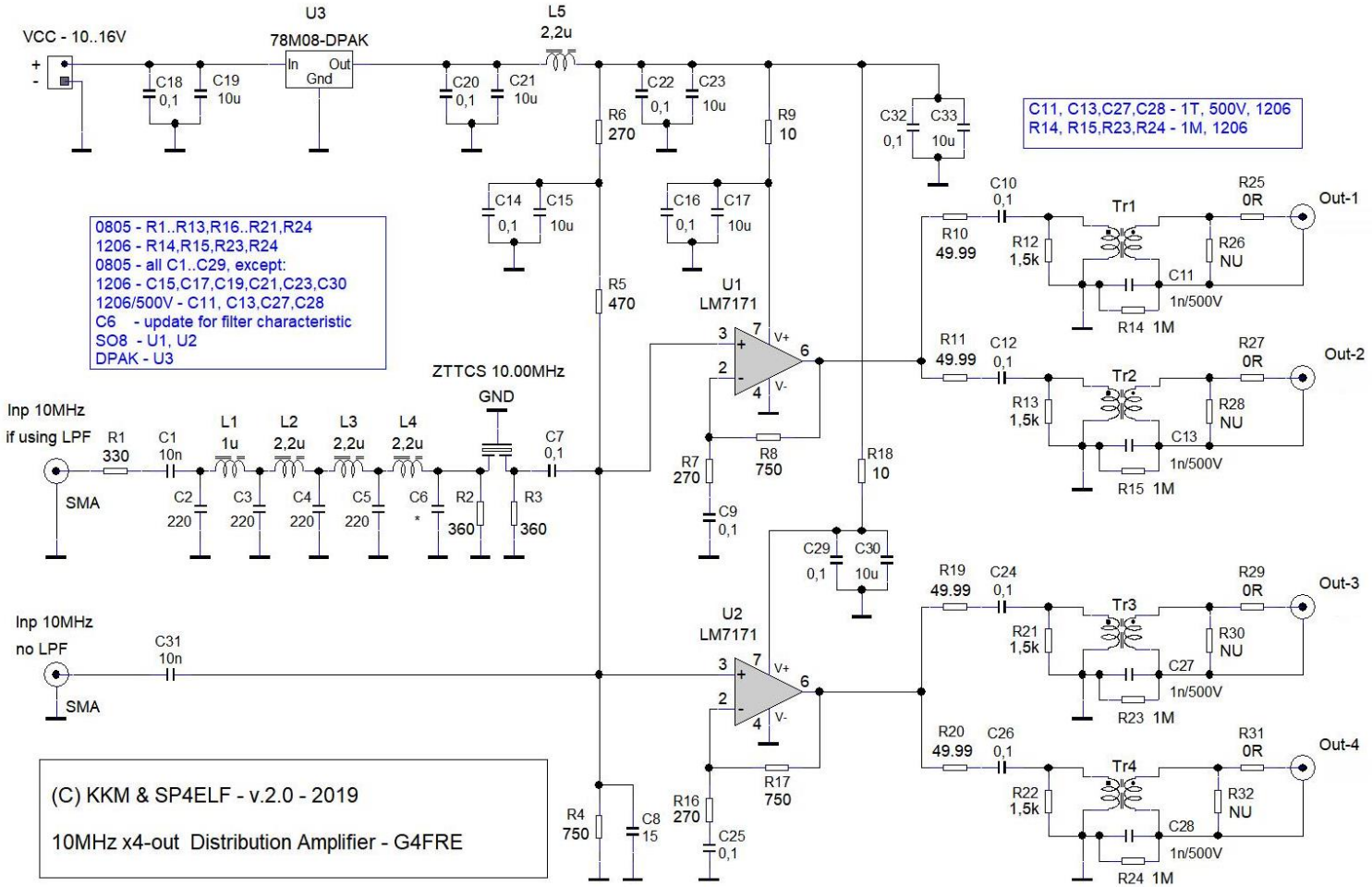
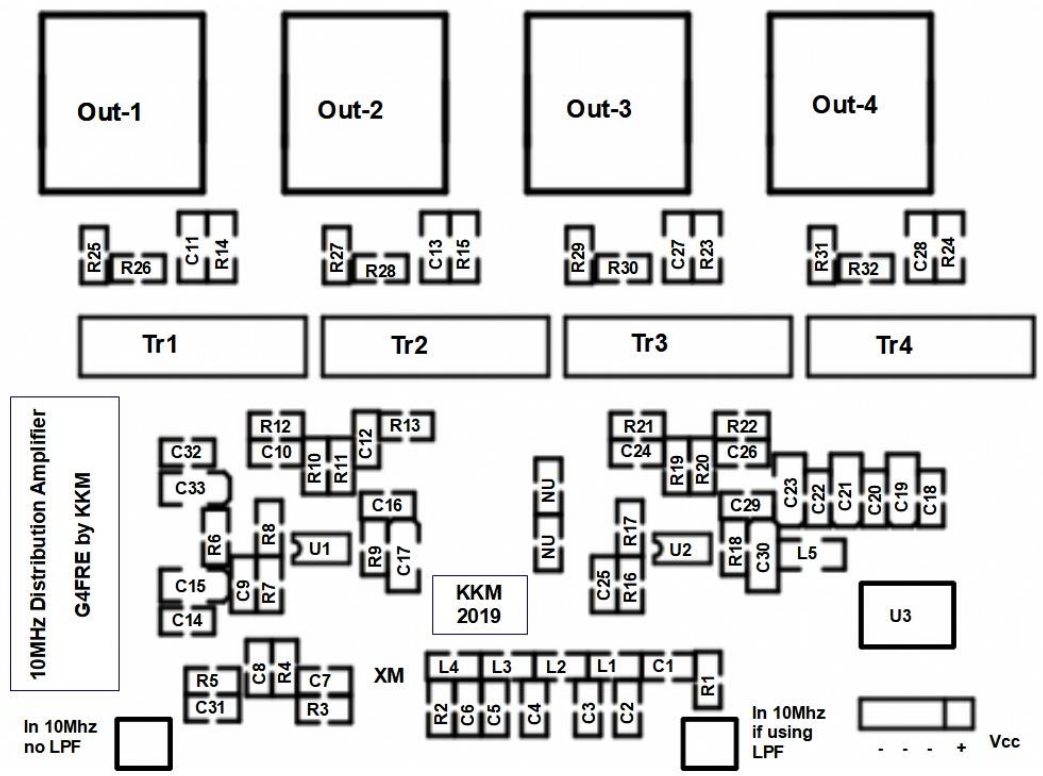
10 MHz distribution unit with isolated output ports

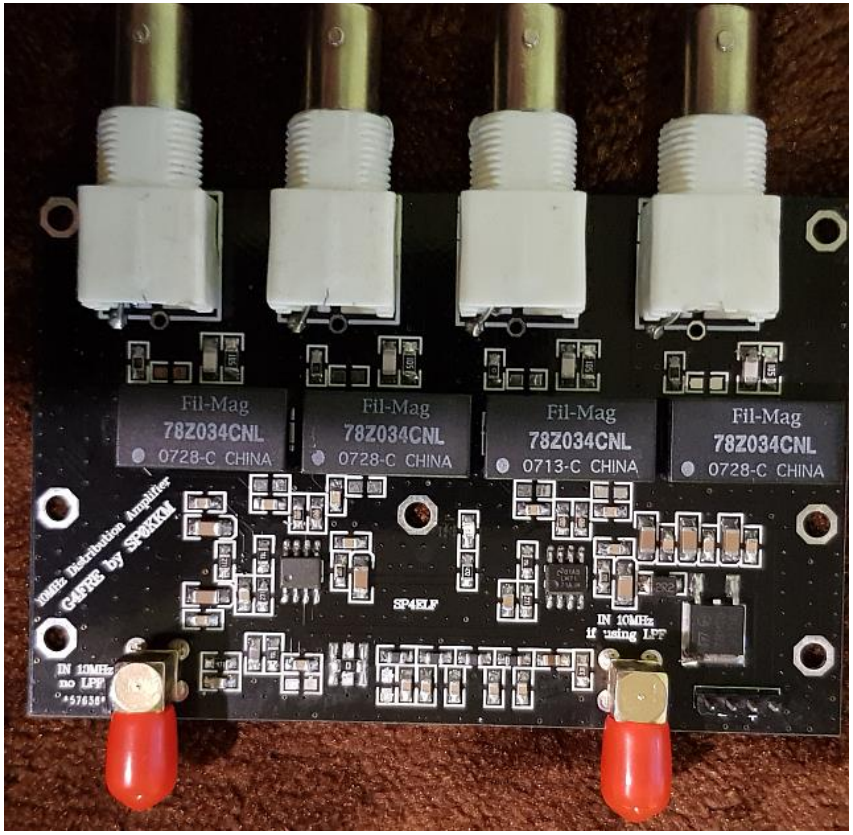
DD1US Matthias Rev.3 July 11th 2019

A friend, Marek SP4ELF, designed a 10 MHz distribution amplifier with 4 isolated output ports. It is based on a design from G4FRE and Marek adopted my recommendation and added some output transformers/filters, which was recommended to me by Paul M0EYT. This is the schematic of the unit:



Next you will find a drawing of the placement of the components and of the assembled PCB:





The distribution unit features 2 inputs: one without any filtering (left) and another input with a 10 MHz lowpass filter plus 10 MHz ceramic bandpass filter (right). Please note that in my unit the 10 MHz bandpass filter was not assembled.

The supply voltage is 10-16V DC. It is regulated in the unit to +8V.

Here is the BOM (Bill of Material) for the board: GPS-10MHz Distribution Amplifier based on G4FRE design by KKM v.2.0 - 2019

Identifier	Quantity	Value	Name	Description
Capacitors				
C7,C9,C10,C12, C14,C16,C18, C20, C22, C24,C25,C26, C29	13	0,1uF	C-0805	C Ceramic Capacitors SMD 0805
C1	1	10nF	C-0805	C Ceramic Capacitors SMD 0805
C15,C17,C19,C21,C23,C30	6	10uF	C-1206	C Ceramic Capacitors SMD 1206
C8	1	15pF	C-0805	C Ceramic Capacitors SMD 0805
C11,C13,C27,C28	4	1nF/500V	C-1206	C Ceramic Capacitors SMD 1206
C2,C3,C4,C5	4	220pF	C-0805	C Ceramic Capacitors SMD 0805
C6	1	TBD	C-0805	C Ceramic Capacitors SMD 0805 (to be defined to optimize filter response)
Connectors				
CN4	1		CONN2	Connectors gold pin 1x2, raster 2,54mm
CX1,CX2	2		SMA	SMA Connectors
Out-1,Out-2,Out-3,Out-4	4		BNC	Isolated BNC Connectors
Crystal filter				
XM	1	10.00MHz	ZTTCS	10.00MHz monolitic crystal filter, 3 pins
Inductors				
L1	1	1uH	I-0805	Inductors SMD 0805
L2,L3,L4,L5	4	2,2uH	I-0805	Inductors SMD 0805

Identifier	Quantity	Value	Name	Description
Transformers				
Tr1,Tr2,Tr3,Tr4	4	Tr	Tr10B	10Base-T Transformers Fil-Mag 78Z034CNL
Resistors				
R1	1	330Ohm	R-0805	R Resistors SMD 0805
R2,R3	2	360Ohm	R-0805	R Resistors SMD 0805
R12,R13,R21,R22	4	1,5kOhm	R-0805	R Resistors SMD 0805
R9,R18	2	10Ohm	R-0805	R Resistors SMD 0805
R14,R15,R23,R24	4	1MOhm	R-1206	R Resistors SMD 1206
R6,R7,R16	3	270Ohm	R-0805	R Resistors SMD 0805
R25,R27,R29,R31	4	0Ohm	R-0805	R Resistors SMD 0805
R5	1	470Ohm	R-0805	R Resistors SMD 0805
R10,R11,R19,R20	4	49.99Ohm	R-0805	R Resistors SMD 0805
R4,R8,R17	3	750Ohm	R-0805	R Resistors SMD 0805
R26,R28,R30,R32	4	NU	R-0805	R Resistors SMD 0805 (not used)
Semiconductors				
U1,U2	2	LM7171		Advanced CMOS low noise precision operational amplifier, SO8
U3	1	78M08-DPAK		8v linear voltage regulator 0.5A, DPAK (TO252), 3 terminal

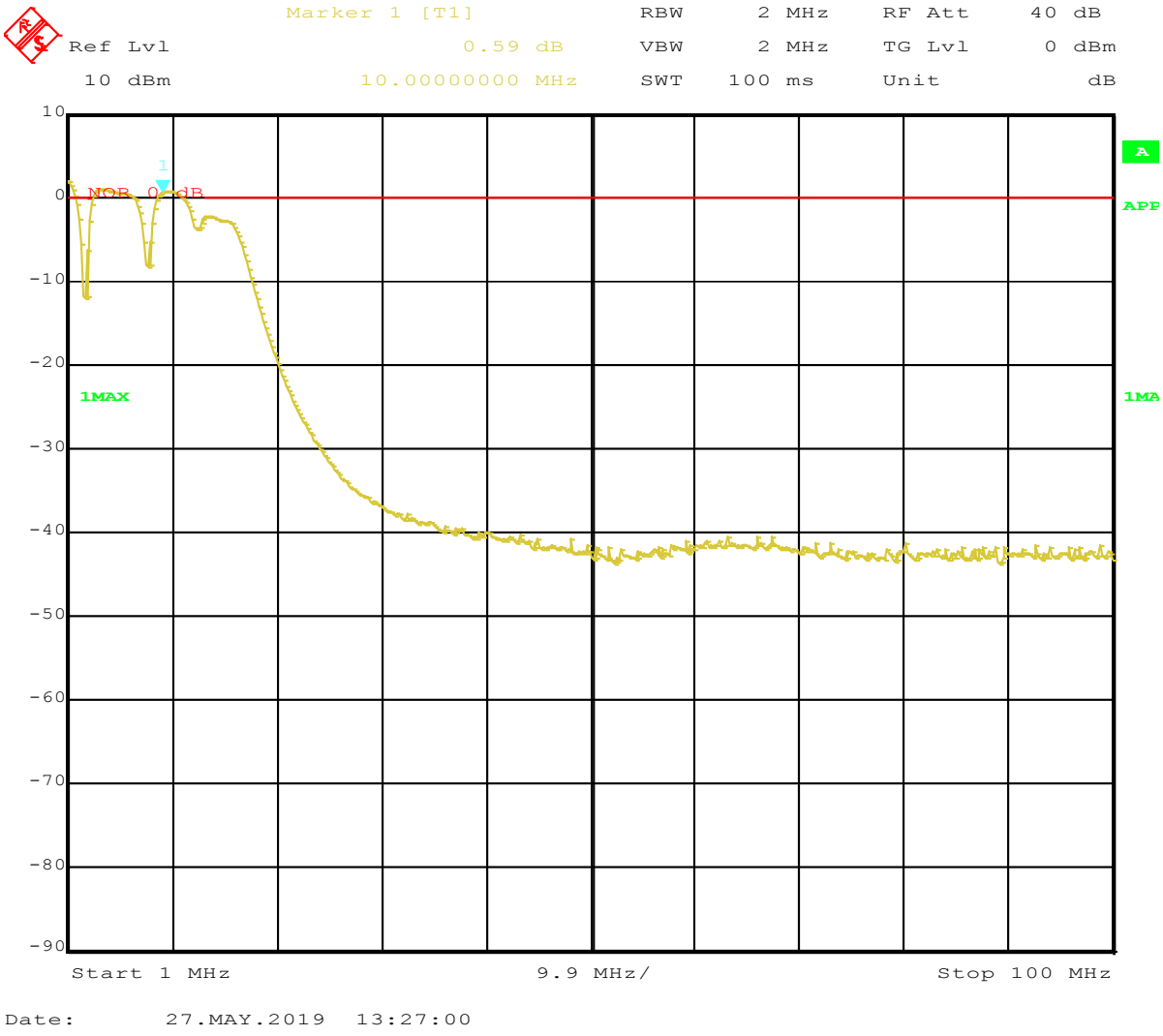
Marek was kind enough to send me a unit. I have built the unit in a shielded enclosure to make sure, that there are no spurious emissions / injections.

Here are some pictures of my unit:

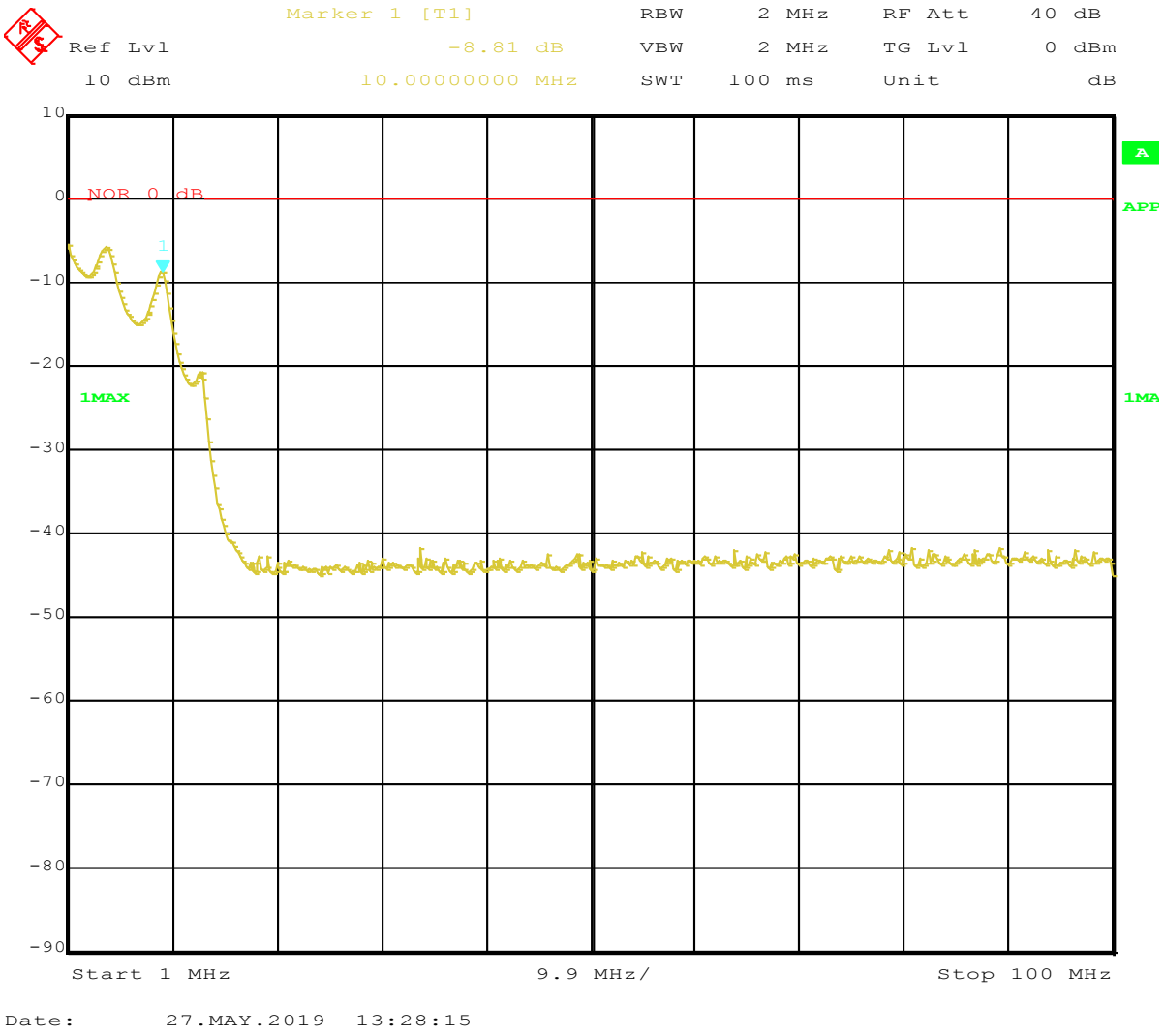

10 MHz output 4x
10MHz input
without filter
Vs=11...16V
10MHz input
with filter

I made some measurements. Here are the results:

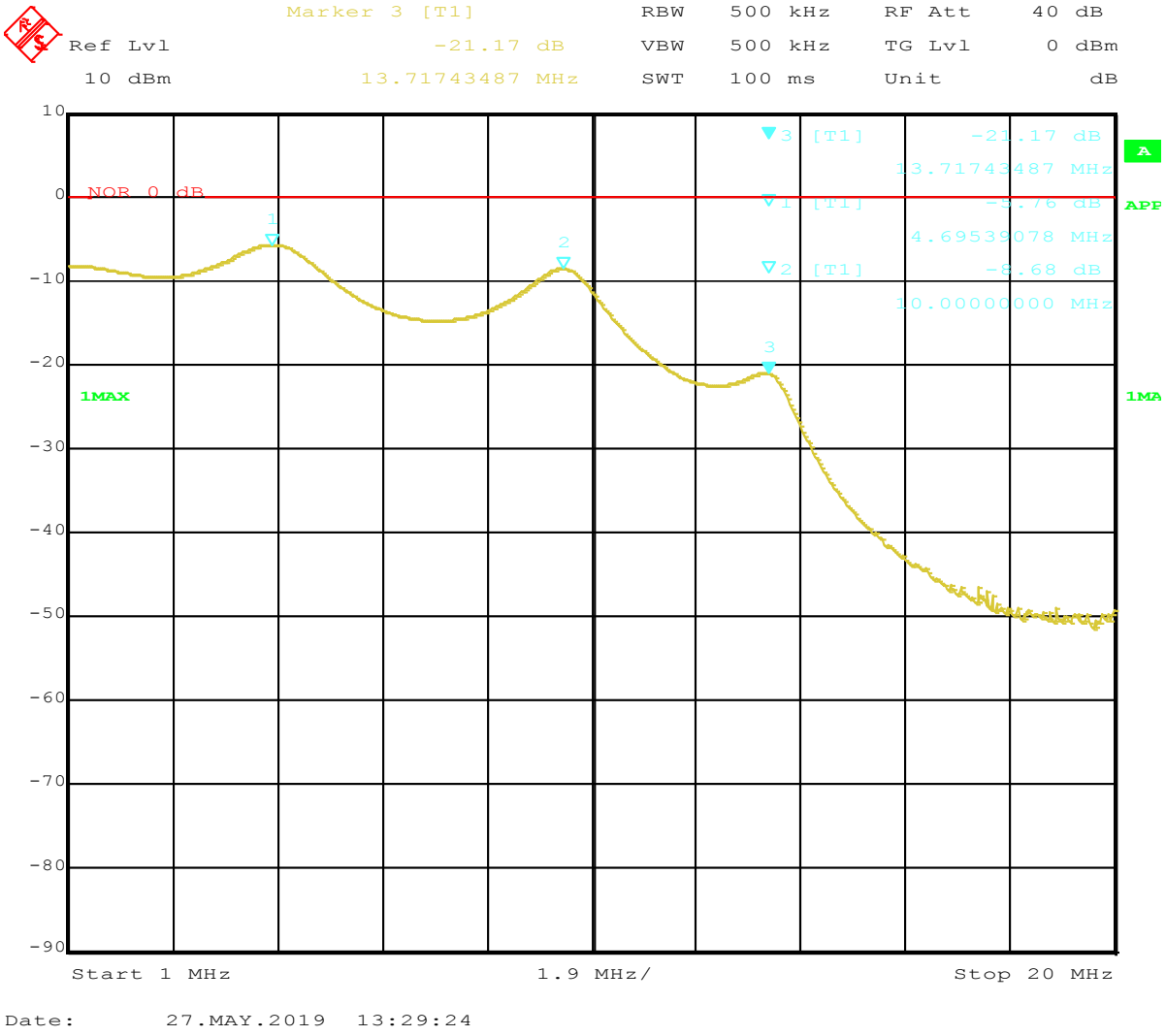
1.) Measuring the transfer characteristics with a spectrum analyser and tracking generator. Input power to the distribution unit was +0dBm, at the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 100 MHz. The input port “<u>without filter</u>” was used.



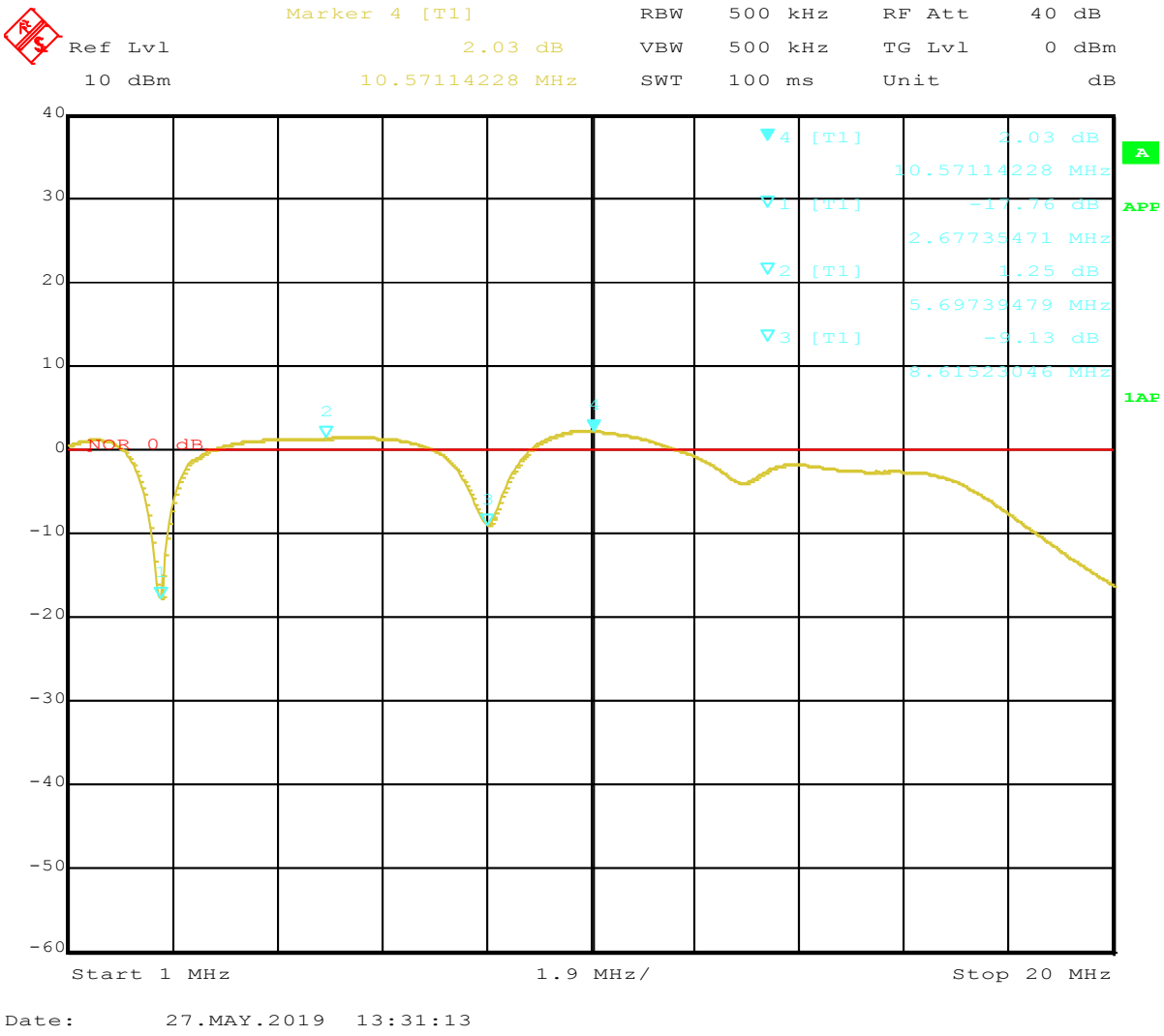
2.) Measuring the transfer characteristics with a spectrum analyser and tracking generator. Input power to the distribution unit was +0dBm, at the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 100 MHz. The input port "<u>with filter</u>" was used.



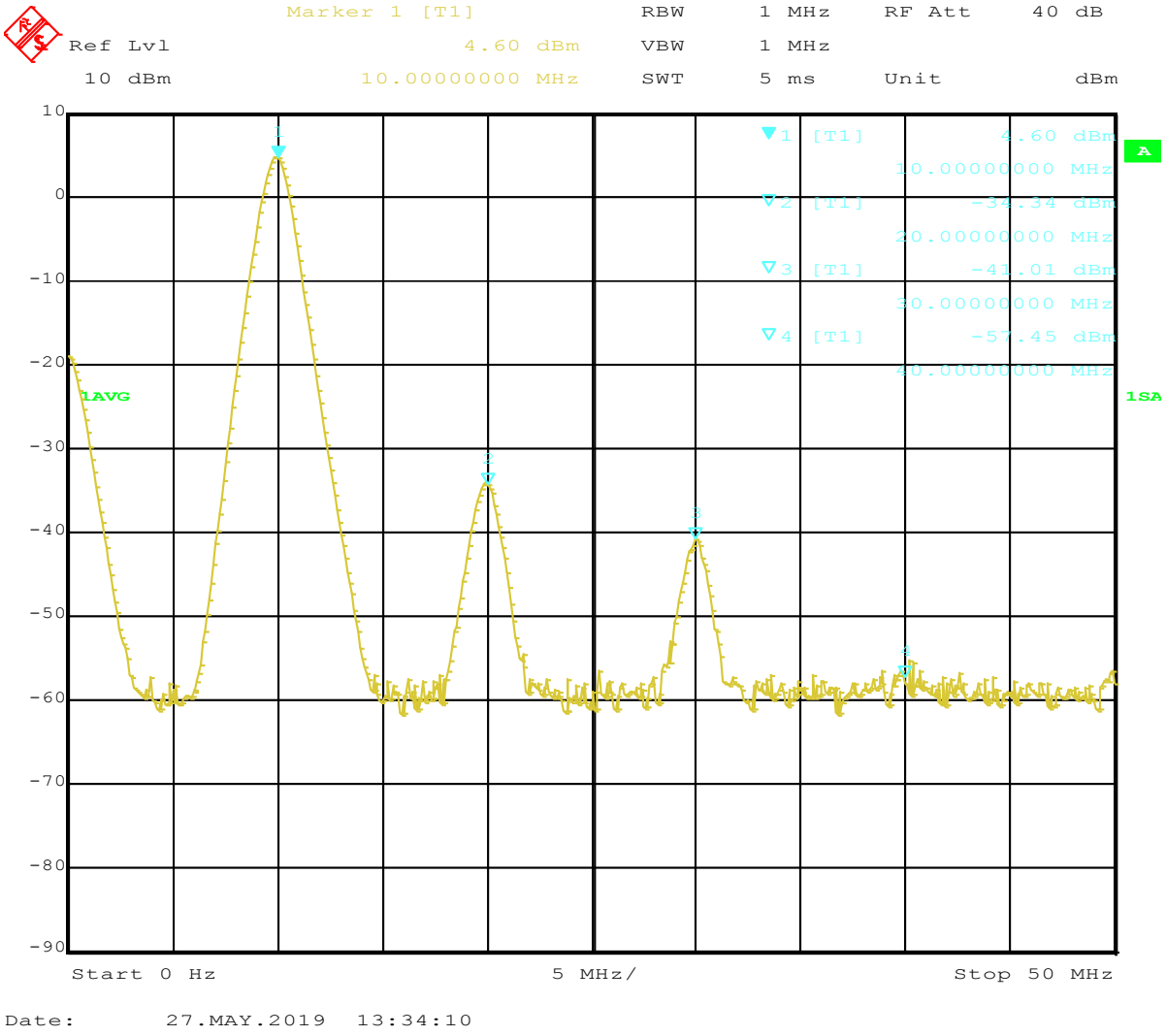
3.) Measuring the transfer characteristics with a spectrum analyser and tracking generator. Input power to the distribution unit was +0dBm, at the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 20 MHz. The input port "with filter" was used.



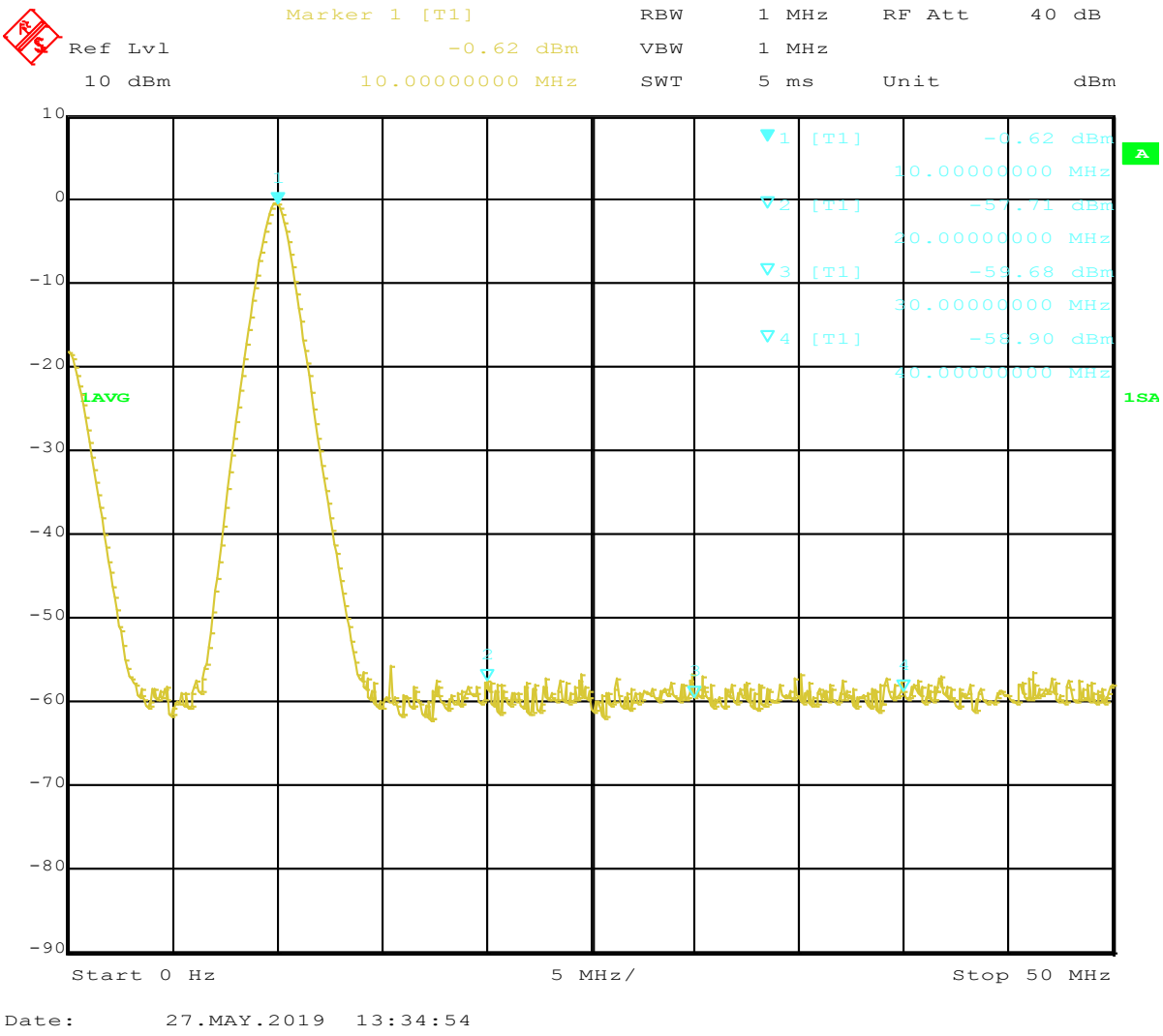
4.) Measuring the transfer characteristics with a spectrum analyser and tracking generator. Input power to the distribution unit was +0dBm, at the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 20 MHz. The input port "without filter" was used.



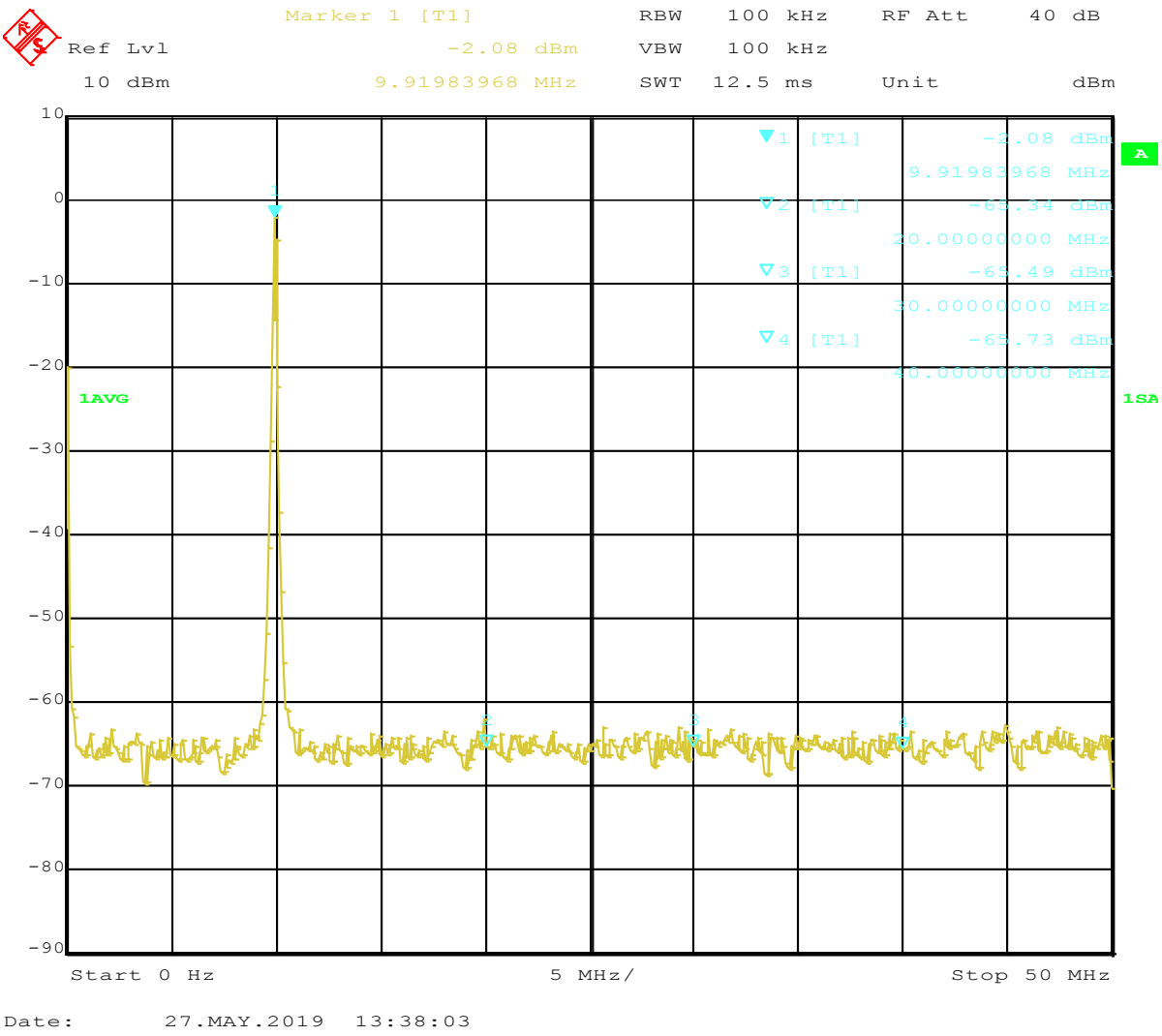
5.) Measuring the output spectrum of the distribution amplifier with a spectrum analyser. The 10 MHz signal was generated with a signal generator. The input signal to the distribution unit was +10dBm. At the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 50 MHz. The input port "<u>without filter</u>" was used.



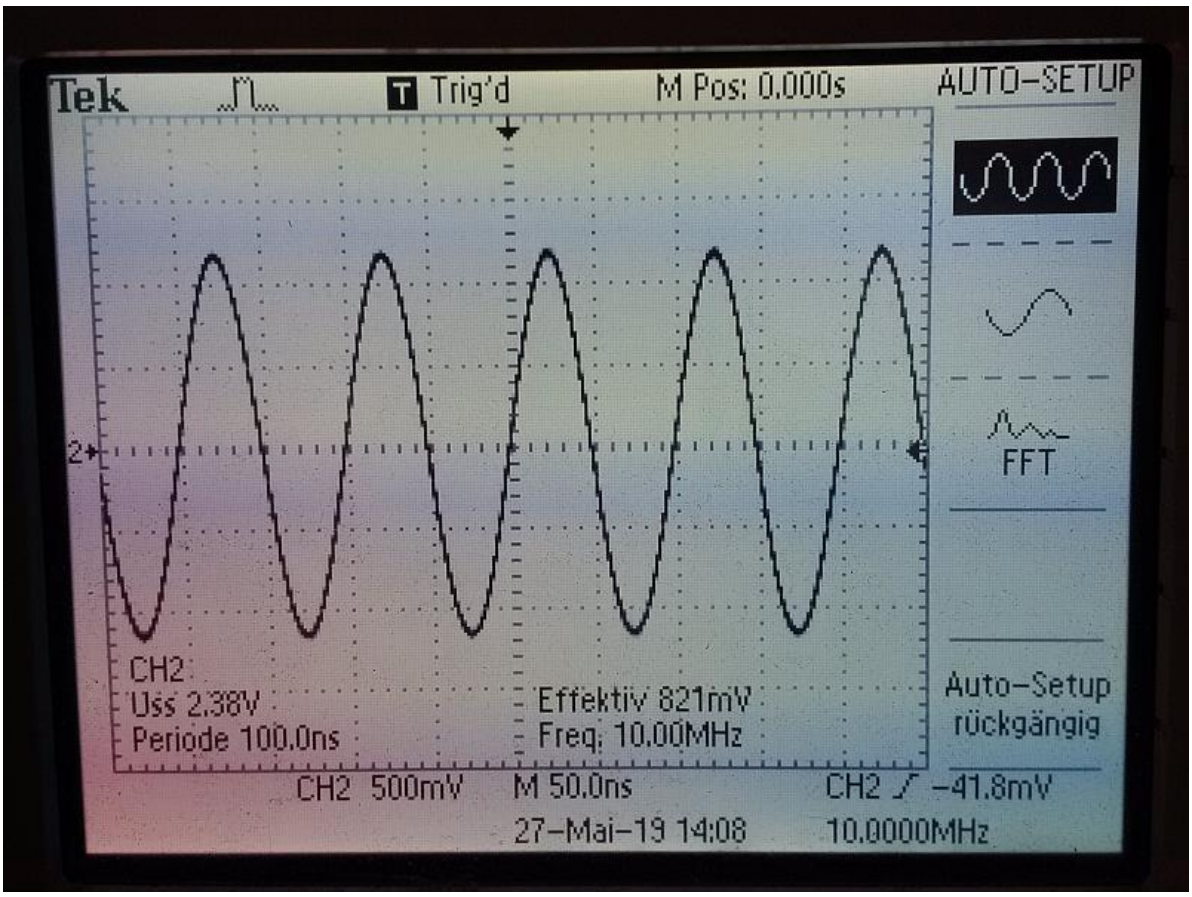
6.) Measuring the output spectrum of the distribution amplifier with a spectrum analyser. The 10 MHz signal was generated with a signal generator. The input signal to the distribution unit was +10dBm. At the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 50 MHz. The input port "with filter" was used.

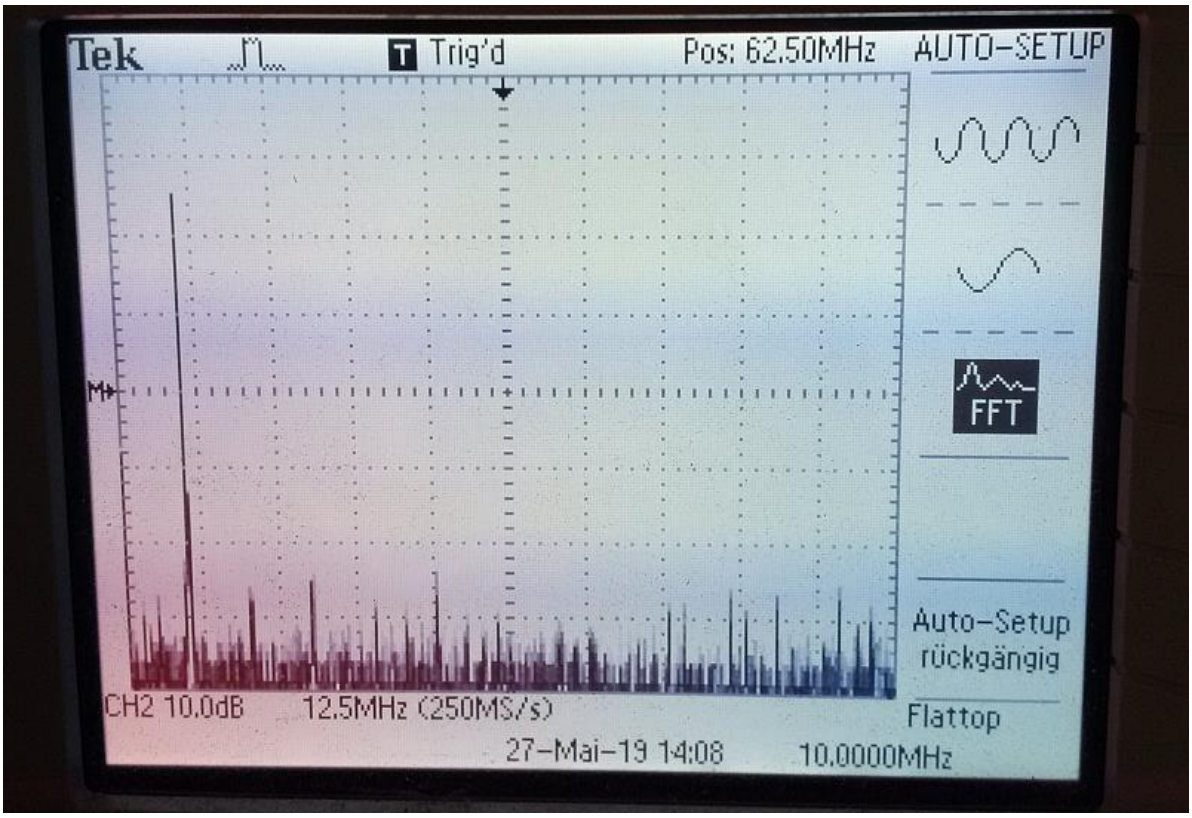


7.) Measuring the output spectrum of the distribution amplifier with a spectrum analyser. The 10 MHz signal was generated with a signal generator. The input signal to the distribution unit was +10dBm. At the output of the distribution unit was a 6dB attenuator to protect the spectrum analyser. There you have to add +6dB to the gain and output level.
This measurement was with a span of 50 MHz. The input port "with filter" was used. In order to lower the noise level of the analyser and thus increase the dynamic range the resolution bandwidth of the spectrum analyser was reduced from 2 MHz to 100kHz.

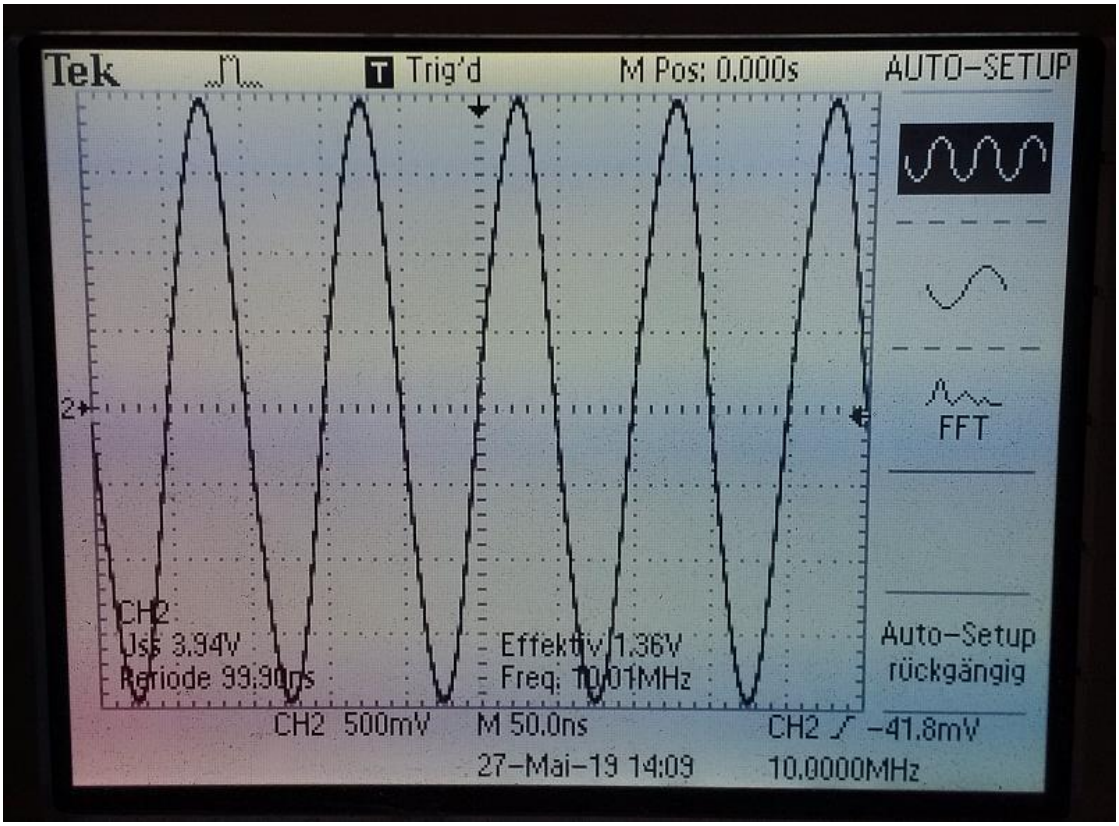


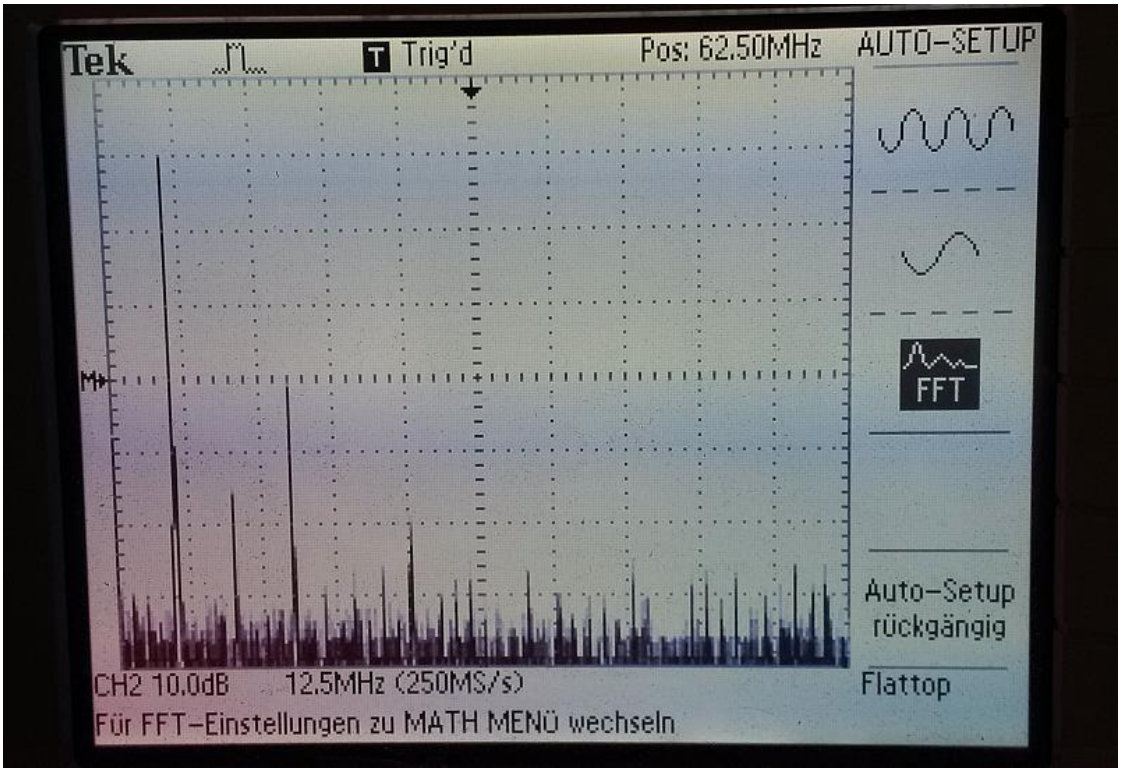
8.) This measurement was done with an oscilloscope with a bandwidth of 40 MHz. The input signal from the signal generator to the distribution unit was +10dBm. The input port "with filter" was used. You can see the time domain output signal and the FFT of the output signal.



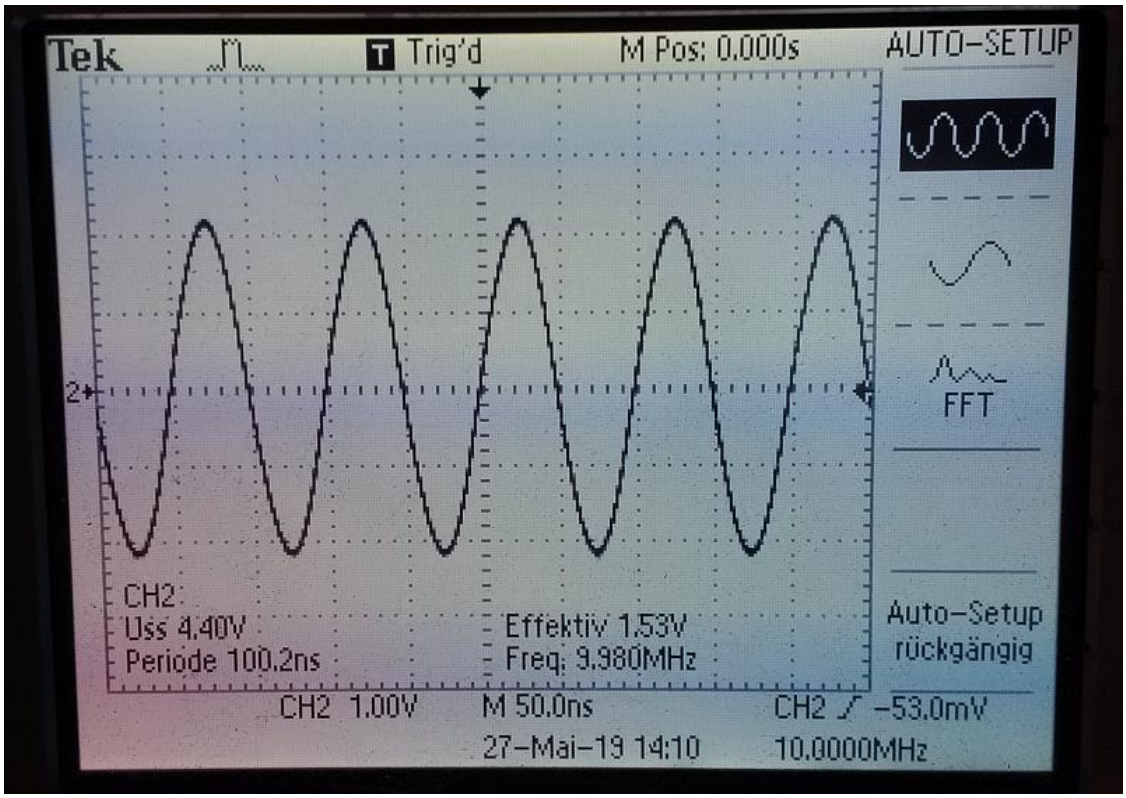


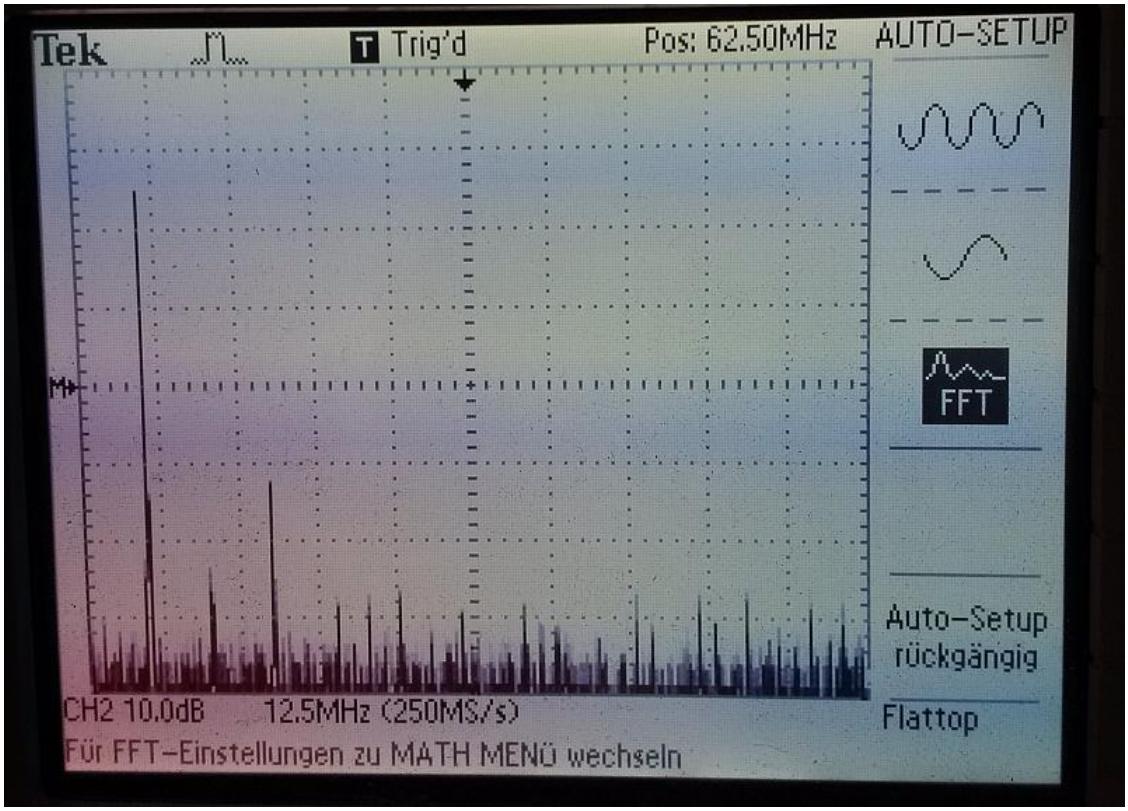
9.) This measurement was done with an oscilloscope with a bandwidth of 40 MHz. The input signal from the signal generator to the distribution unit was +10dBm. The input port "without filter" was used. You can see the time domain output signal and the FFT of the output signal.



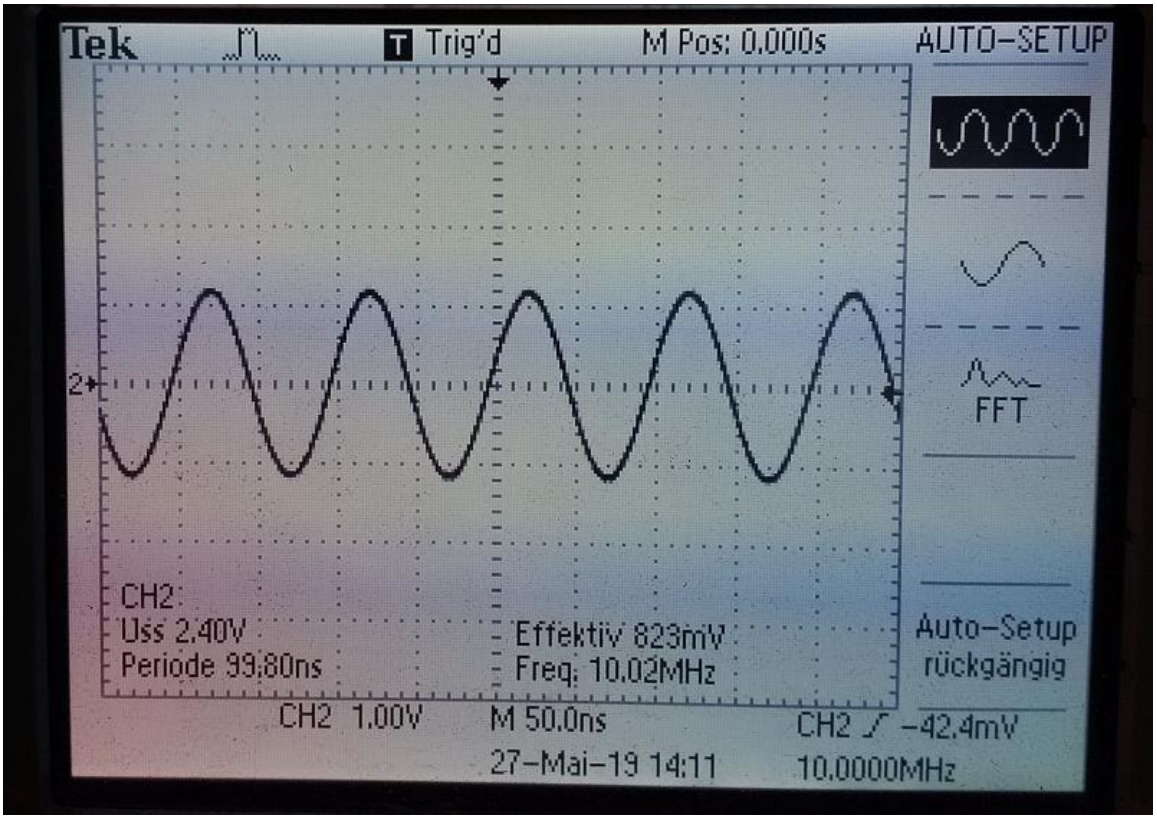


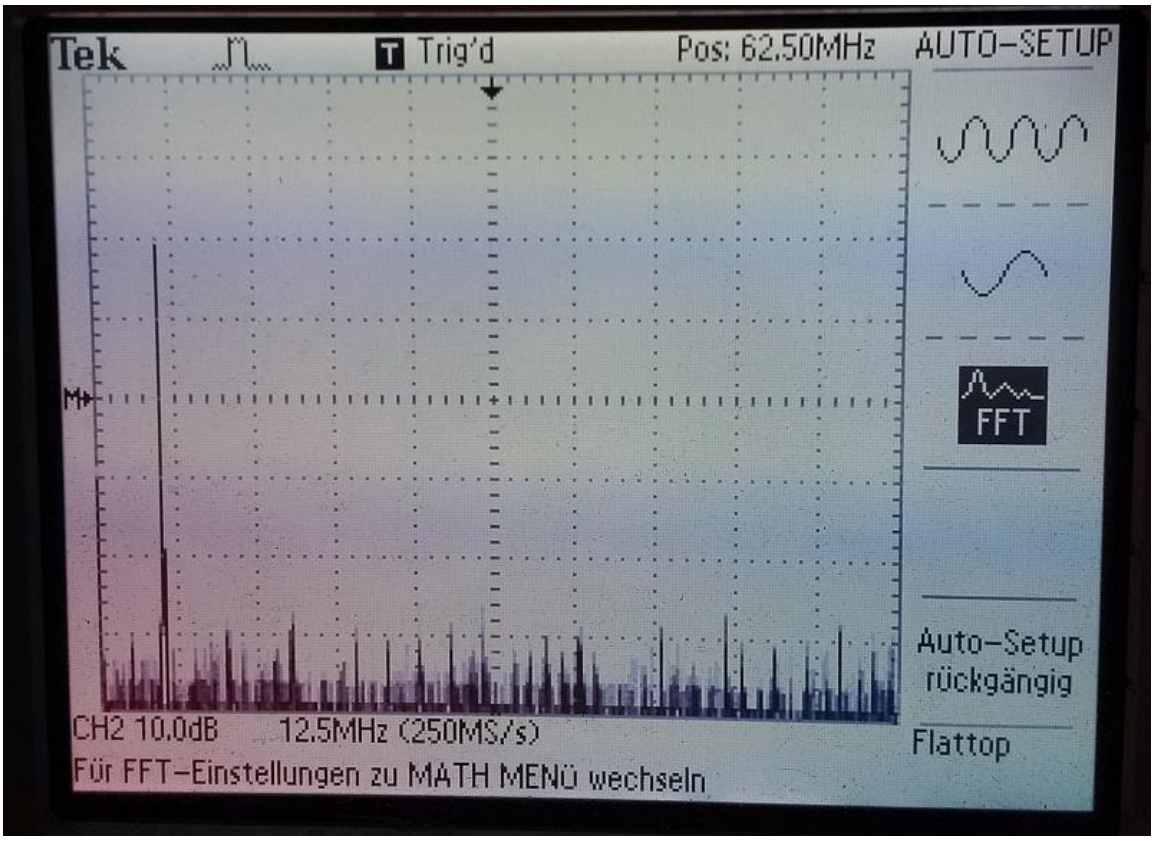
10.)This measurement was done with an oscilloscope with a bandwidth of 40 MHz. The input signal came from a GPSDO from Leo Bodnar. The output level of the GPSDO was set to its minimum level (8mA drive). The input port "without filter" was used. You can see the time domain output signal and the FFT of the output signal.



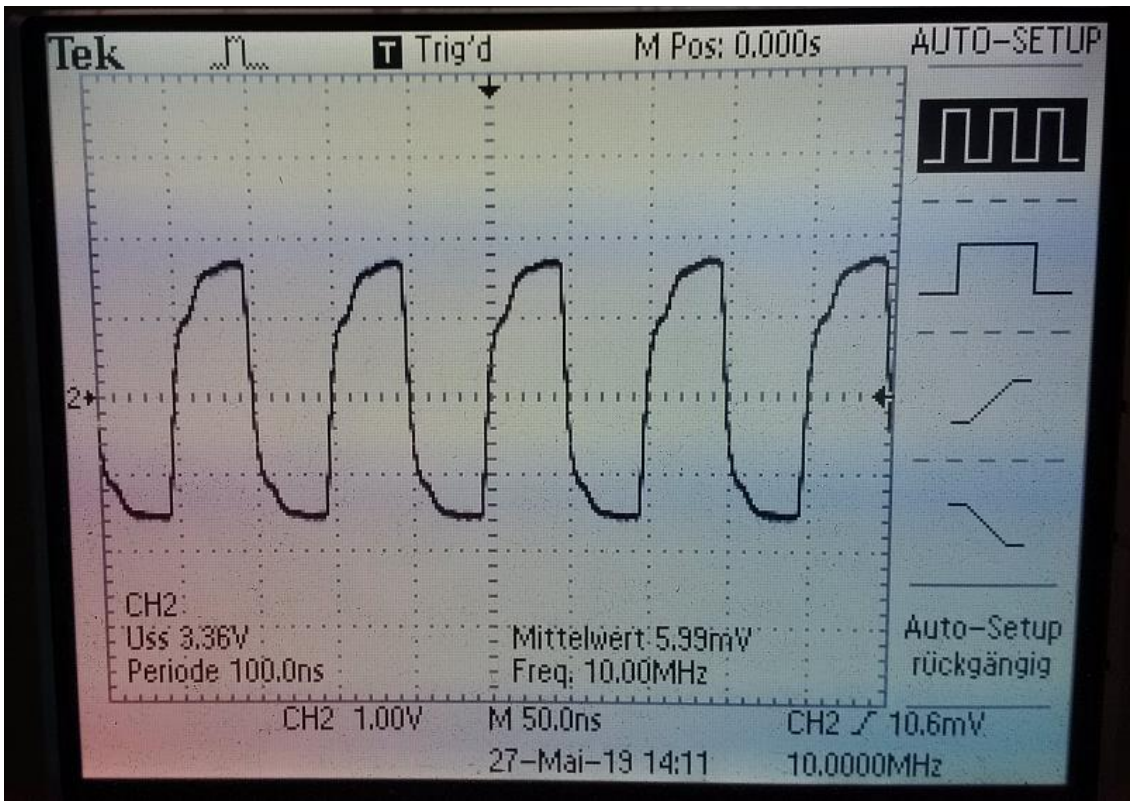


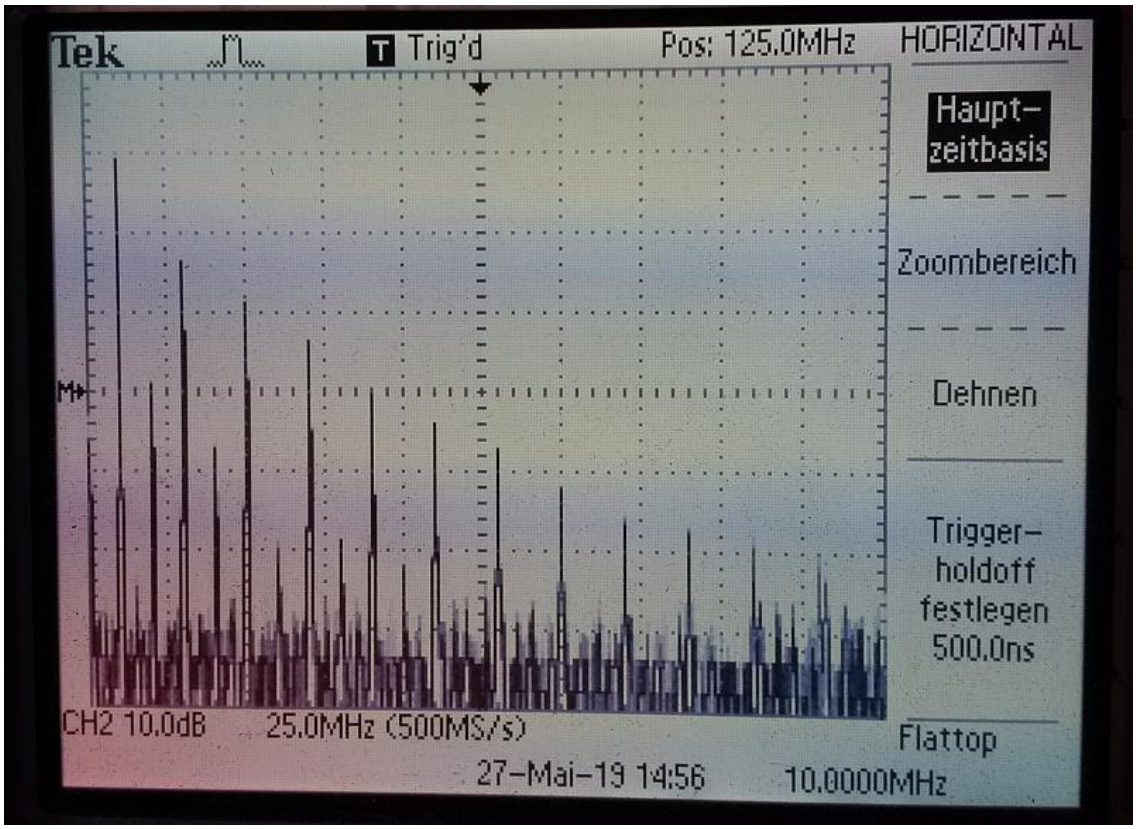
11.)This measurement was done with an oscilloscope with a bandwidth of 40 MHz. The input signal came from a GPSDO from Leo Bodnar. The output level of the GPSDO was set to its minimum level (8mA drive). The input port "with filter" was used. You can see the time domain output signal and the FFT of the output signal.





12.)This measurement was done with an oscilloscope with a bandwidth of 40 MHz. The output of the GPSDO from Leo Bodnar was measured (without the distribution unit inserted) in order to have a reference what the input signal in the previous measurements did look alike.





My assessment is that this distribution amplifier provides excellent results.

I would like to thank Marek SP4ELF for designing the board and providing me an assembled unit.

As always, I appreciate feedback or suggestions for improvements. I will also answer any questions.

Please send it to the Email address given below.

Kind regards

Matthias DD1US

Email: dd1us@amsat.org Homepage: www.dd1us.de