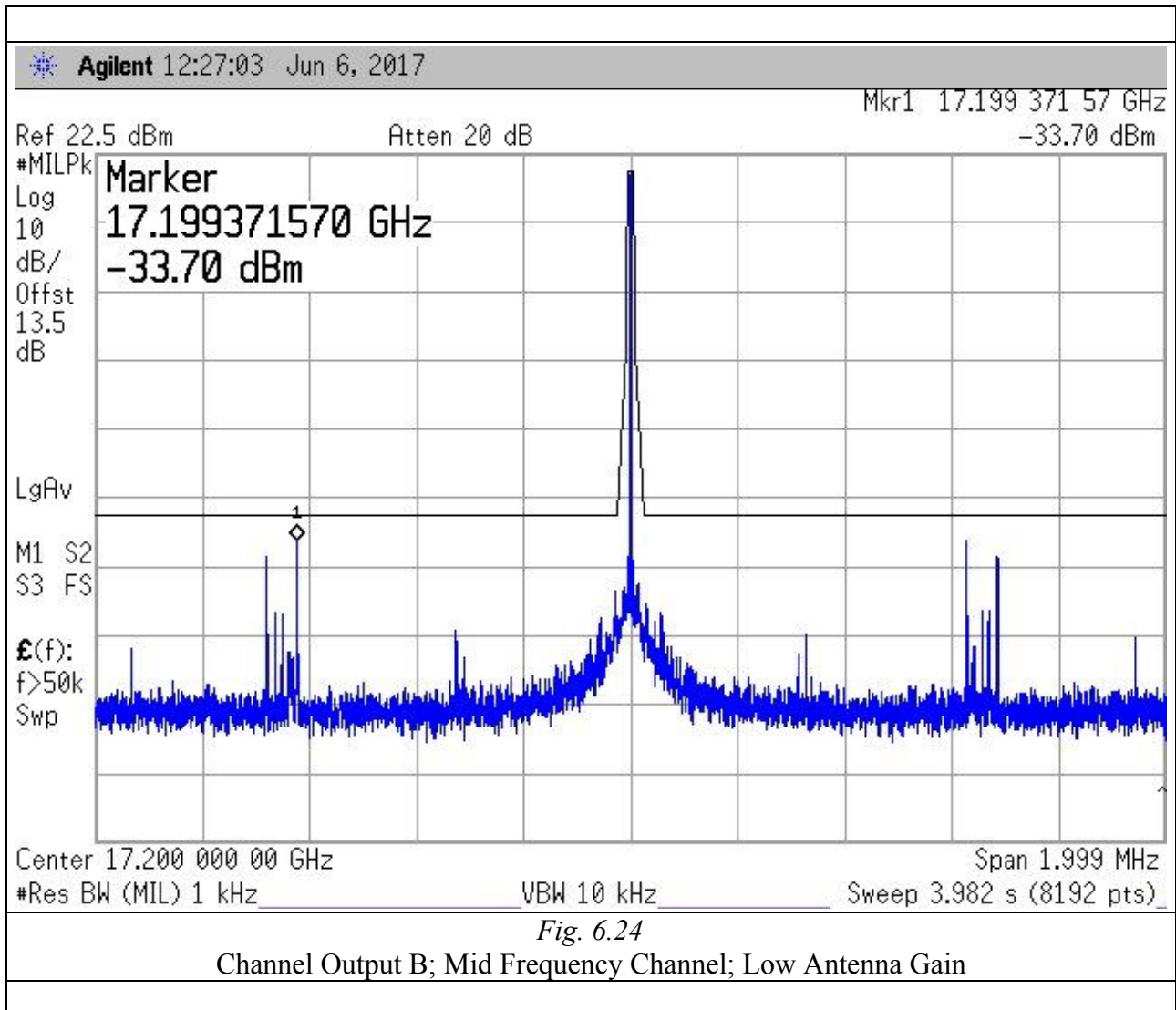
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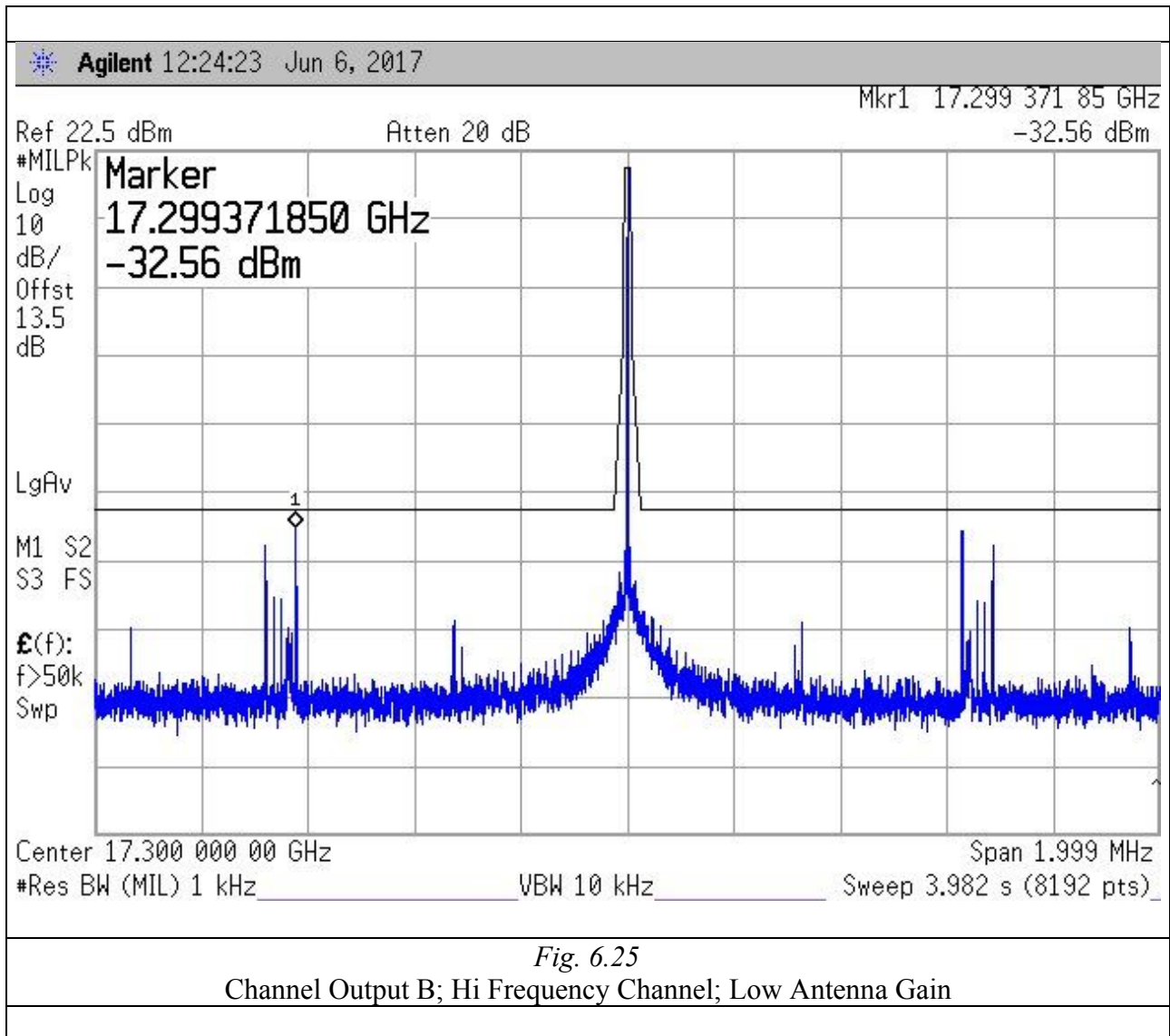
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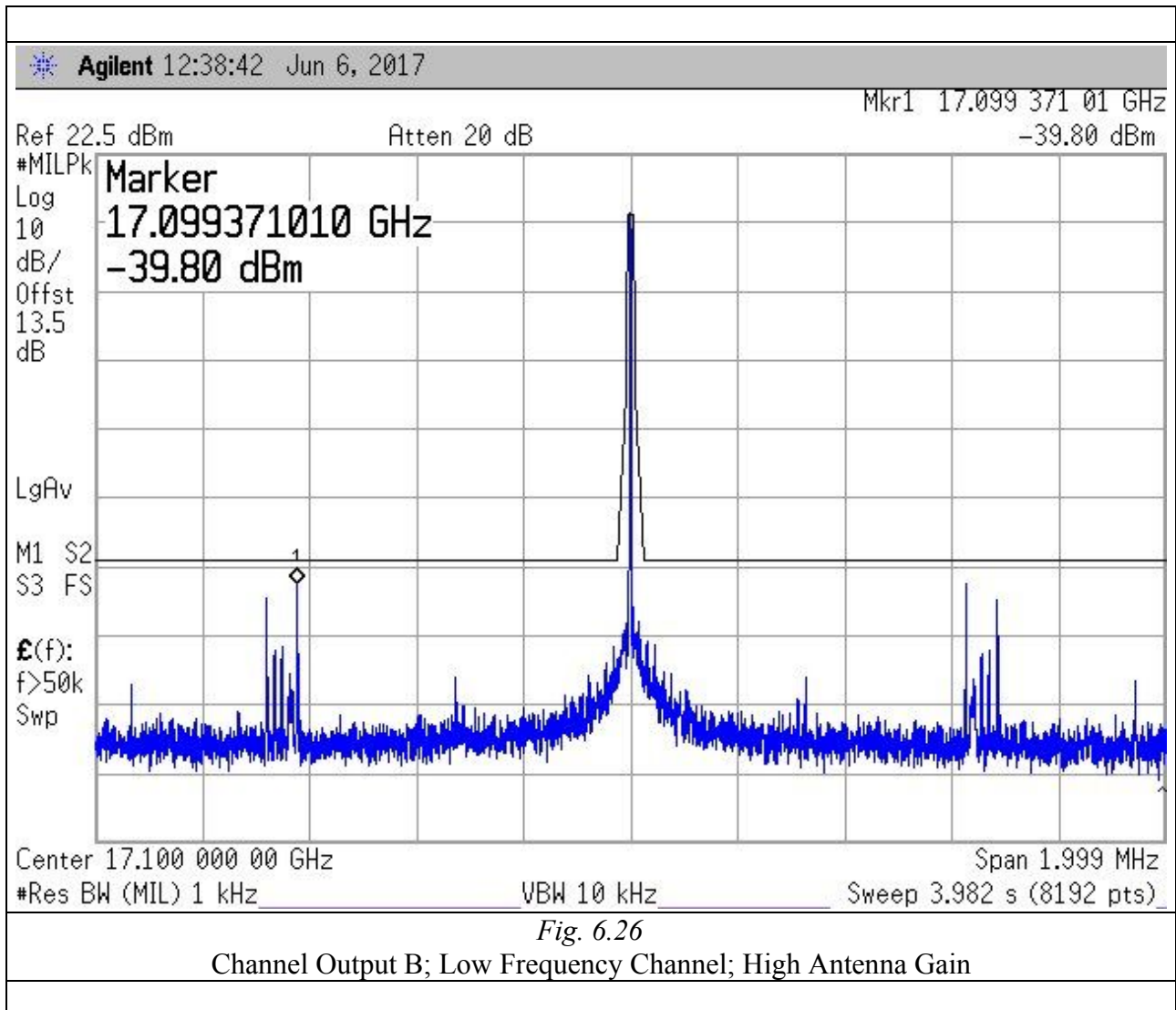
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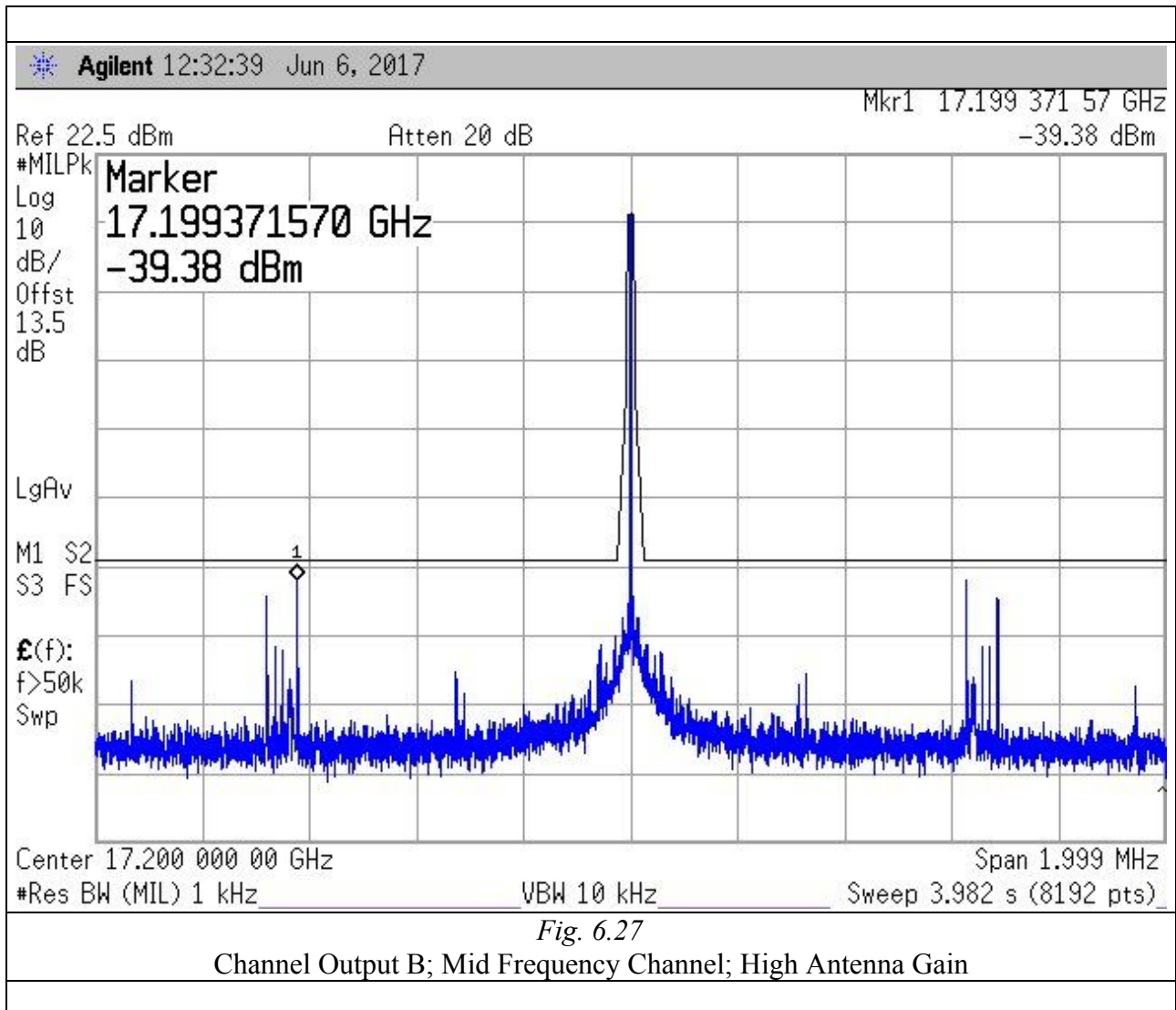
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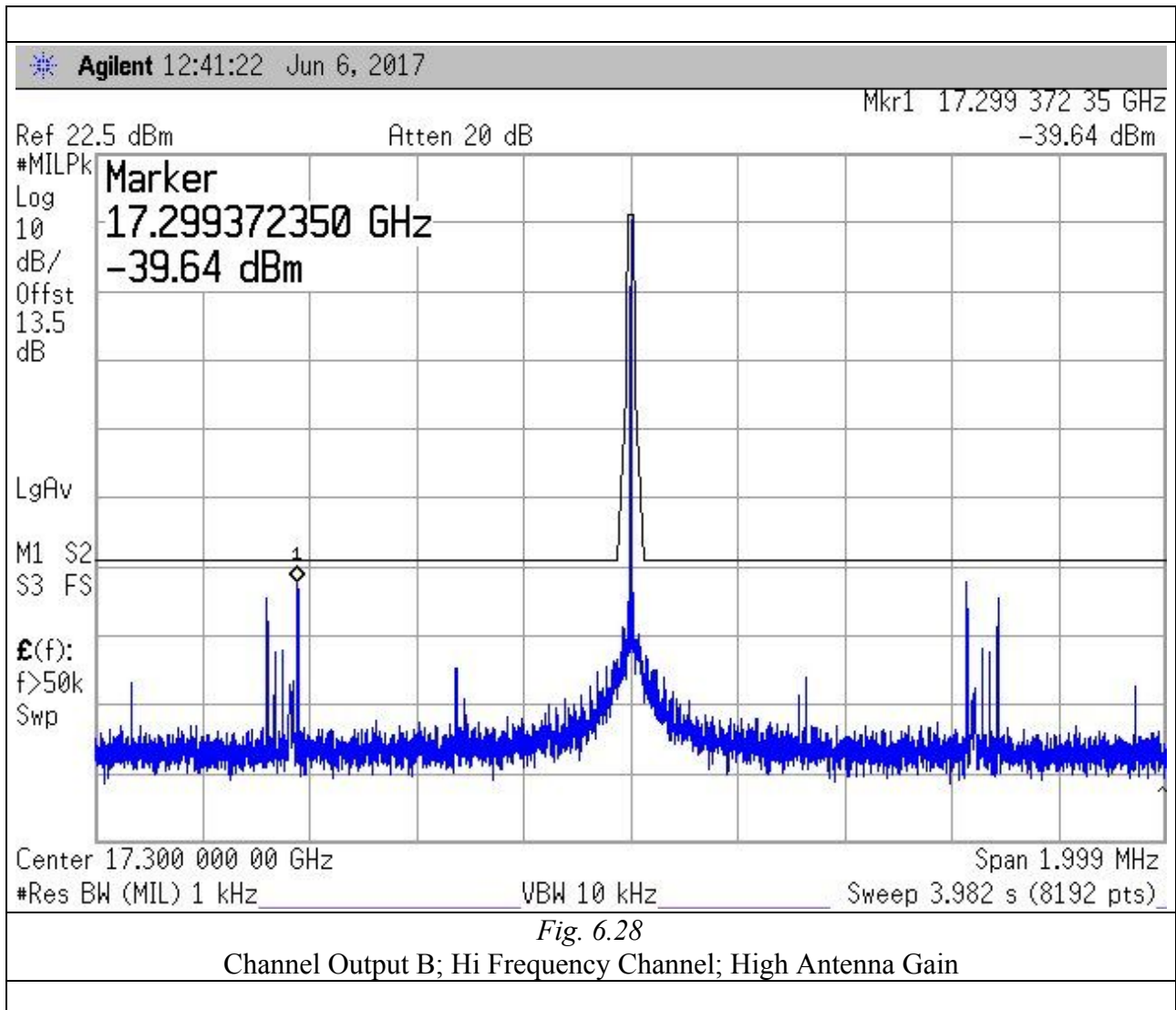
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6.5. *FREQUENCY STABILITY*

EUT was set for mid channel with modulated mode and highest RF output power

The spectrum analyzer was connected to the antenna terminal.

Requirements

The frequency stability shall be measured with variation of ambient temperature as follows:

- from -30° to $+50^{\circ}$ centigrade;
- frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range.

The frequency stability shall be measured with variation of primary supply voltage as follows:

- primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

Measurement (conducted)*Channel Output A*

Frequency stability versus temperature

<i>TEMPERATURE</i> (°C)	<i>MEAS. FREQ.</i> (MHz)	<i>FREQ. DRIFT</i> (kHz)	<i>FREQ. DEVIATION</i> <i>LIMIT</i>	<i>RESULT</i>
50	17199.999750	-0.051	--	Pass
40	17199.999722	-0.079	--	Pass
30	17199.999868	+0.067	--	Pass
20	Reference (MHz): 17199.999801			
10	17199.999721	-0.080	--	Pass
0	17199.999888	+0.087	--	Pass
-10	17200.000000	+0.199	--	Pass
-20	17200.000134	+0.333	--	Pass
-30	17200.000095	+0.294	--	Pass

Frequency stability versus input voltage

<i>MEAS. VOLTAGE</i> (V _{DC})	<i>MEAS. FREQ.</i> (MHz)	<i>FREQ. DRIFT</i> (kHz)	<i>FREQ. DEVIATION</i> (LIMIT: 0.01 %)	<i>RESULT</i>
10.20	17199.999940	+0.018	< 0.01	Pass
12.00	17199.999957	+0.035	< 0.01	Pass
24.00	17199.999922	0	--	Pass
27.66	17199.999932	+0.010	< 0.01	Pass

The frequency of the transmitter was measured at 85% and 115% of the rated power supply voltage at environmental temperature (20 °C).

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Channel Output B

Frequency stability versus temperature

TEMPERATURE (°C)	MEAS. FREQ. (MHz)	FREQ. DRIFT (kHz)	FREQ. DEVIATION LIMIT	RESULT
50	17199.999640	-0.145	--	Pass
40	17199.999642	-0.143	--	Pass
30	17199.999808	+0.023	--	Pass
20	Reference (MHz): 17199.999785			
10	17199.999721	-0.064	--	Pass
0	17199.999918	+0.133	--	Pass
-10	17199.999931	+0.146	--	Pass
-20	17199.999998	+0.213	--	Pass
-30	17199.999999	+0.214	--	Pass

Frequency stability versus input voltage

MEAS. VOLTAGE (V _{DC})	MEAS. FREQ. (MHz)	FREQ. DRIFT (kHz)	FREQ. DEVIATION (LIMIT: 0.01 %)	RESULT
10.20	17199.999941	+0.015	< 0.01	Pass
12.00	17199.999952	+0.026	< 0.01	Pass
24.00	17199.999926	0	--	Pass
27.66	17199.999931	+0.005	< 0.01	Pass

The frequency of the transmitter was measured at 85% and 115% of the rated power supply voltage at environmental temperature (20 °C).

Result*Pass*

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6.6. CONDUCTED SPURIOUS EMISSION AT ANTENNA PORT

EUT was set for chirp sweep with modulated mode and highest RF output power.

Two antennas with lowest and highest gains was imposed.

The spectrum analyzer was connected to the antenna terminal.

Requirements

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: at least $83 \log(f_d/5)$ dB;
- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: at least $29 \log(f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation;
- On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least $43 + 10\log(P)$ dB.

Measurement (conducted)

The single values are:

CHANNELS	Bandwidth (MHz)	
	Low Antenna Gain (13.3 dBi)	High Antenna Gain (22 dBi)
Output A	Pass	Pass
Output B	Pass	Pass

Result

Pass

Notes:

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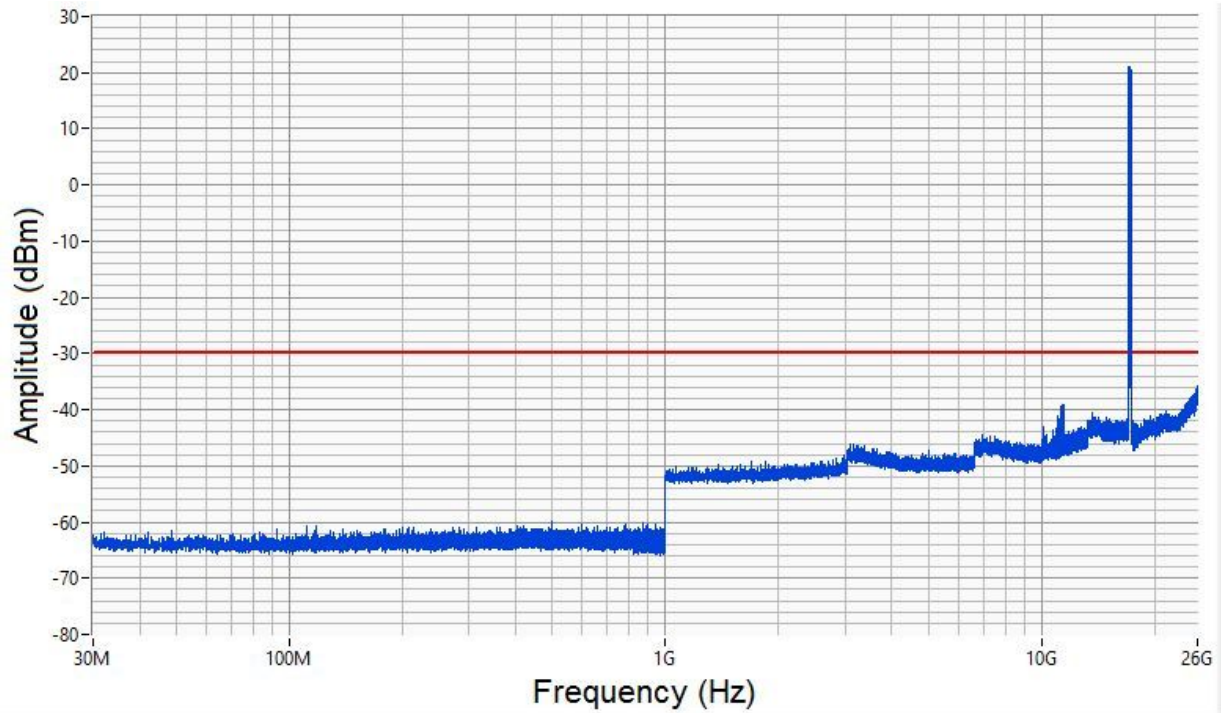


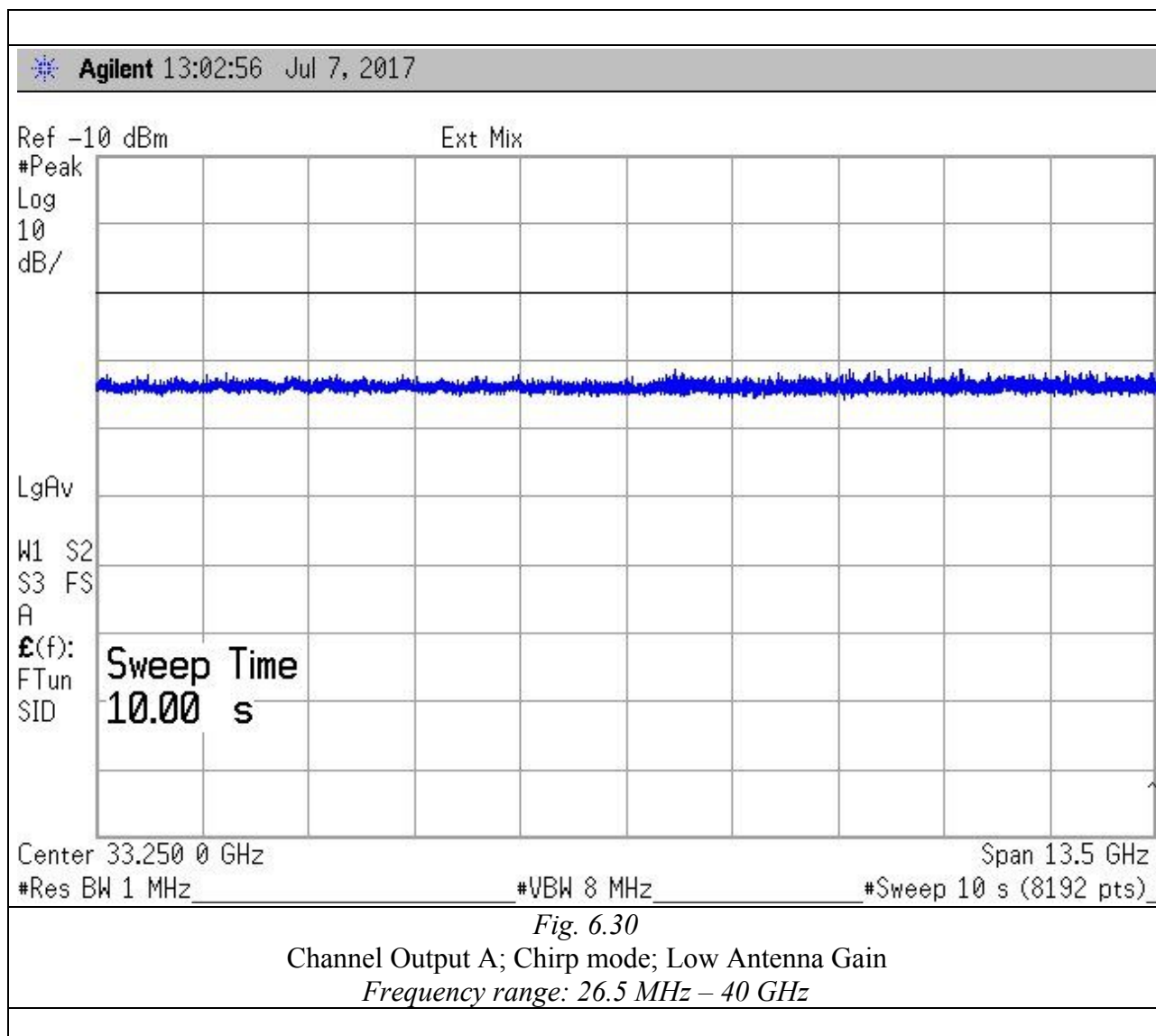
Fig. 6.29

Channel Output A; Chirp mode; Low Antenna Gain
Frequency range: 30 MHz – 26.5 GHz

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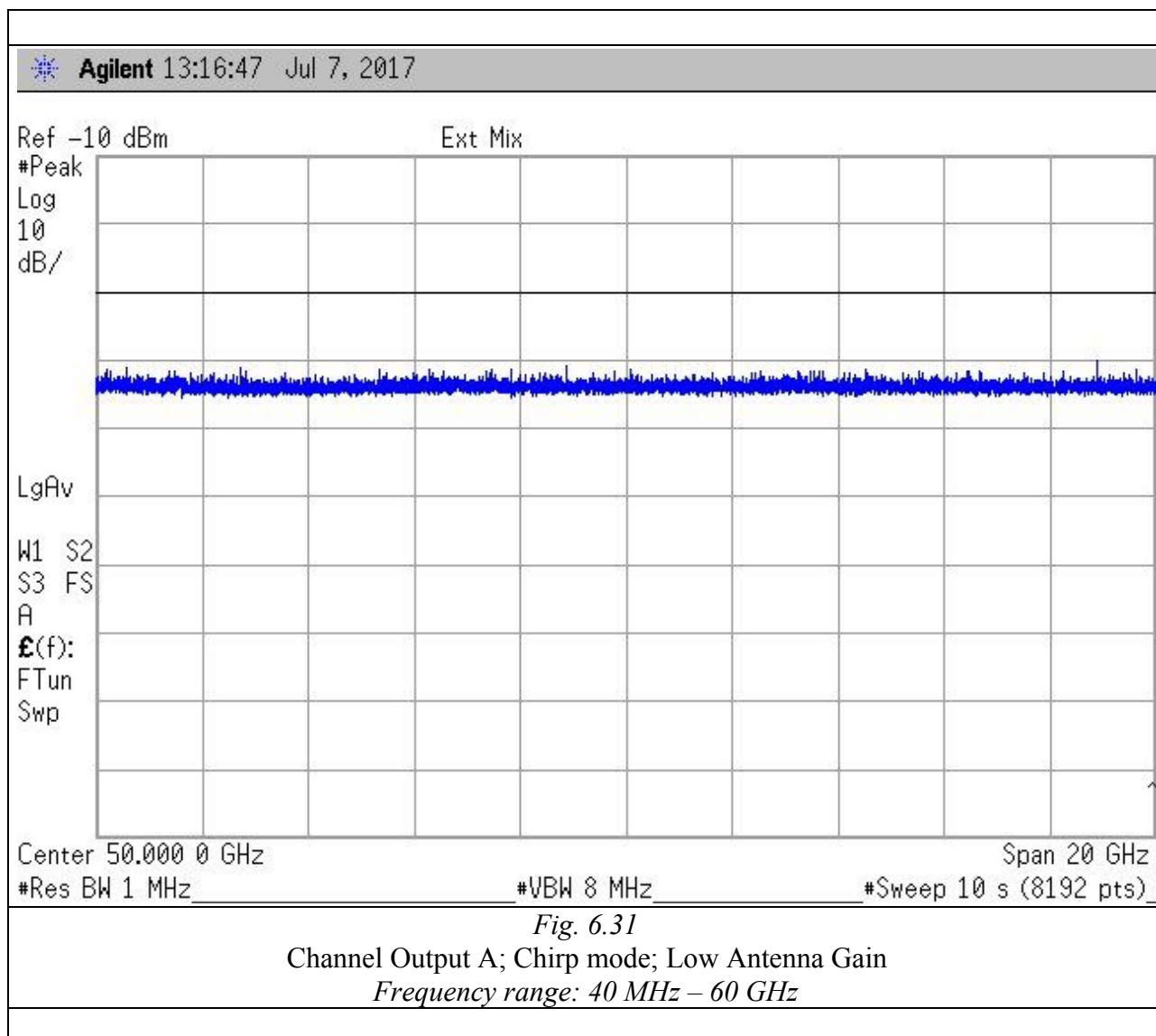
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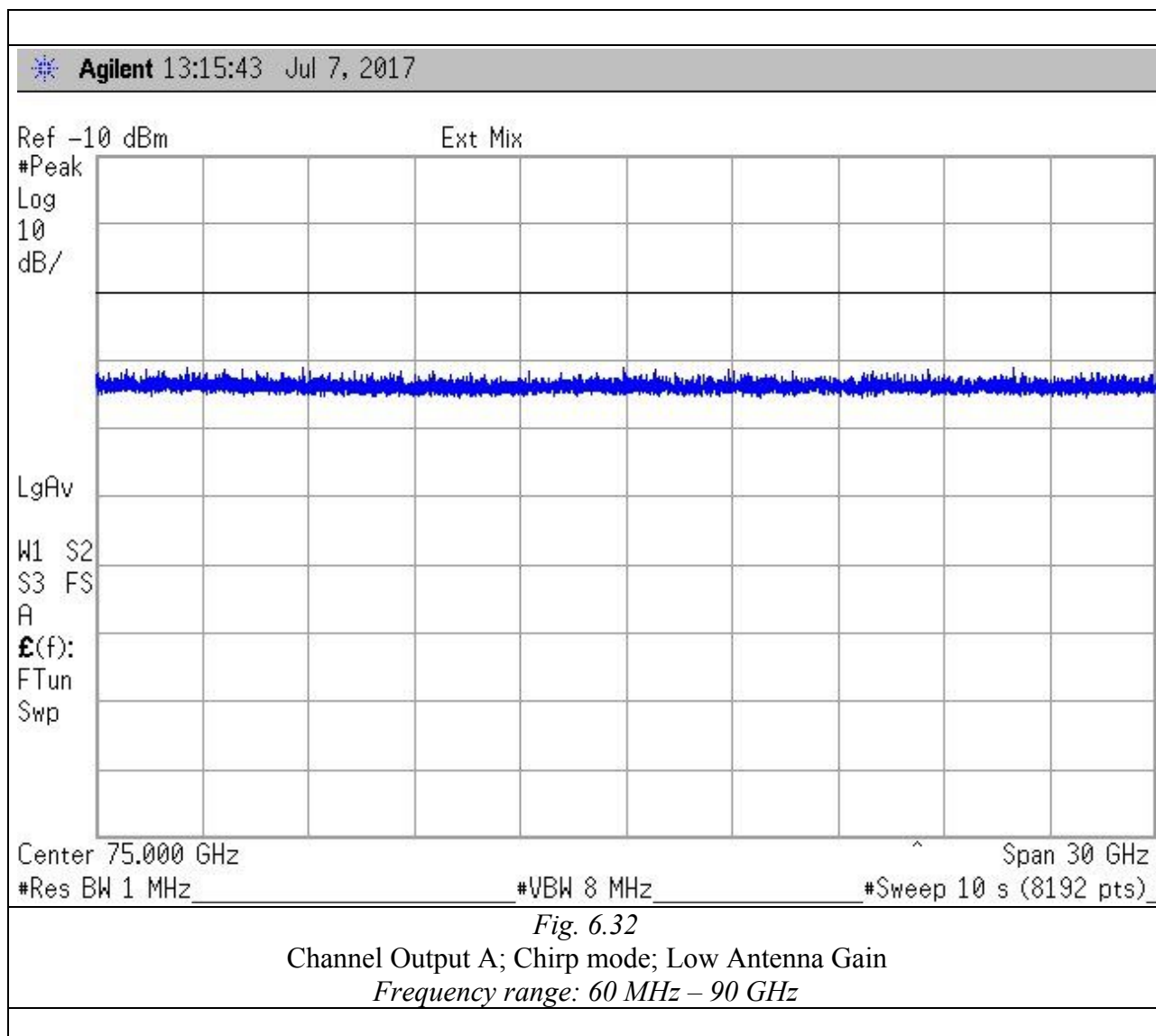
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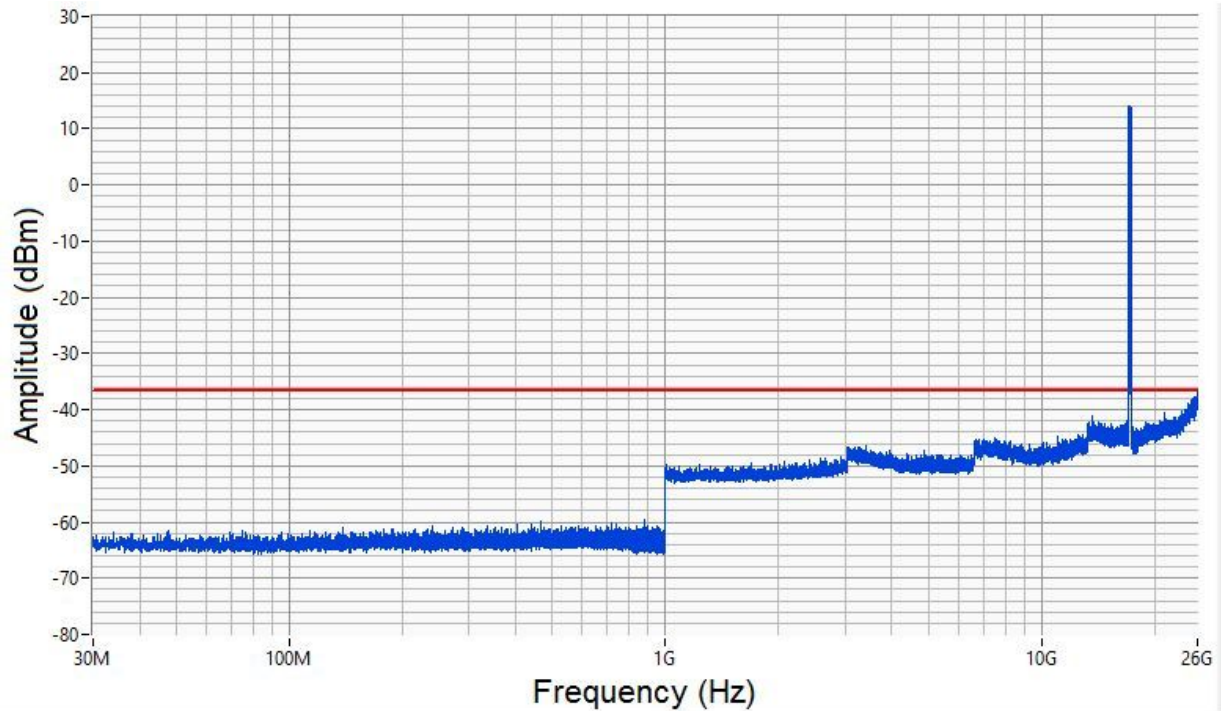
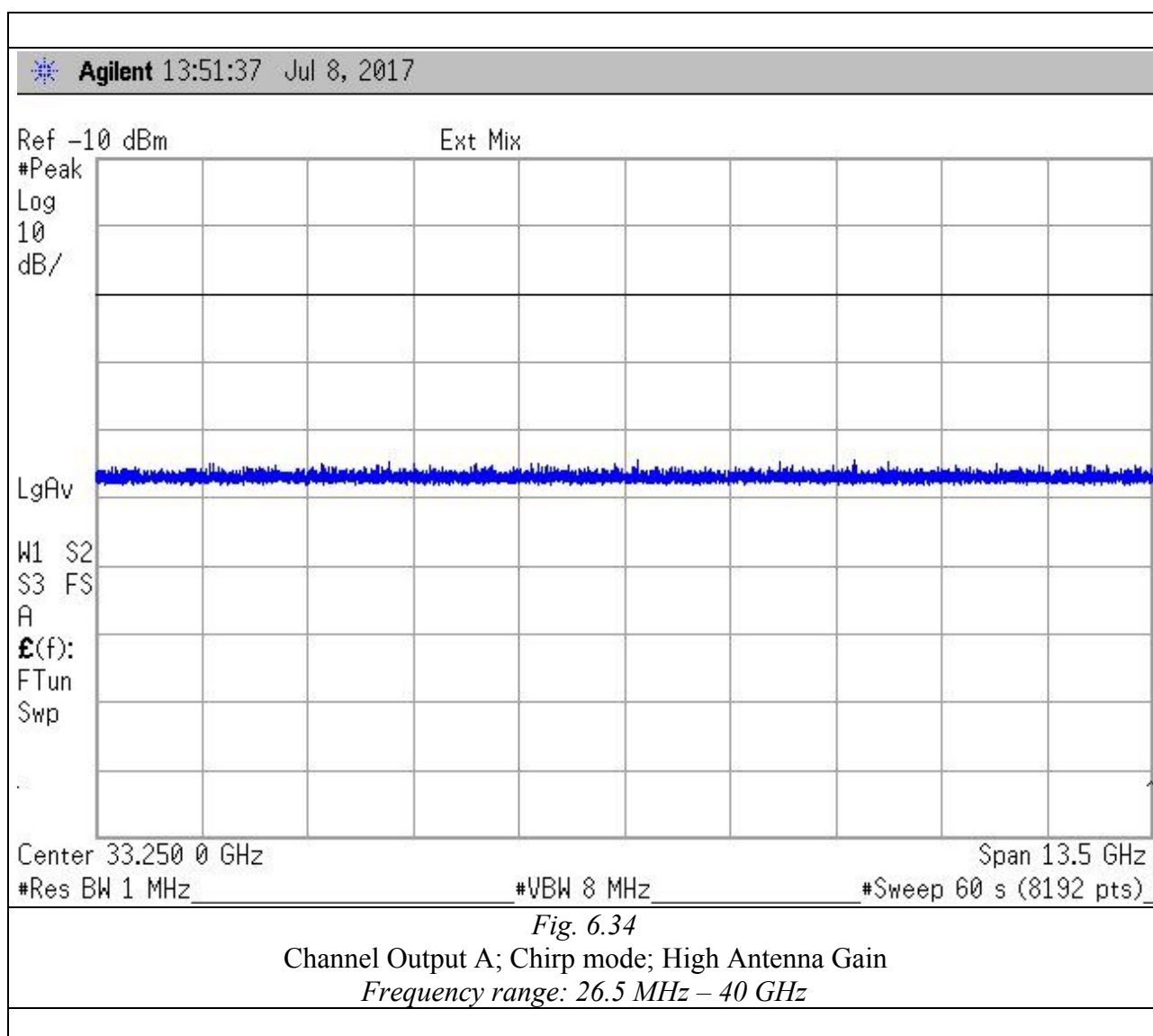


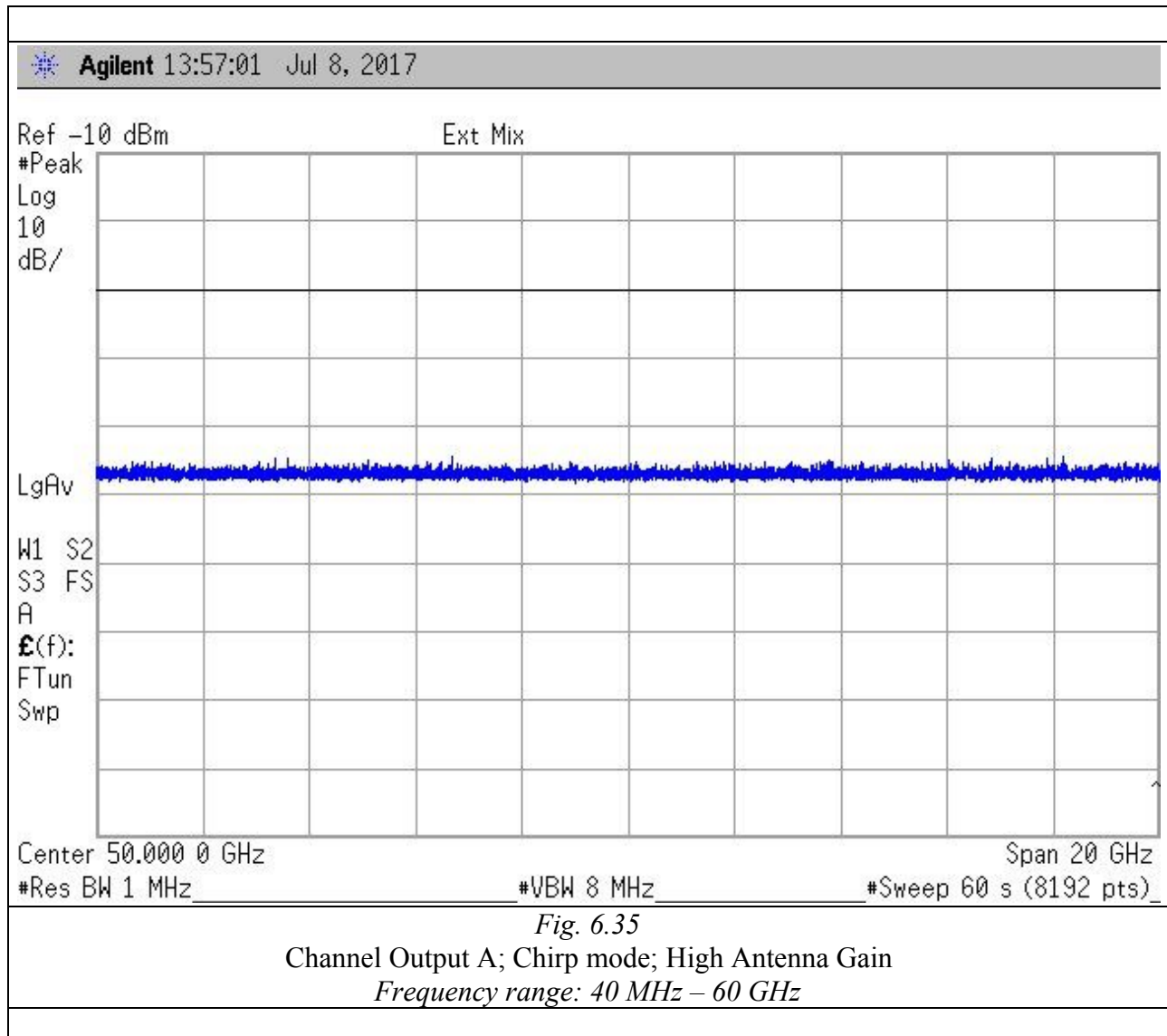
Fig. 6.33
Channel Output A; Chirp mode; High Antenna Gain
Frequency range: 30 MHz – 26.5 GHz

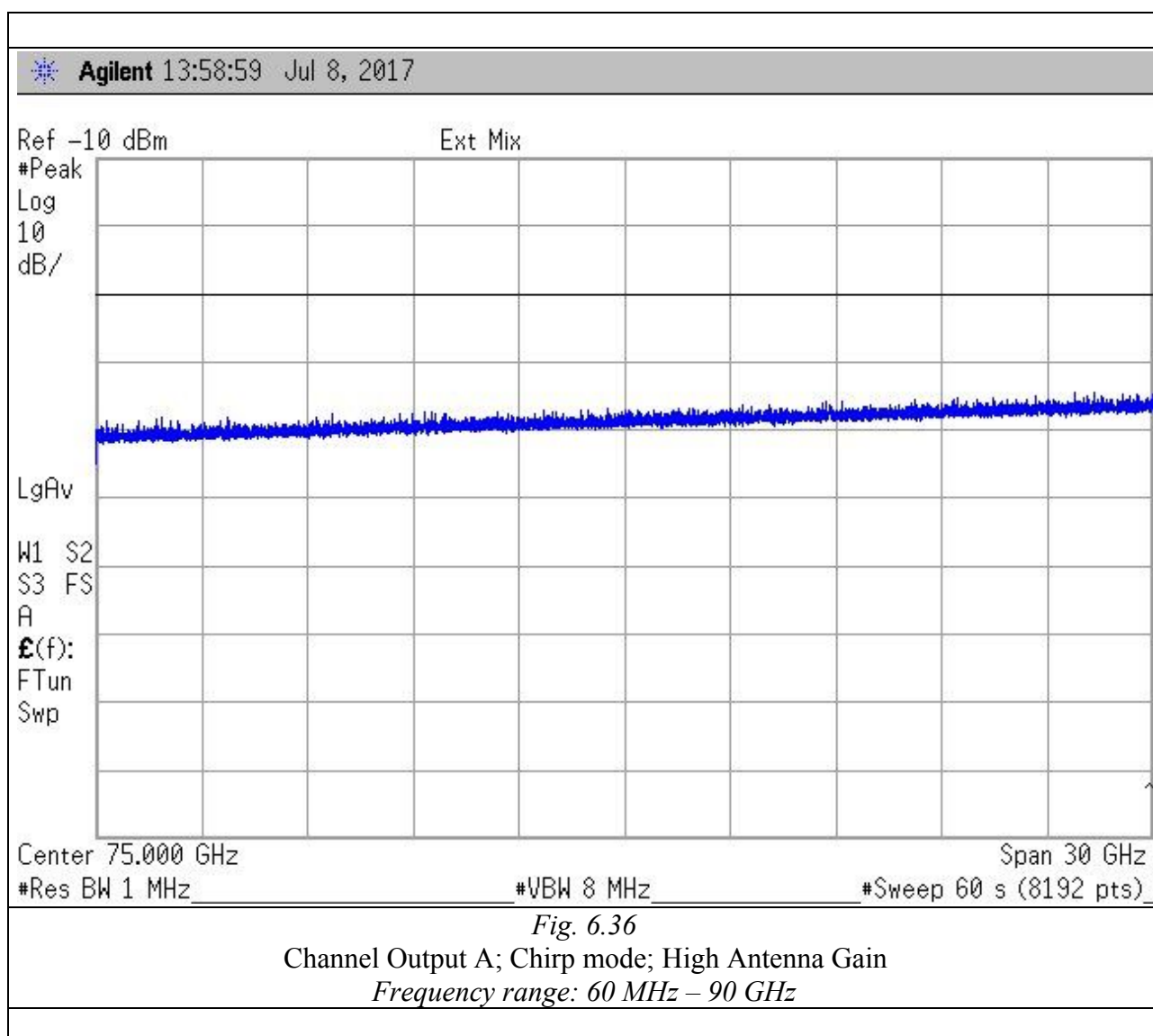


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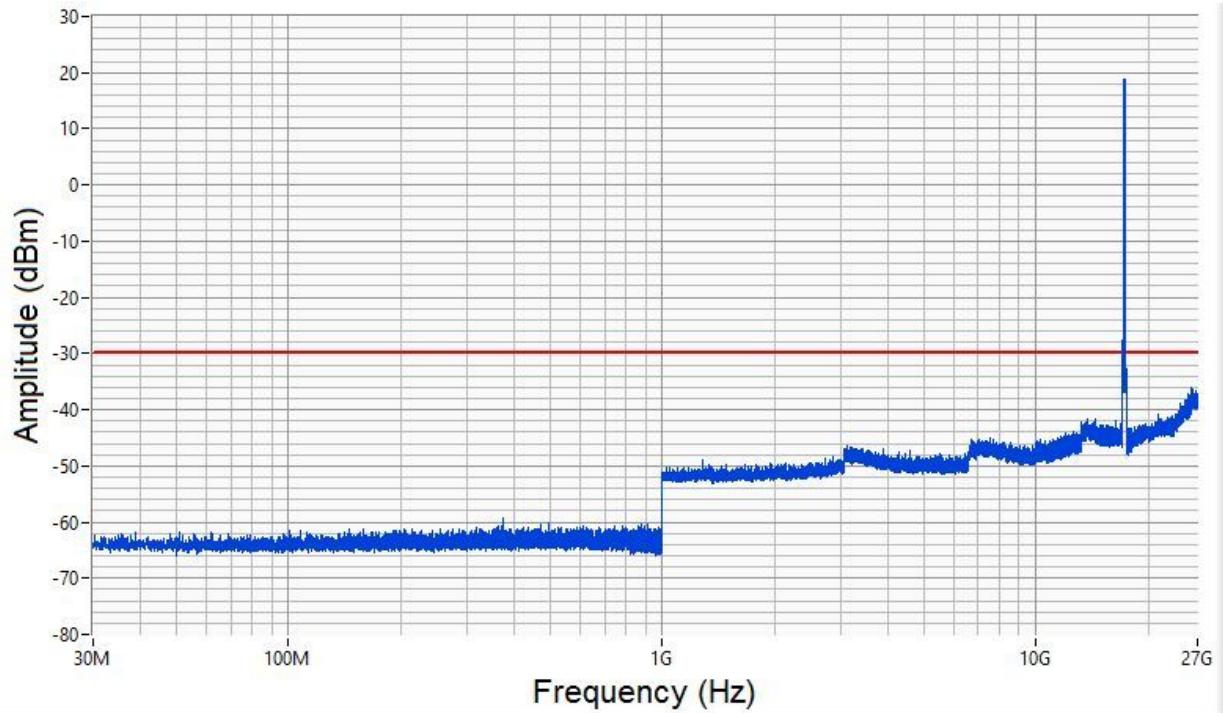
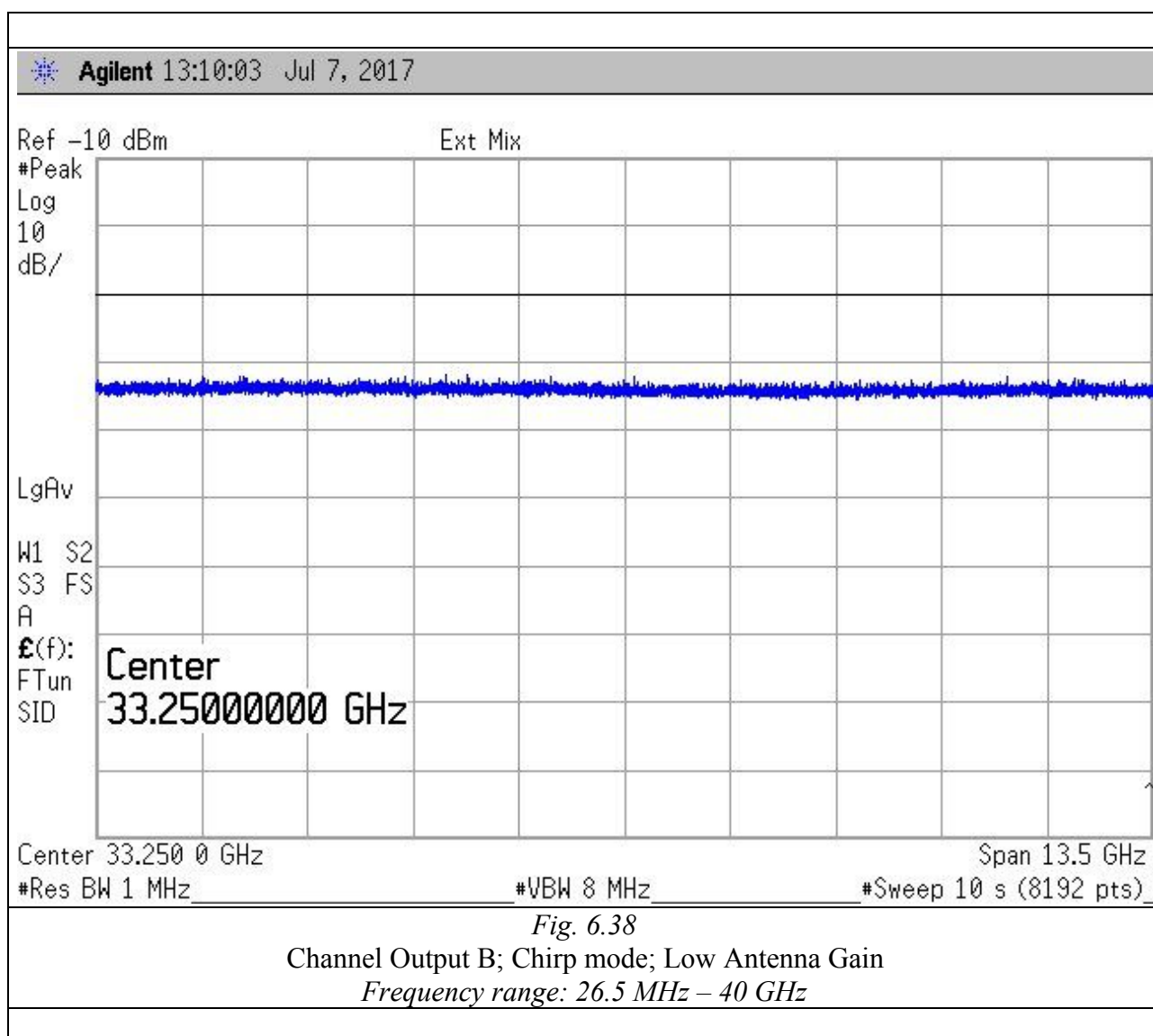


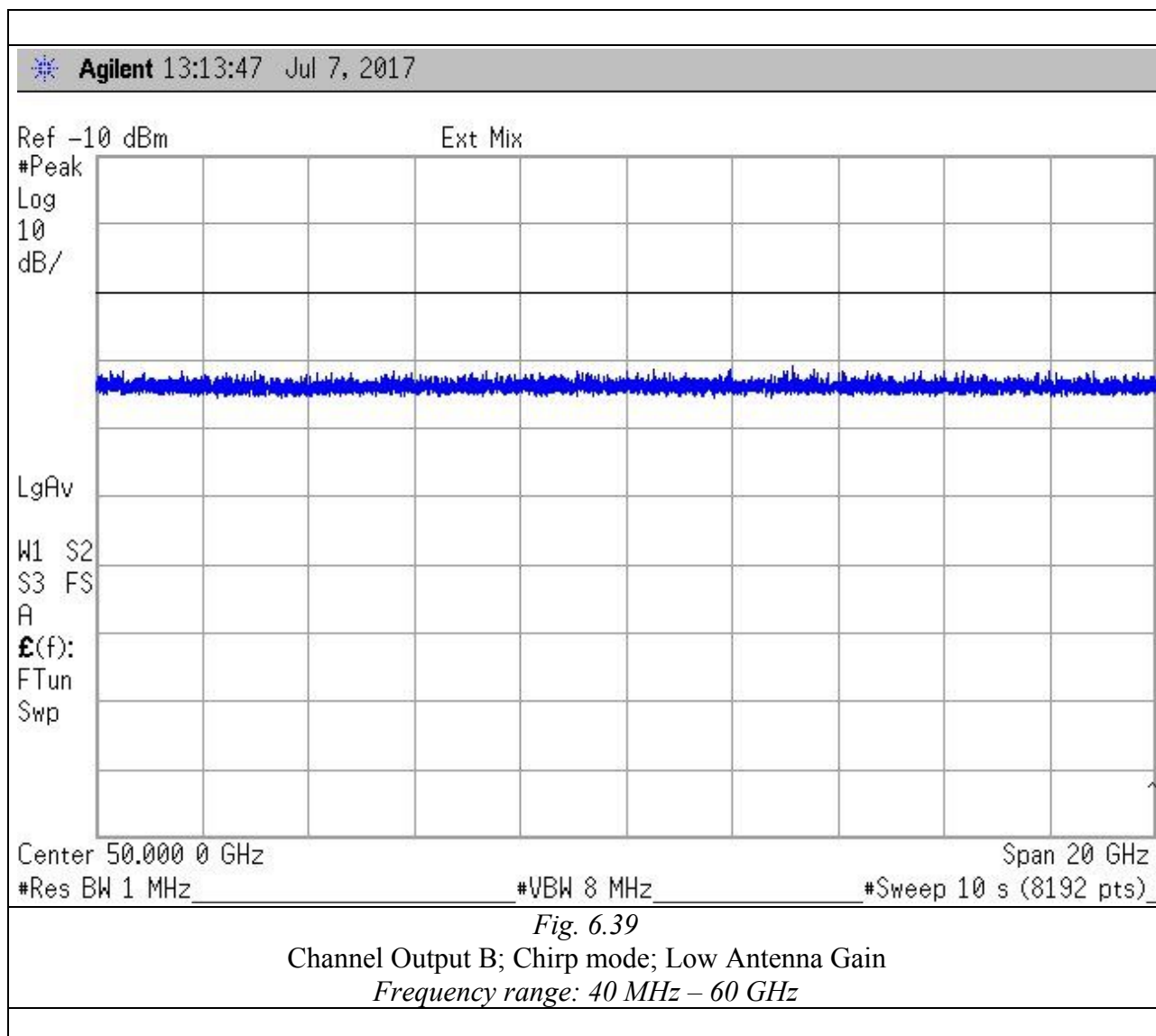
Fig. 6.37
Channel Output B; Chirp mode; Low Antenna Gain
Frequency range: 30 MHz – 26.5 GHz



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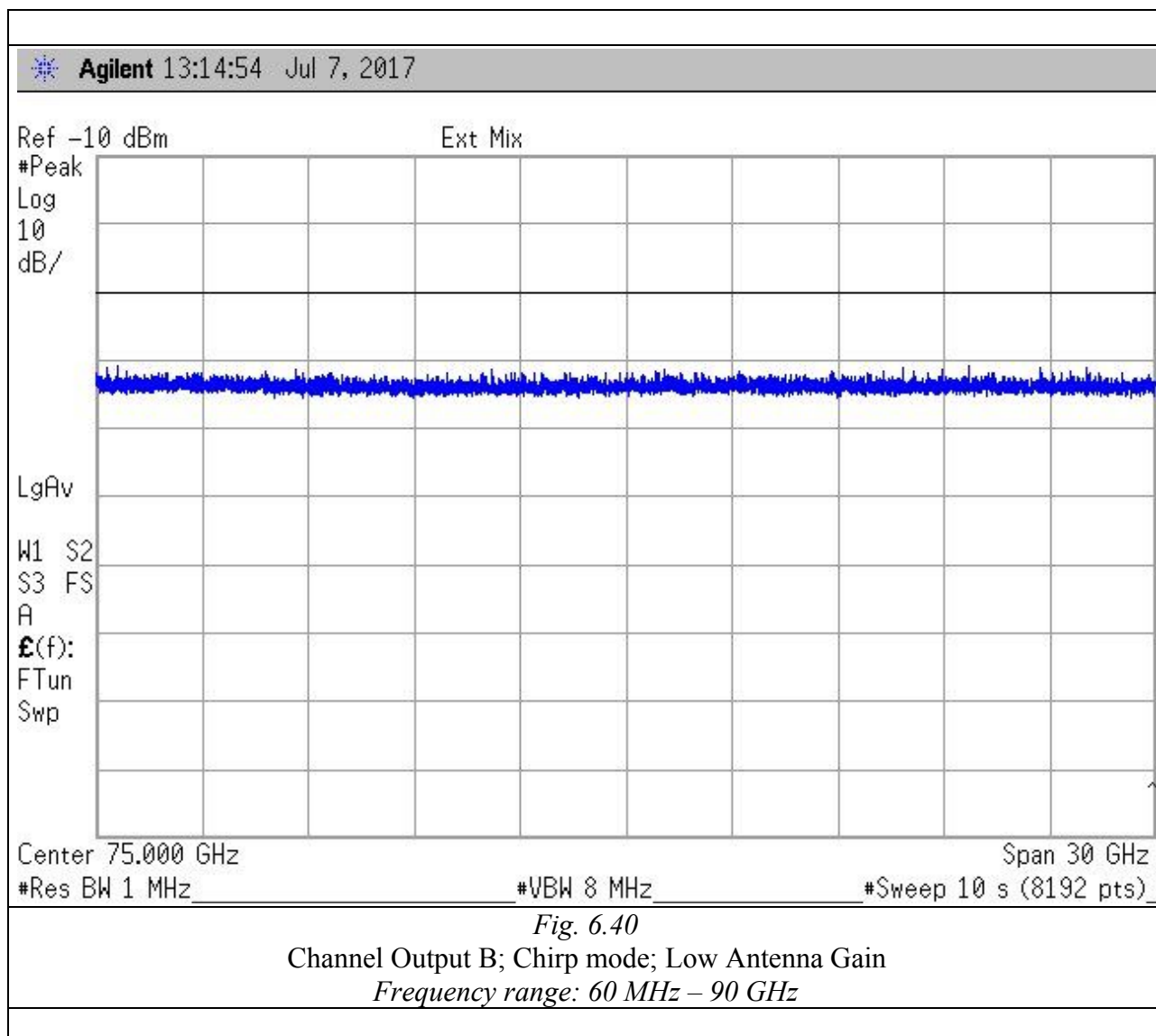
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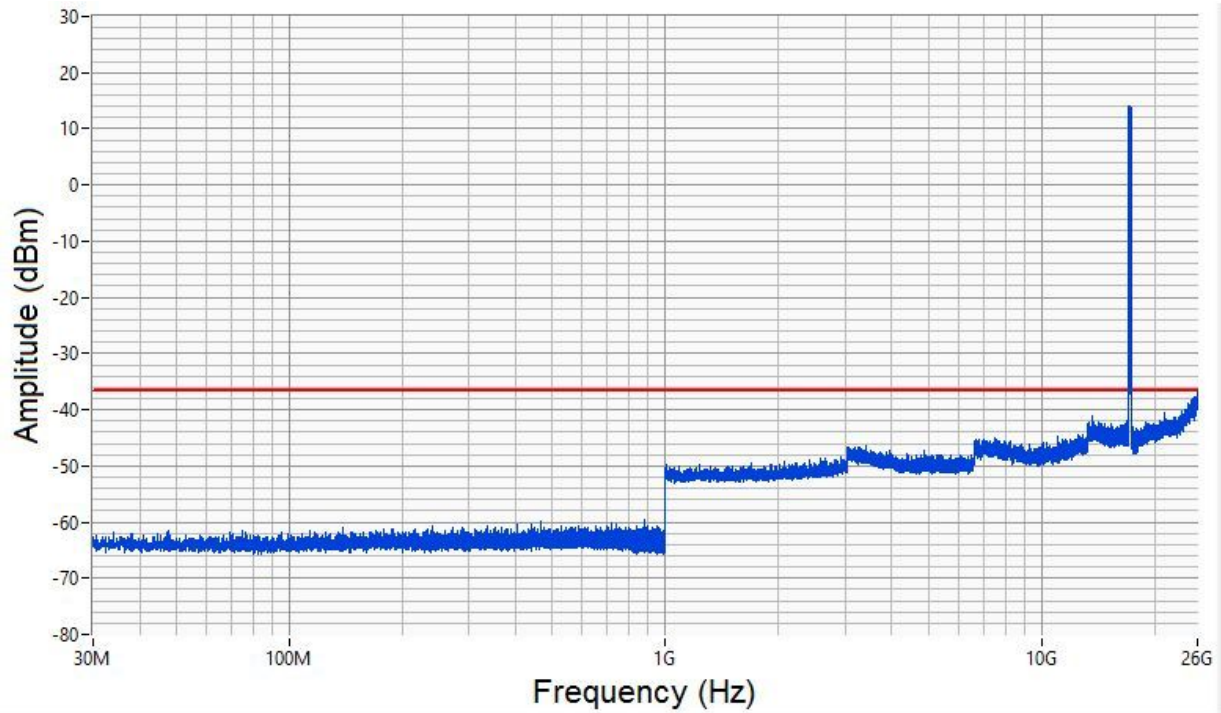
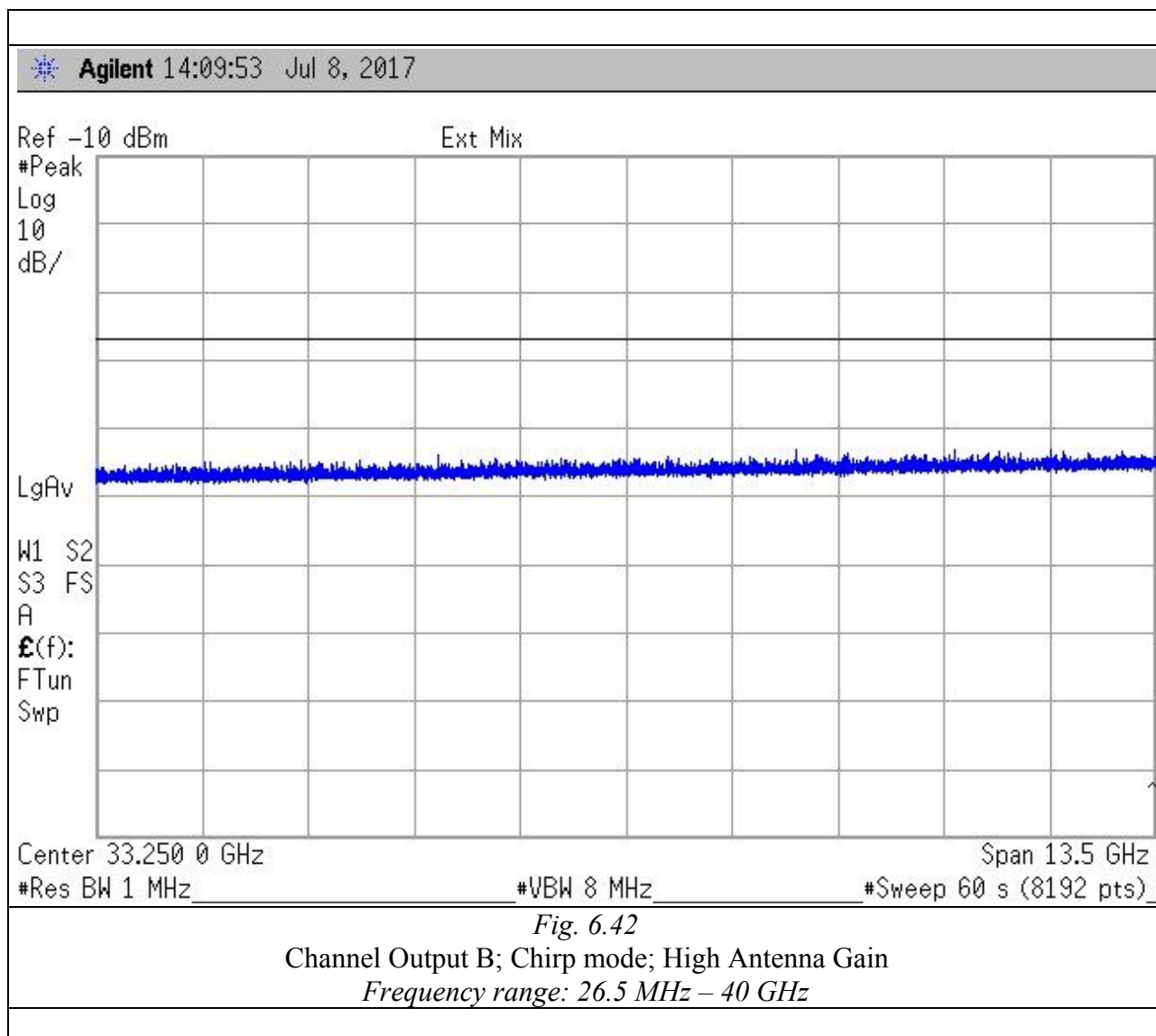


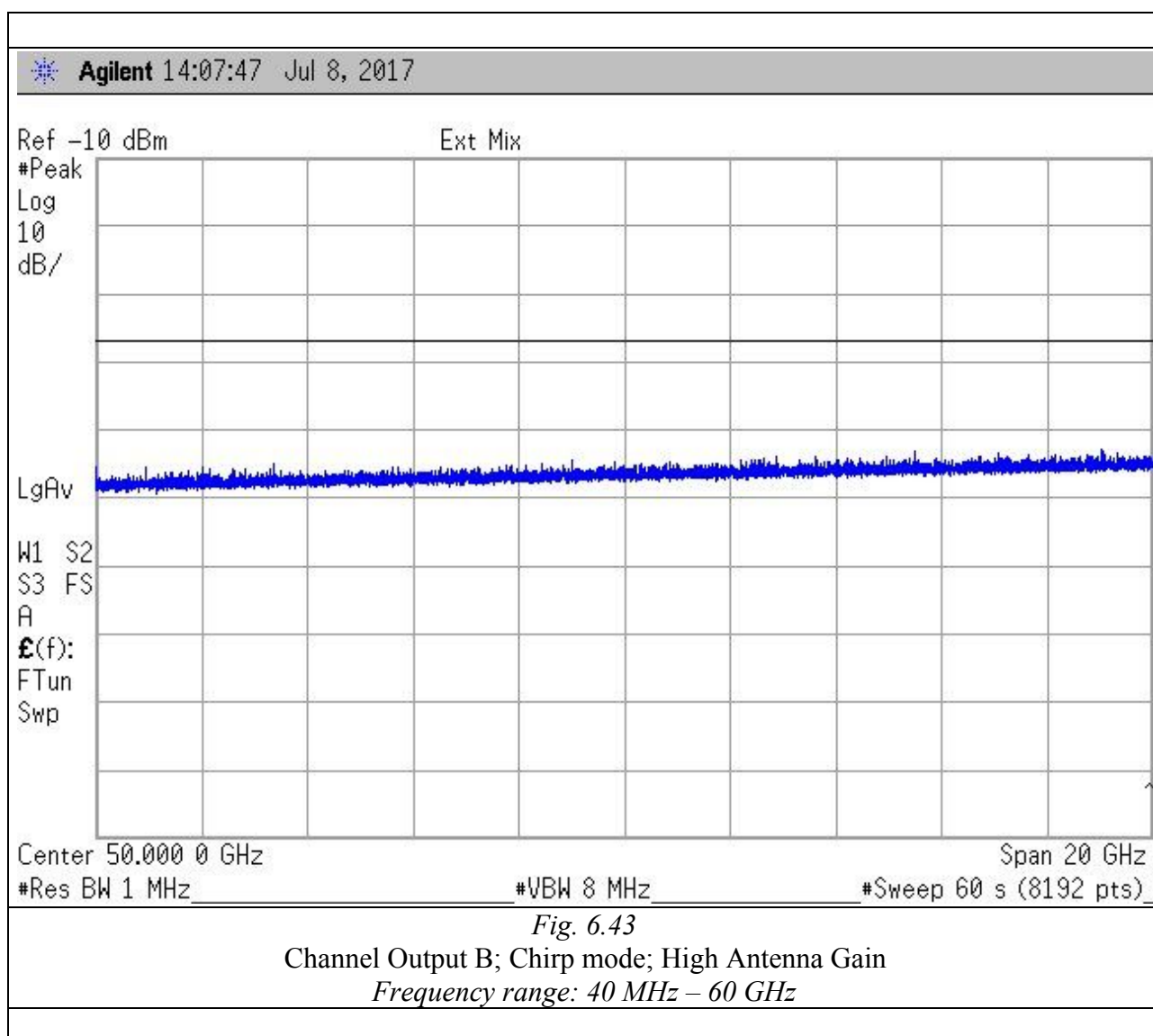
Fig. 6.41
Channel Output B; Chirp mode; High Antenna Gain
Frequency range: 30 MHz – 26.5 GHz



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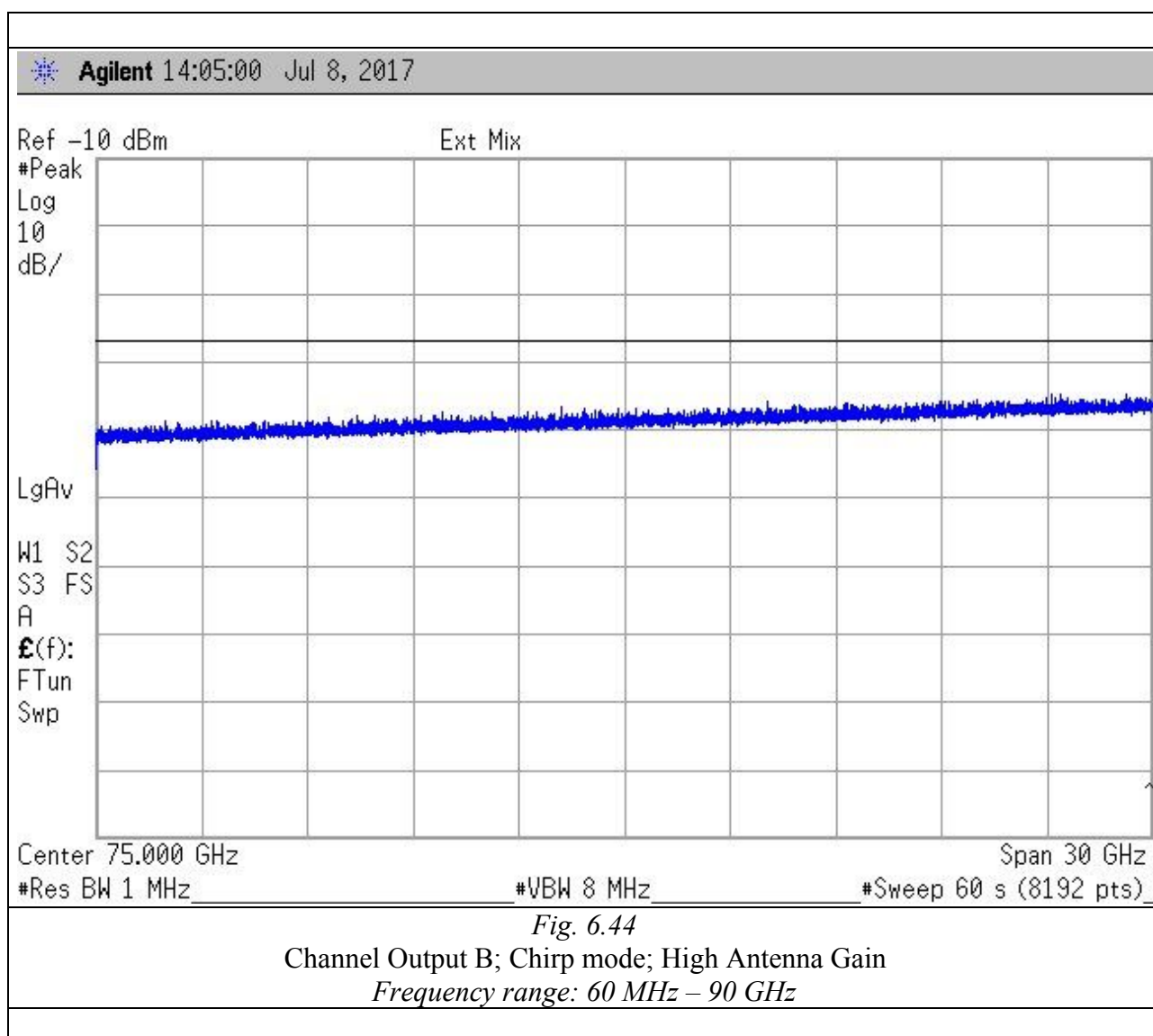
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<u>Test Equipment</u>			
EQUIPMENT	MANUFACTURER	MODEL	CAL. DUE
MXE EMI Receiver	Agilent/Keysight	N9038A	01/2018
EMI Receiver	Agilent	E4440	01/2018
Attenuator	Narda	768-10	01/2018
<u>Test procedure:</u> CT15C01			

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6.7. SPURIOUS RADIATED EMISSIONS

Nr Harmonics	AV Level (dBµV/m)						AV Limits (dBµV/m)	Remark
	Ch Low		Ch Mid		Ch High			
	F (GHz)	(dBµV/m)	F (GHz)	(dBµV/m)	F (GHz)	(dBµV/m)		
2	34.2	--	34.4	--	34.6	--	54.0	
3	51.3	--	51.6	--	51.9	--	54.0	
4	68.4	--	68.8	--	69.2	--	54.0	
5	85.5	--	86.0	--	86.5	--	54.0	
6		--		--		--	54.0	
7		--		--		--	54.0	
8		--		--		--	54.0	
9		--		--		--	54.0	
10		--		--		--	54.0	

Note: Levels below 20 dB of limits are indicated with (--).

Nr Harmonics	Peak Level (dBµV/m)						AV Limits (dBµV/m)	Remark
	Ch 0		Ch 24		Ch 49			
	F (MHz)	(dBµV/m)	F (MHz)	(dBµV/m)	F (MHz)	(dBµV/m)		
2	34.2	--	34.4	--	34.6	--	74.0	
3	51.3	--	51.6	--	51.9	--	74.0	
4	68.4	--	68.8	--	69.2	--	74.0	
5	85.5	--	86.0	--	86.5	--	74.0	
6		--		--		--	74.0	
7		--		--		--	74.0	
8		--		--		--	74.0	
9		--		--		--	74.0	
10		--		--		--	74.0	

Note: Levels below 20 dB of limits are indicated with (--).

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<u>Test Equipment</u>			
EQUIPMENT	MANUFACTURER	MODEL	CAL. DUE
MXE EMI Receiver	Agilent/Keysight	N9038A	01/2018
EMI Receiver	Agilent	E4440	01/2018
Harmonic mixer	HP	11971A	01/2018
Harmonic mixer	Keysight	11970U	07/2020
EXA Signal Analyzer	Keysight	N9010B	01/2018
Waveguide Harmonic Mixer	Keysight	M1970E	11/2017
Anechoic Chamber	Comtest	CSA01	01/2018
Bilog Antenna	Schaffner	CBL6112B	01/2018
Horn Antenna	EMCO	3115	01/2018
Horn Antenna	Alpha Industries	61932500	01/2018
Standard Gain Horn Antenna	A-INFOMW	LB-19-20-A	01/2018
Standard Gain Horn Antenna	A-INFOMW	LB-12-20-A	01/2018
Controller	Deisel	HD100	01/2018
Turn Table	Deisel	MA240	01/2018
<u>Test procedure:</u> CT15R01			

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