

PRODUCT DESCRIPTION

Managing Noise Levels in the ACS704 Current Sensor

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INTRODUCTION

The minimum current that can be resolved by the ACS704 current sensor is limited by the noise present in the output of the sensor.

Resolution can be improved by the addition of an external filter on the sensor output. However, such filtering limits the bandwidth and response time of the sensor.



This application note is a guide to evaluating the trade-off of resolution versus response time when using the ACS704 current sensor.

NOISE SOURCES AND ON-BOARD FILTERING

In order to reduce the temperature drift of offset in the sensor, the axis of operation of the Hall element on the die is switched 90 degrees at a rate of 200 to 250 kHz. This “chopper” circuit is the source of most of the noise in the sensor output. Another source is “shot” noise in the Hall element, which is very similar to the shot noise characteristic of a resistor.

The ACS704 has a 50 kHz on-board filter to reduce this noise on its output signal. Due to the relatively loose tolerances to which resistors and capacitors can be fabricated on semiconductor die, the tolerance of the on-board filter is $\pm 30\%$. With only this on-board filter, the minimum resolvable current of an ACS704 is ≈ 700 mA.

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IMPROVING RESOLUTION AND NOISE PERFORMANCE

The filtering tolerances achievable using discrete external filters can be much tighter than the tolerances available with on-board filters. An external filter with a lower roll-off value than the on-board filter lowers noise and improves the available

resolution. This is, however, at the cost of reducing the bandwidth and response time of the solution.

The following table shows the noise reduction, resolution, bandwidth, and response time tradeoffs that are produced by various values of external filters. Filtering the output of the ACS704 below the minimum values in this table does not produce further improvements in current resolution.

ACS704 Noise Filtering, RC Filter Values, and Frequency Response Performance

Break Frequency of Filter (kHz)	Resistance (Ω)	Capacitance (μF)	Nominal Programmed Sensitivity (mV/A)	Filtered Peak-to-Peak Noise (mV)	Resolution with Filtering (A)	Rise Time for 12 A Step, Filtered (μs)
ACS704ELC-015						
Unfiltered	–	–	100	75	~0.75	8
50	320	0.01		46	~0.46	10
40	392	0.01		43	~0.43	12
10	1500	0.01		24	~0.25	35
5.0	3150	0.01		17	~0.17	70
3.3	4800	0.01		12	~0.12	100
ACS704ELC-005						
Unfiltered	–	–	133	90	~0.67	8
50	320	0.01		55	~0.42	10
40	392	0.01		47	~0.35	12.5
10	1500	0.01		26	~0.20	35
5.0	3150	0.01		20	~0.15	71
3.3	4800	0.01		13	~0.10	100

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EXPERIMENTAL RESULTS: ACS704ELC-015

The ACS704ELC-015 was mounted on an evaluation PCB and connected with various RC filter

combinations. Its response to a 12 A step and its peak-to-peak output voltage noise was measured for each combination. The results are shown in figures 1–6.

Figure 1. ACS704ELC-015: No external filtering

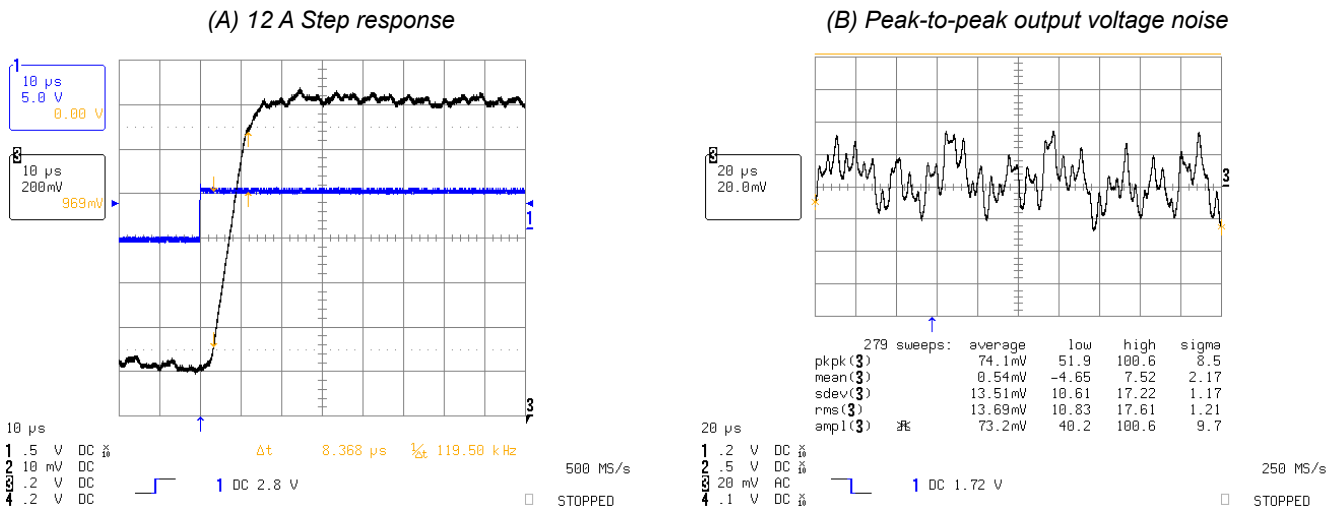
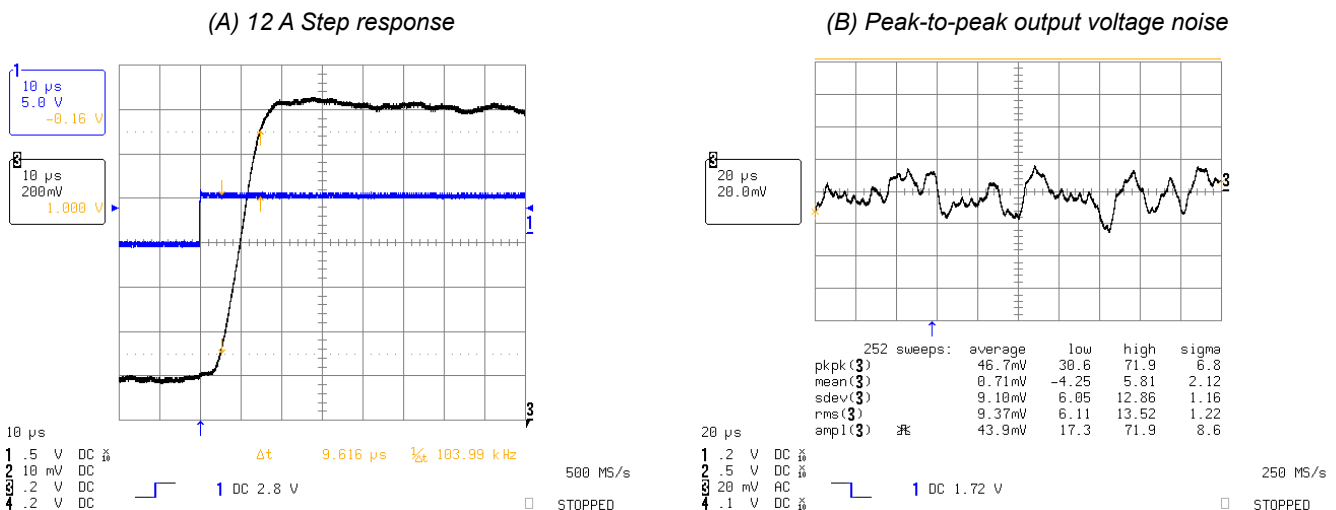


Figure 2. ACS704ELC-015: 50 kHz External Filter with 320 Ω resistor and 0.01 μF capacitor



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Figure 3. ACS704ELC-015: 40 kHz External Filter with 392 Ω resistor and 0.01 μ F capacitor

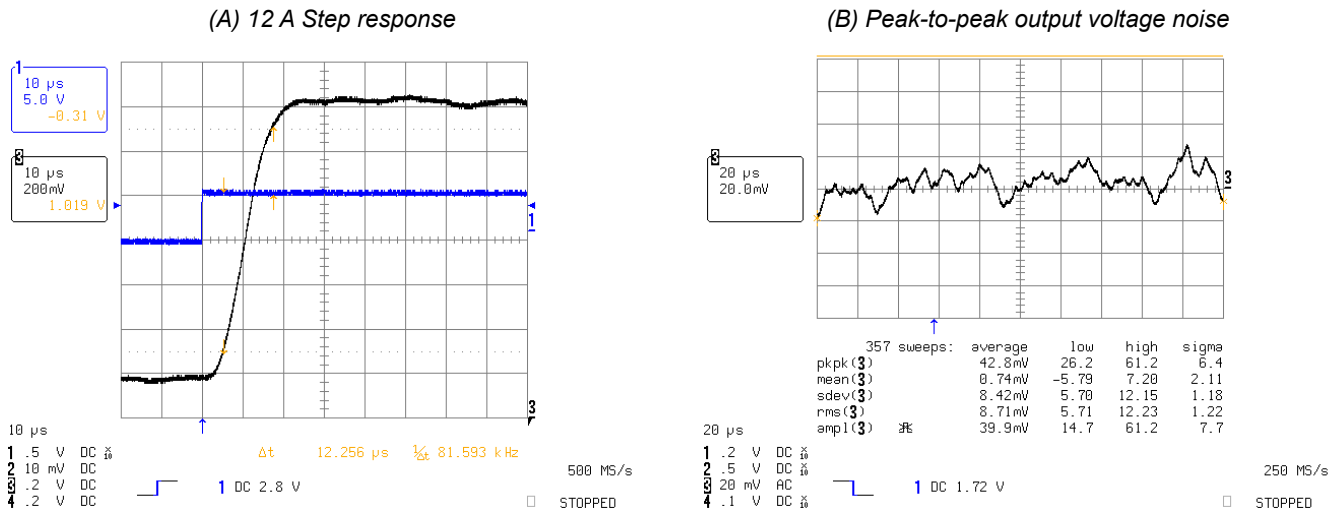
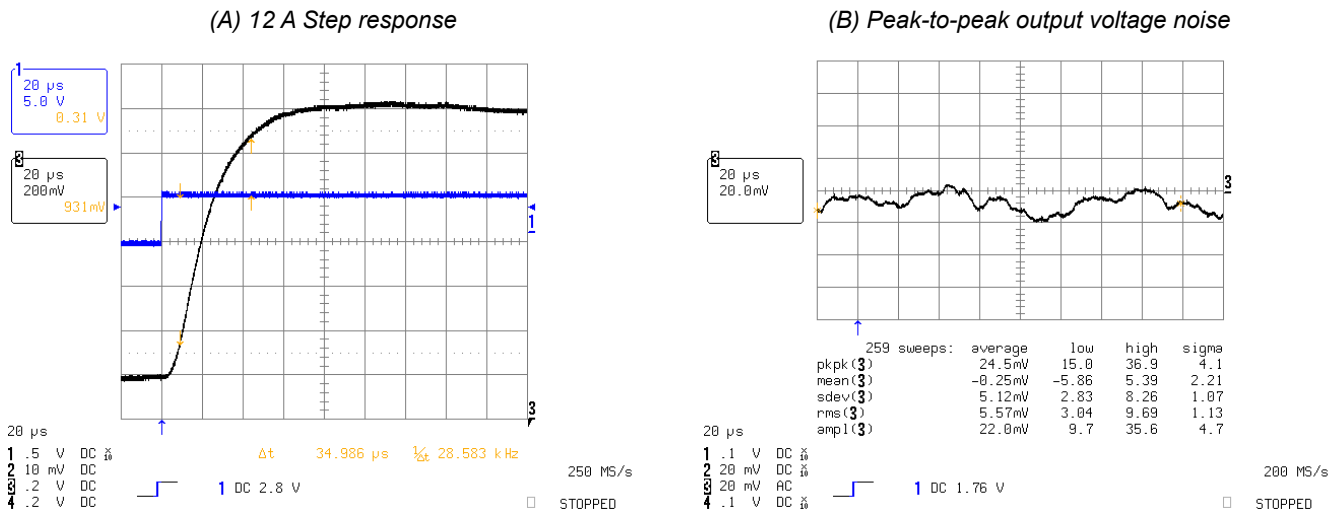


Figure 4. ACS704ELC-015: 10 kHz External Filter with 1500 Ω resistor and 0.01 μ F capacitor



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Figure 5. ACS704ELC-015: 5 kHz External Filter with 3150 Ω resistor and 0.01 μF capacitor

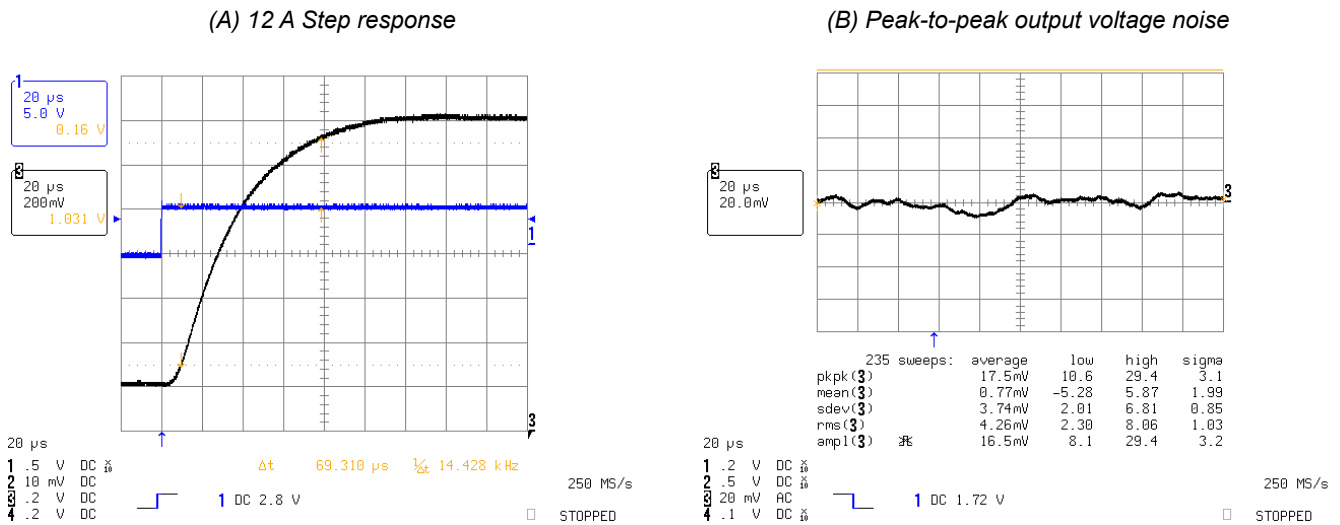
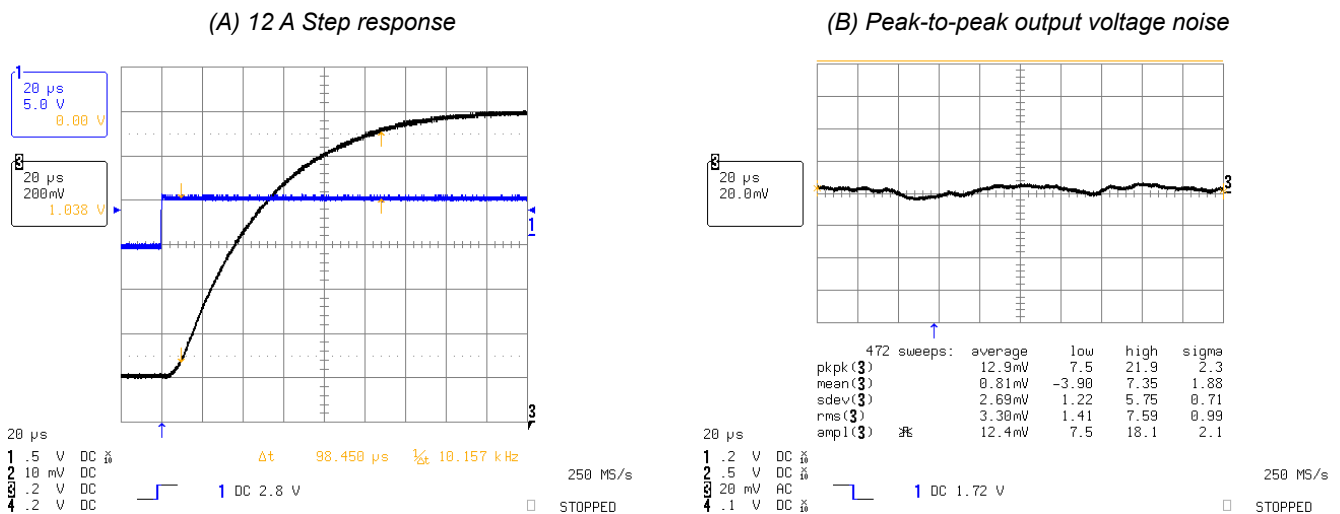


Figure 6. ACS704ELC-015: 3.3 kHz External Filter with 4800 Ω resistor and 0.01 μF capacitor



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EXPERIMENTAL RESULTS: ACS704ELC-005

The ACS704ELC-015 was mounted on an evaluation PCB and connected with various RC filter

combinations. Its response to a 12 A step and its peak-to-peak output voltage noise was measured for each combination. The results are shown in figures 7–12.

Figure 7. ACS704ELC-005: No external filtering

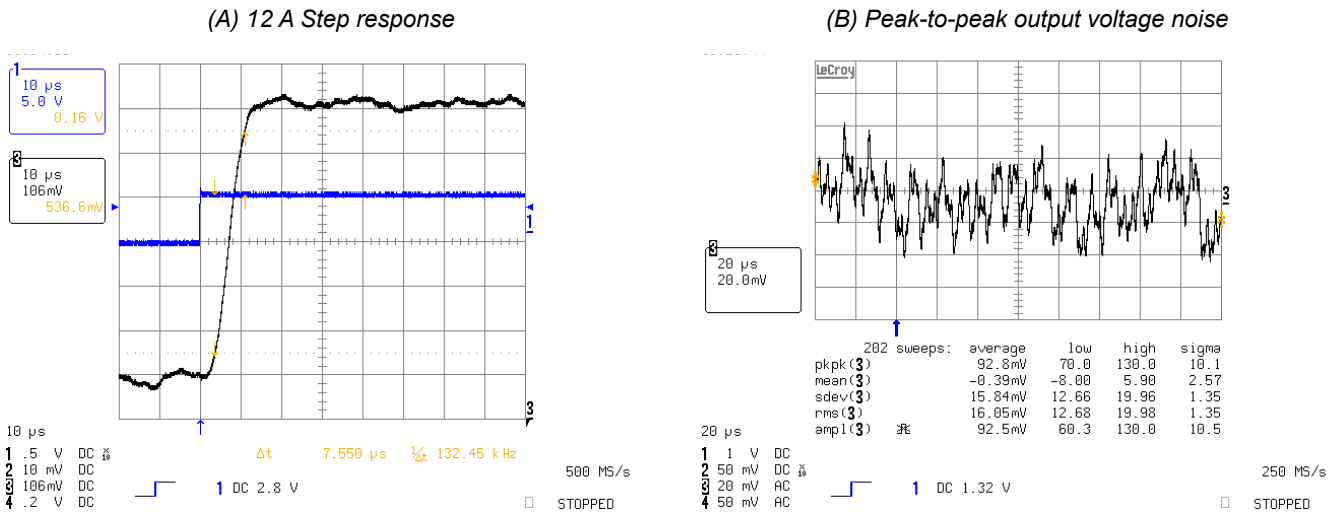
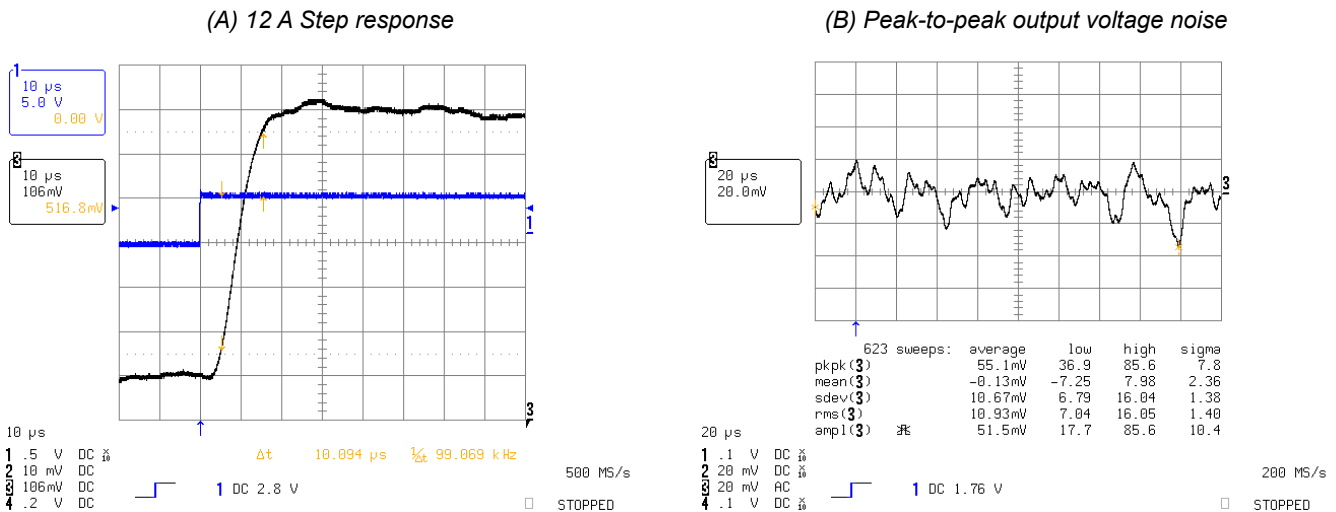


Figure 8. ACS704ELC-005: 50 kHz External Filter with 320 Ω resistor and 0.01 μF capacitor



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Figure 9. ACS704ELC-005: 40 kHz External Filter with 392 Ω resistor and 0.01 μF capacitor

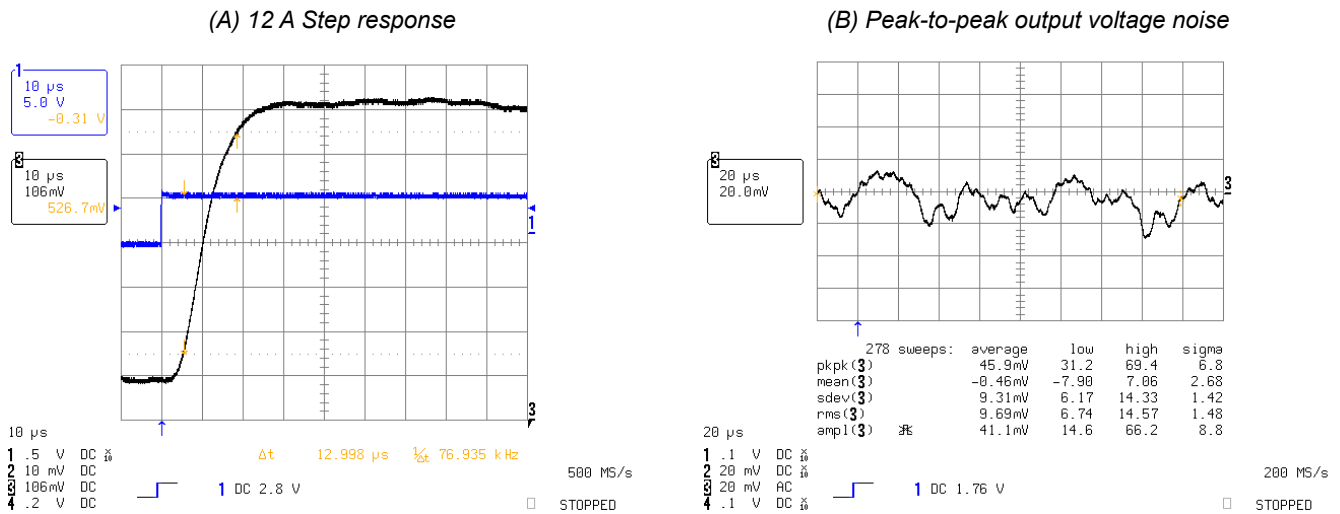
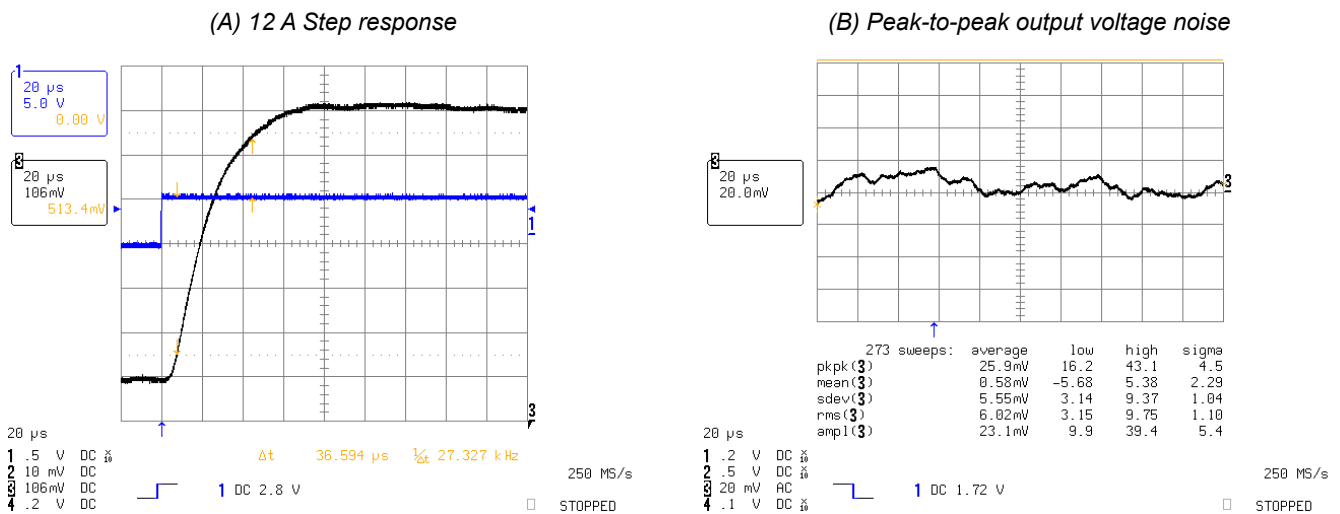


Figure 10. ACS704ELC-005: 10 kHz External Filter with 1500 Ω resistor and 0.01 μF capacitor



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Figure 11. ACS704ELC-005: 5 kHz External Filter with 3150 Ω resistor and 0.01 μF capacitor

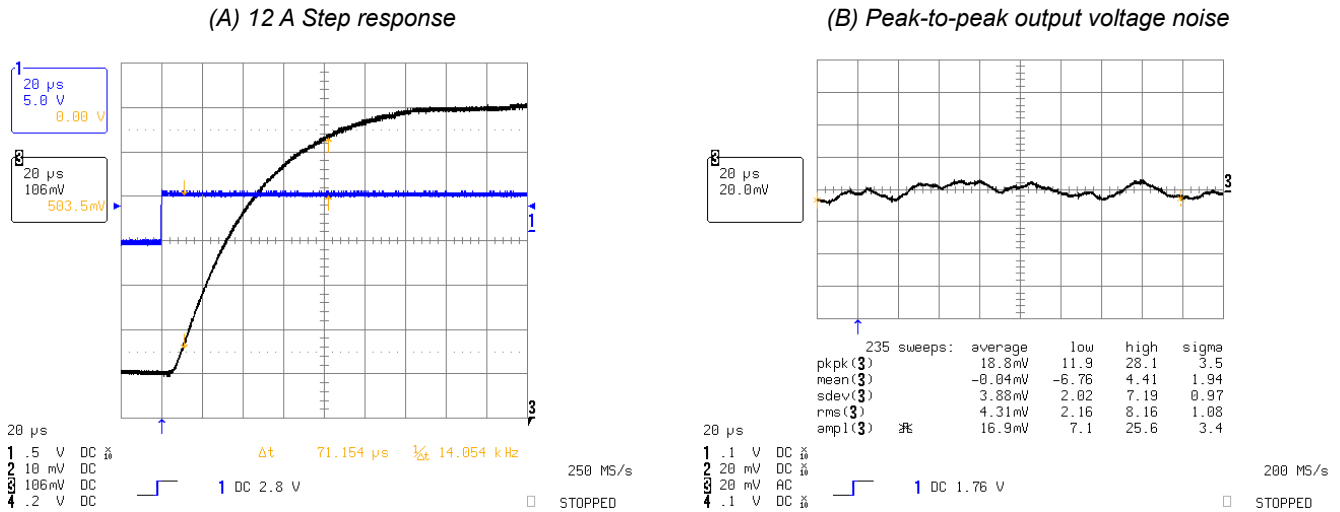
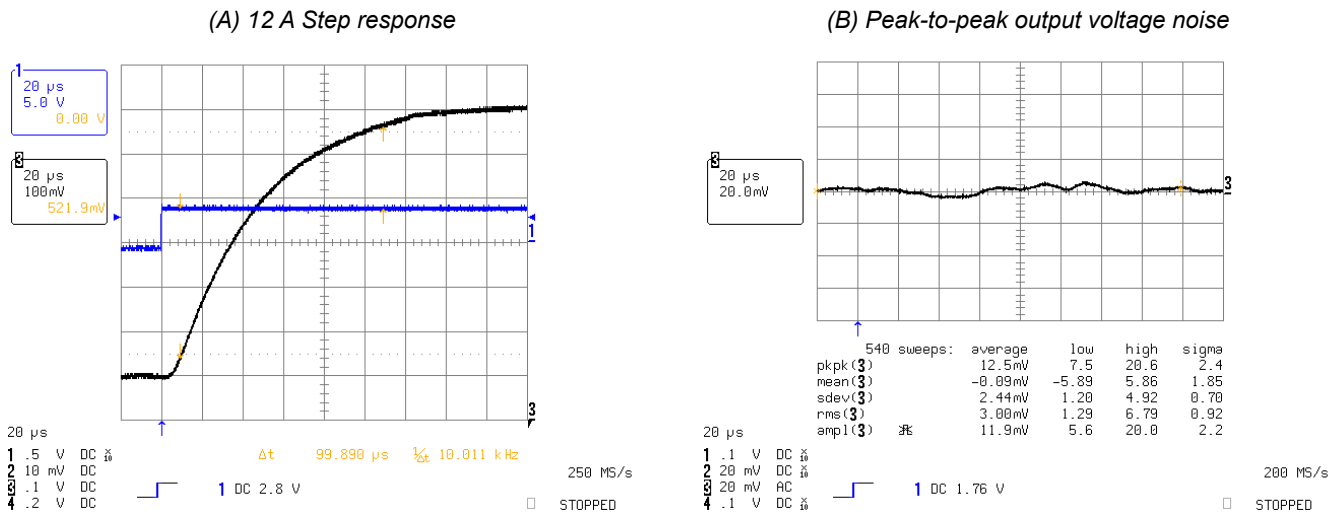


Figure 12. ACS704ELC-005: 3.3 kHz External Filter with 4800 Ω resistor and 0.01 μF capacitor



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SUMMARY

This application note describes the trade-offs that can be made between noise and response time (bandwidth) to improve the resolution of an

ACS704 current sensor implementation.

If you need further assistance with your ACS704 design, please contact your local Allegro sales office to be put in touch with one of our applications engineers.

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