Pre-Amplifier SPA Series

- **External Pre-Amplifier for all A/D cards**
- **Low noise/high gain**
- **Allows to acquire smallest signals with high resolution**
- **7 different versions**
- **20 dB to 60 dB gain**
- **up to 2 GHz bandwidth**
- **AC/DC coupling**
- **Manual offset compensation (DC versions)**
- **No programming necessary**

General Information

Although all Spectrum A/D cards have a very powerful input section with a highly configurable input amplifier and a variety of input ranges it is sometimes necessary to have additional external amplifiers if the signal to acquire has an extremely low level. Spectrum offers a range of perfectly matching external amplifiers to cover such cases. These powerful amplifiers have been rated using the Spectrum cards and offer best performance together with high amplification rates.

The amplifiers are simply connected between the signal source and the Spectrum A/D card input and can be manually switched between different settings using small lever keys. All amplifiers with DC coupling allow the offset compensation by trimming a potentiometer.

Bandwidth

For optimum signal-to-noise performance choose an amplifier with sufficient bandwidth corresponding to the required signal bandwidth. However, keep in mind that unnecessary high bandwidth introduces more wide-band noise. Therefore, Spectrum offers SPA Voltage Amplifiers with four different upper cut-off frequencies to match individual measurement requirements. The bandwidth remains constant when switching between the different gain settings which is very important for measuring fast signals and pulses.

True DC with zero output offset

True DC-Coupling is extremely important for accurate pulse amplification and analysis especially when different pulse lengths occur like in digital codes or transients with micro- to millisecond duration. If the amplifier is AC coupled or has a large output offset to be decoupled by the AC setting of the digitizer there will be significant undershoots and baseline shifts in the measurements. Therefore, all SPA Amplifiers below 1 GHz offer a true DC coupling and an adjustable output offset control even with the 500 MHz model.

Very low Input Noise

Low input noise is very important for a good signal-to-noise ratio, especially when amplifying small signals. All SPA Amplifiers are optimized for minimum input noise reaching excellent values as low as 0.9 nV/√Hz.

Order and Delivery Information

The SPA amplifier is delivered with an external power supply. The power supply covers 100 to 240 VAC with 50 to 60 Hz.

The SPA amplifier has either female BNC connectors or female SMA connectors on both the input and output. The connector type depends on the type of amplifier.

Please be sure to order an adapter cable that has a matching connector for the purchased amplifier and a matching connector type for your A/D cards input.

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13.9.2023

Technical Data

Model	SPA.1841	SPA.1801	SPA.1601	SPA.1412	SPA.1411	SPA.1232	SPA.1231
Lower cut-off frequency	10 kHz	10 kHz	DC	DC / 1 Hz	DC / 1 kHz	DC / 1 Hz	DC / 1 kHz
Upper cut-off frequency	2.2 GHz	2.5 GHz	500 MHz	200 MHz	200 MHz	10 MHz	10 MHz
Rise/Fall Time 10-90%	160 ps	140 ps	750 ps	1.8 ns	1.8 ns	35 ns	35 ns
Gain (dB) Gain (amplification)	40 dB x100	20 dB x10	20 dB x10	20/40 dB x10/x100	20/40 dB x10/x100	40/60 dB x100/x1000	40/60 dB x100/x1000
Gain Accuracy	±1.0 dB	±1.0 dB	±0.2 dB	±0.2 dB	±0.2 dB	±0.2 dB	±0.2 dB
Input Volt.Noise (20 dB)	n.a.	0.7 nV/√Hz	3.0 nV/√Hz	4.5 nV/√Hz	1.2 nV/√Hz	n.a.	n.a.
Input Volt.Noise (40 dB)	0.7 nV/√Hz	n.a.	n.a.	5.5 nV/√Hz	3.5 nV/√Hz	4.7 nV/√Hz	1.8 nV/√Hz
Input Volt.Noise (60 dB)	n.a.	n.a.	n.a.	n.a.	n.a.	4.7 nV/√Hz	0.9 nV/√Hz
Input Bias Current	n.a.	n.a.	15 µA typ	10 pA	20 µA	2 pA	18 µA typ.
Input Offset Voltage	n.a.	n.a.	1 mV typ	500 uV typ	500 uV typ	250 uV max	500 uV max
Input Voltage Drift	n.a.	n.a.	10 uV/°C	5 uV/°C	1 uV/°C	2 uV/°C	1 uV/°C
Input Impedance	50 Ω	50 Ω	50 Ω	1 MΩ	50 Ω	1 MΩ	50 Ω
Input Capacitance			3 pF	15 pF	12 pF	15 pF	12 pF
Max Input Voltage	±3 V				±5 V		
Max Output Voltage in 1 MΩ	±4 V				±4 V		
Max Output Voltage in 50 Ω	±1.9 V				±1.9 V		
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω
Output Termination Recommendation	terminate with 50 Ω load			terminate with 50 Ω load for best performance			
Output Offset Trimmer Range	n.a.	n.a.	±100 mV	±100 mV	±100 mV	±500 mV	±500 mV
Connection Type	SMA female		BNC female				
Dimension	54 mm x 43 mm x 22 mm		94 mm x 51 mm x 27 mm				
Weight	100 grams		200 grams				

Measuring Results 2 GHz bandwidth

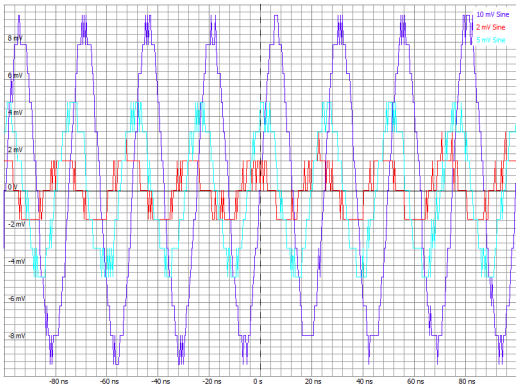
These measurements have been taken using a M4i.2220-x8 (1 channel 8 bit 2.5 GS/s digitizer with 1.5 GHz bandwidth) from series production. For the dynamic parameter measurements a pure sine wave signal from a RF signal generator in combination with a matching 7th order low pass filter (10 MHz and 600 MHz plots) was used. For reference the same measuring results with and without the amplifier are shown.

Results shown here are typical values which may vary from card to card and may depend on the environment.

Dynamic Params 40 MHz sine signal

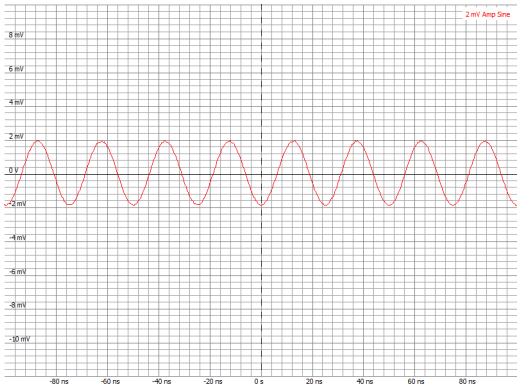
	Plain Card	Plain Card	With Amplifier
Test Signal	200 mV Sine	2 mV Sine	2 mV Sine
Input Range	+/-200 mV	+/-200 mV	+/-200 mV
SNR	46.1 dB	7.6 dB	35.4 dB
THD	-55.5 dB	-18.7 dB	-48.6 dB
SFDR	58.0 dB	23.1 dB	59.2 dB
ENOB (SINAD)	7.3 bit	0.9 bit	5.6 bit
Test Signal	500 mV Sine	5 mV Sine	5 mV Sine
Input Range	+/-500 mV	+/-200 mV	+/-500 mV
SNR	46.1 dB	14.1 dB	41.8 dB
THD	-55.8 dB	-29.0 dB	-51.0 dB
SFDR	58.6 dB	31.9 dB	53.1 dB
ENOB (SINAD)	7.3 bit	2.0 bit	6.6 bit
Test Signal	1000 mV Sine	10 mV Sine	10 mV Sine
Input Range	+/-1 V	+/-200 mV	+/-1 V
SNR	46.1 dB	20.0 dB	44.7 dB
THD	-55.6 dB	33.9 dB	-45.9 dB

2 mV, 5 mV and 10 mV sine signal without amplifier5



	Plain Card	Plain Card	With Amplifier
SFDR	59.8 dB	36.7 dB	46.5 dB
ENOB (SINAD)	7.3 bit	3.0 bit	6.7 bit

2 mV sine signal with SPA.1841 amplifier

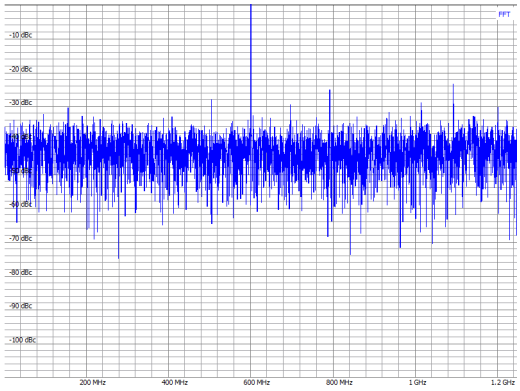


Dynamic Params 600 MHz sine signal

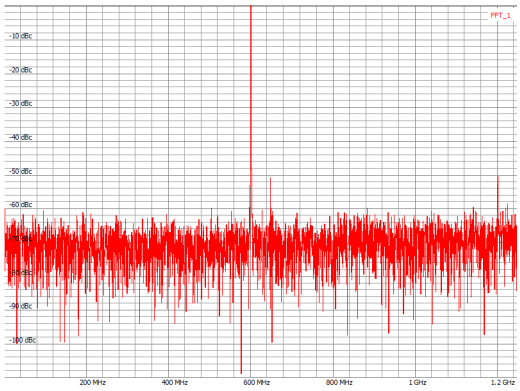
	Plain Card	Plain Card	With Amplifier
Test Signal	200 mV Sine	2 mV Sine	2 mV Sine
Input Range	+/-200 mV	+/-200 mV	+/-200 mV
SNR	43.9 dB	7.9 dB	35.4 dB
THD	-45.6 dB	-20.2 dB	-46.8 dB
SFDR	46.3 dB	23.5 dB	50.5 dB
ENOB (SINAD)	6.6 bit	1.0 bit	5.5 bit
Test Signal	500 mV Sine	5 mV Sine	5 mV Sine
Input Range	+/-500 mV	+/-200 mV	+/-500 mV
SNR	44.0 dB	15.9 dB	41.4 dB
THD	-48.1 dB	-29.0 dB	-51.6 dB
SFDR	48.9 dB	32.1 dB	51.4 dB
ENOB (SINAD)	6.8 bit	2.3 bit	6.5 bit
Test Signal	1000 mV Sine	10 mV Sine	10 mV Sine
Input Range	+/-1 V	+/-200 mV	+/-1 V
SNR	44.4 dB	21.0 dB	43.6 dB
THD	-47.4 dB	34.7 dB	-48.4 dB
SFDR	47.8 dB	36.8 dB	52.0 dB
ENOB (SINAD)	6.8 bit	3.2 bit	6.8 bit

FFT plot in dBC

2 mV sine signal, no amplifier



2 mV sine signal with SPA.1841 amplfier



RMS Input Noise Level (Open Inputs)

Input Range	Plain Card M4i.2220-x8		Amplifier SPA.1841 (40 dB)	
+/-200 mV	0.31 LSB	0.24 mV	1.29 LSB	1.01 mV
+/-500 mV	0.42 LSB	0.82 mV	0.65 LSB	1.27 mV
+/-1 V	0.35 LSB	1.37 mV	0.47 LSB	1.84 mV
+/-2.5 V	0.26 LSB	2.54 mV	0.30 LSB	2.93 mV

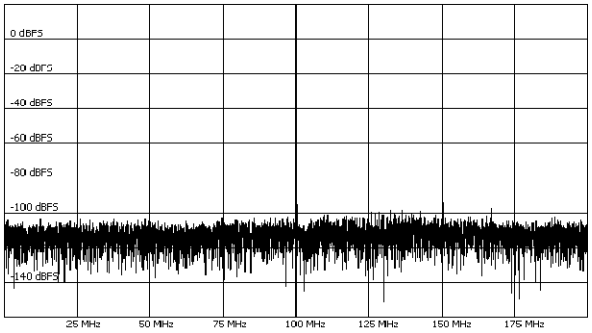
Measuring Results 200 MHz bandwidth

These measurings have been taken using a M3i.4140 (1 channel 14 bit 400 MS/s digitizer with 200 MHz bandwidth) from series production. All measurings have been done using the +/-500 mV input range with 50 Ohm termination. The amplifer was also connected to this input range. For the dynamic paramter measurements a pure sine wave signal from a RF signal generator in combination with a matching 7th order low pass filter (1 MHz and 9 MHz plots) was used. For reference the same measuring results with and without the amplifier are shown.

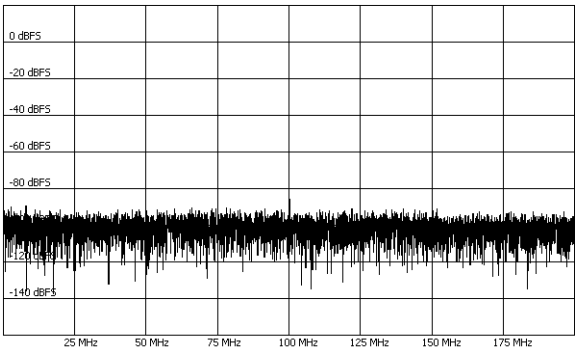
Results shown here are typical values which may vary from card to card and may depend on the environment.

Input Noise Level (Open Inputs)

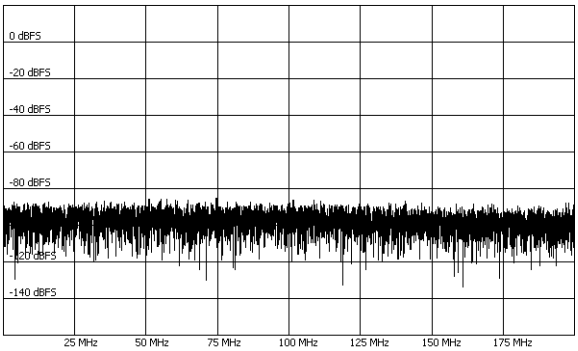
Card with no amplifier ->±500 mV input



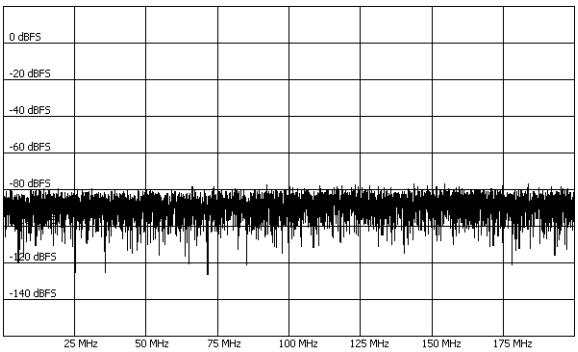
Card with SPA.1411 (200 MHz, 50Ω amp), 20 dB -> ±50 mV input



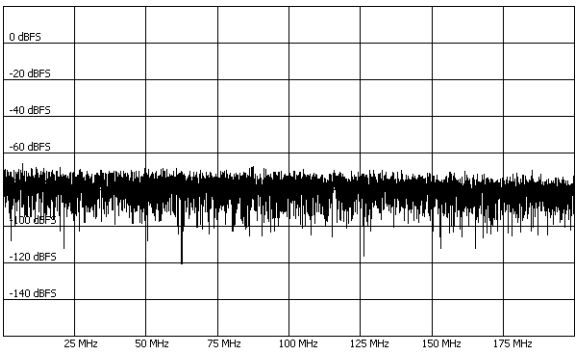
Card with SPA.1411 (200 MHz, 1MΩ amp), 20 dB -> ±50 mV input



Card with SPA.1411 (200 MHz, 50Ω amp), 40 dB ->±5 mV input

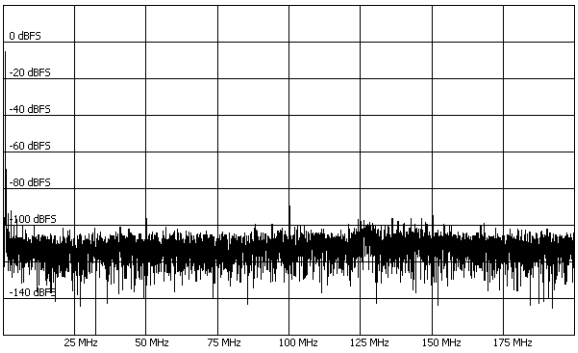


Card with SPA.1411 (200 MHz, 1MΩ amp), 40 dB ->±5 mV input

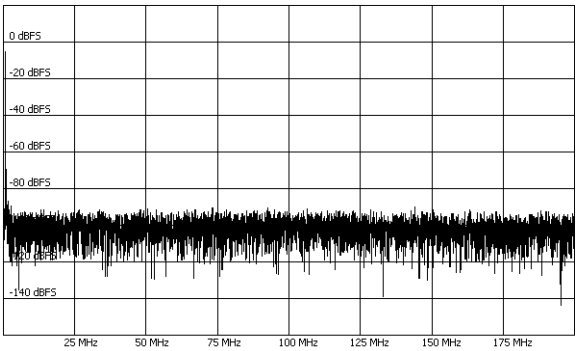


1 MHz sine wave signal with 95% output level

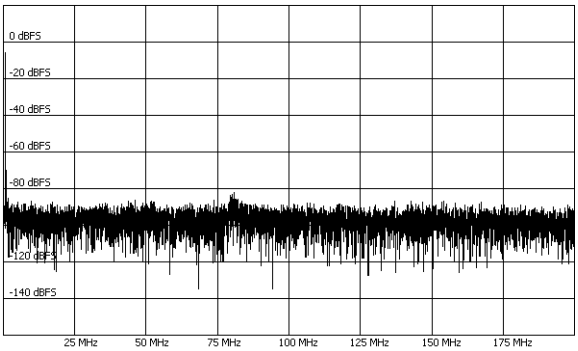
Card with no amplifier ->±500 mV input
SNR = 66.7 dB, THD = -80.6 dB, ENOB = 10.8 LSB



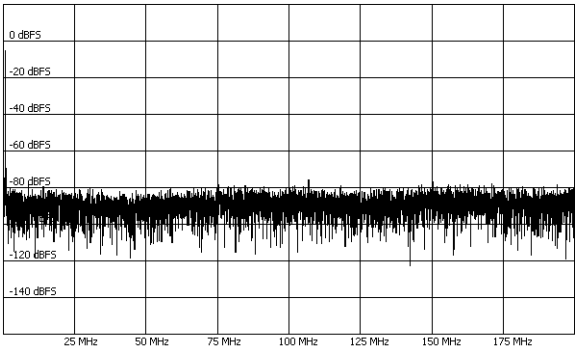
Card with SPA.1411 (200 MHz, 50Ω amp), 20 dB ->±50 mV input
SNR = 56.7 dB, THD = -72.4 dB, ENOB = 9.1 LSB



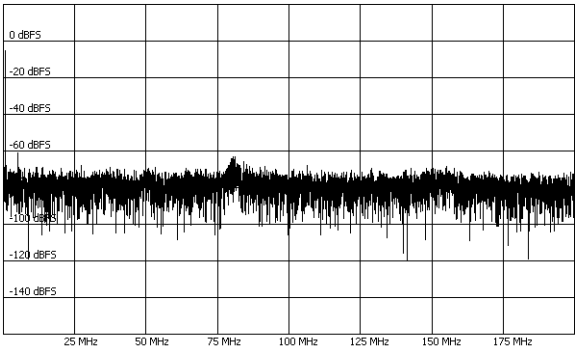
Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±50 mV input
SNR = 52.4 dB, THD = -67.1 dB, ENOB = 8.4 LSB



Card with SPA.1411 (200 MHz, 50Ω amp), 40 dB ->±5 mV input
SNR = 44.5 dB, THD = -61.2 dB, ENOB = 7.1 LSB

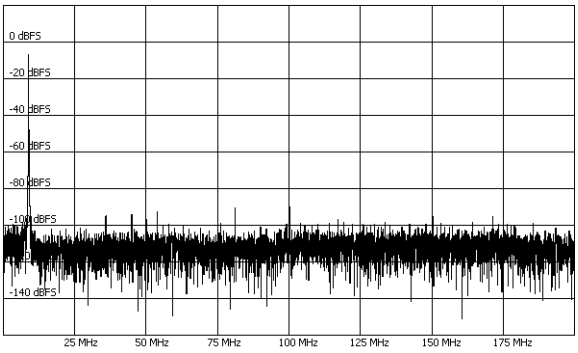


Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±5 mV input
SNR = 34.4 dB, THD = -50.0 dB, ENOB = 5.4 LSB

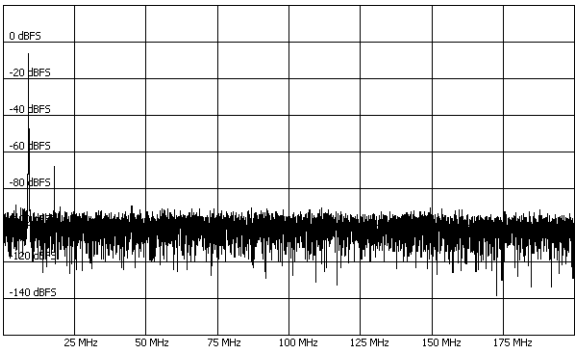


9 MHz sine wave signal with 95% output level

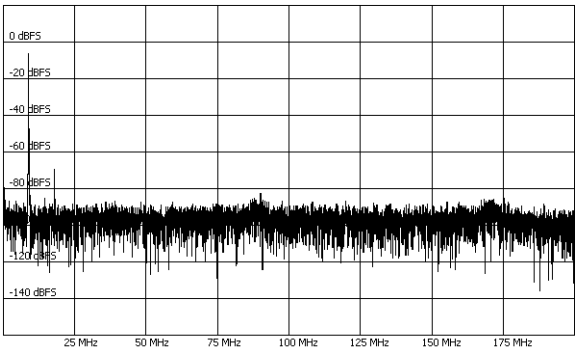
Card with no amplifier ->±500 mV input
SNR = 65.9 dB, THD = -81.8 dB, ENOB = 10.6 LSB



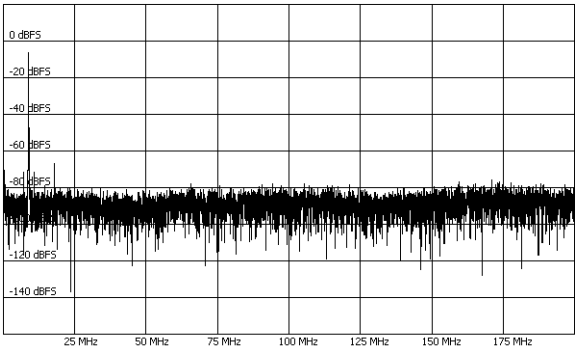
Card with SPA.1411 (200 MHz, 50Ω amp), 20 dB ->±50 mV input
SNR = 56.1 dB, THD = -60.9 dB, ENOB = 9.0 LSB



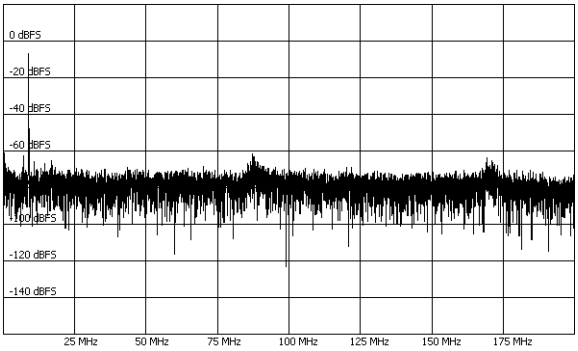
Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±50 mV input
SNR = 52.0 dB, THD = -61.0 dB, ENOB = 8.3 LSB



Card with SPA.1411 (200 MHz, 50Ω amp), 40 dB ->±5 mV input
SNR = 44.0 dB, THD = -59.0 dB, ENOB = 7.0 LSB

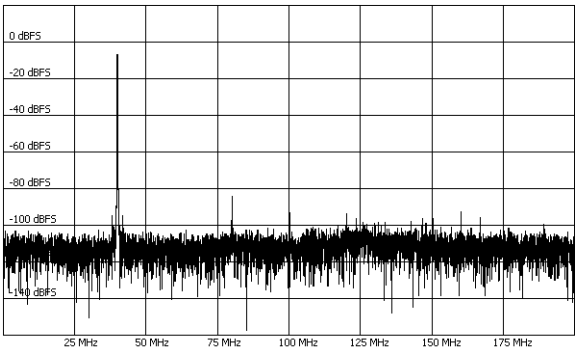


Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±5 mV input
SNR = 33.4 dB, THD = -49.3 dB, ENOB = 5.3 LSB

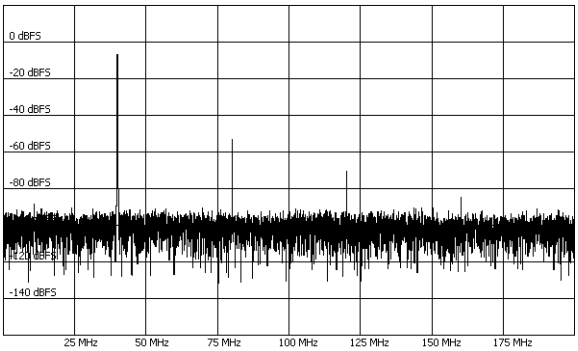


40 MHz sine wave signal with 95% output level

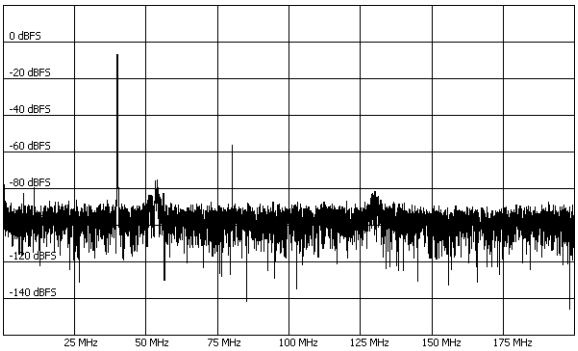
Card with no amplifier ->±500 mV input
SNR = 66.2 dB, THD = -72.8 dB, ENOB = 10.7 LSB



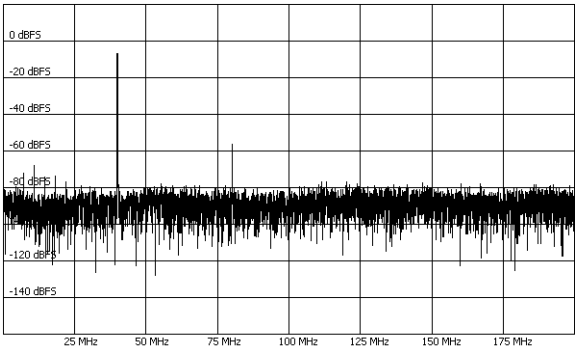
Card with SPA.1411 (200 MHz, 50Ω amp), 20 dB ->±50 mV input
SNR = 56.0 dB, THD = -47.0 dB, ENOB = 9.0 LSB



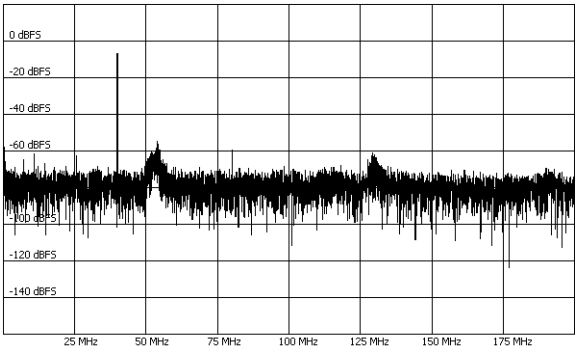
Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±50 mV input
SNR = 51.1 dB, THD = -50.1 dB, ENOB = 8.2 LSB



Card with SPA.1411 (200 MHz, 50Ω amp), 40 dB ->±5 mV input
SNR = 43.6 dB, THD = -49.8 dB, ENOB = 6.9 LSB



Card with SPA.1412 (200 MHz, 1MΩ amp), 20 dB ->±5 mV input
SNR = 31.9 dB, THD = -49.4 dB, ENOB = 5.0 LSB



Order Information

Amplifiers

Order no.	Bandwidth	Connection	Input Impedance	Coupling	Amplification
SPA.1841 [2]	2 GHz	SMA	50 Ohm	AC	x100 (40 dB)
SPA.1801 [2]	2 GHz	SMA	50 Ohm	AC	x10 (20 dB)
SPA.1601 [2]	500 MHz	BNC	50 Ohm	DC	x10 (20 dB)
SPA.1412 [2]	200 MHz	BNC	1 MOhm	AC/DC	x10/x100 (20/40 dB)
SPA.1411 [2]	200 MHz	BNC	50 Ohm	AC/DC	x10/x100 (20/40 dB)
SPA.1232 [2]	10 MHz	BNC	1 MOhm	AC/DC	x100/x1000 (40/60 dB)
SPA.1231 [2]	10 MHz	BNC	50 Ohm	AC/DC	x100/x1000 (40/60 dB)
Information	External Amplifiers with one channel, BNC/SMA female connections on input and output, manually adjustable offset, manually switchable settings. An external power supply for 100 to 240 VAC is included. Please be sure to order an adapter cable matching the amplifier connector type and matching the connector type for your A/D card input.				

[1] : Just one of the options can be installed on a card at a time.
[2] : Third party product with warranty differing from our export conditions. No volume rebate possible.