Measurements of EMI Susceptibility of Precision Voltage References

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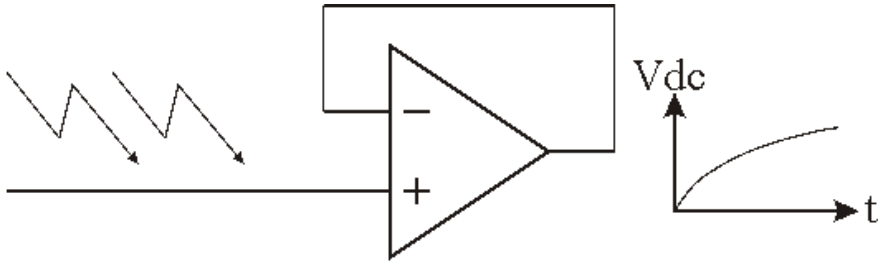
Summary

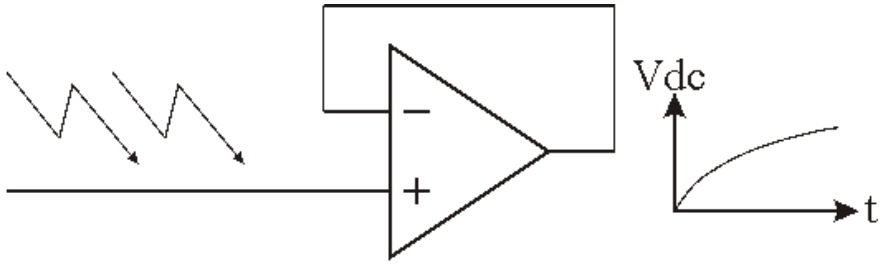
- EMI effects on Analog Circuits
- EMI coupling mechanisms
- Susceptibility in commercial precision Voltage References
- Conclusions

EMI effects on Analog Circuits



- The most sensitive ICs are the analog ones and among them the operational amplifiers
- Worst effect: shift of the output voltage mean value (unexpected: EMI is a 0DC signal)
- EMI may be distinguished between radiated and conducted

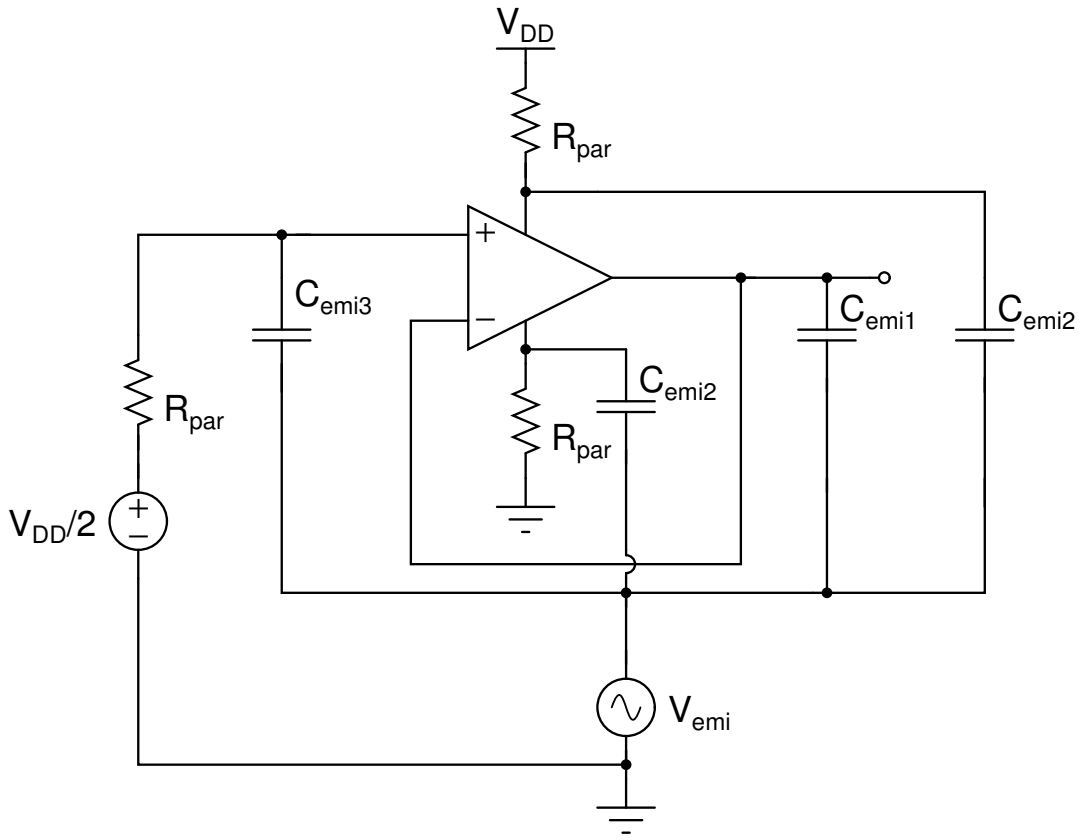
EMI coupling mechanisms (I)



In the literature, the direct EMI injection into the input and power supply pins has been widely investigated.

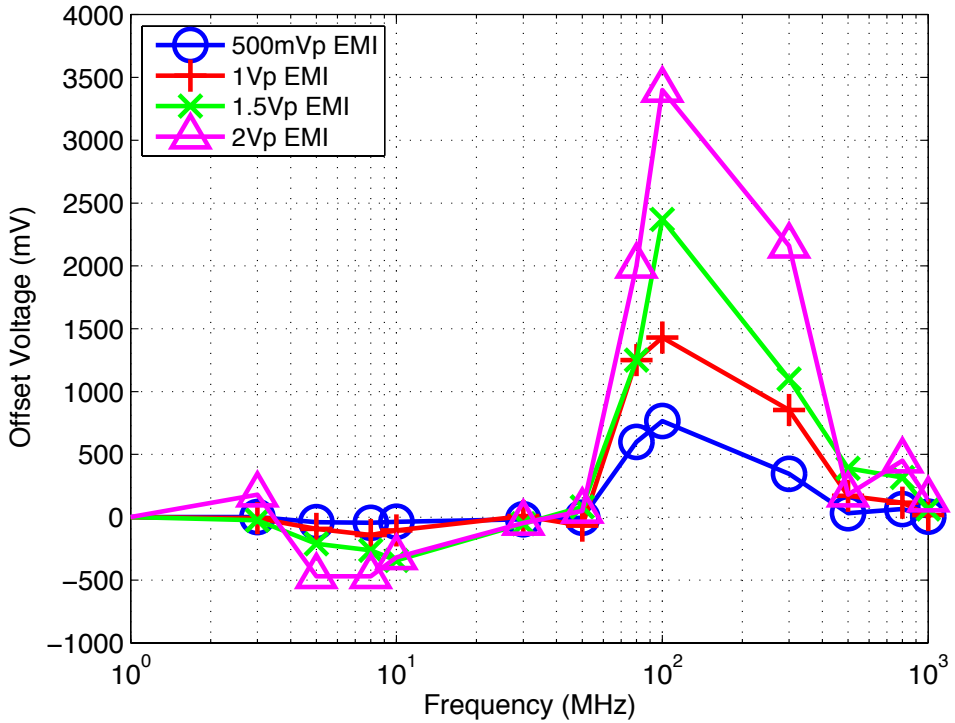
Another scenario must be investigated.

EMI coupling mechanisms (II)



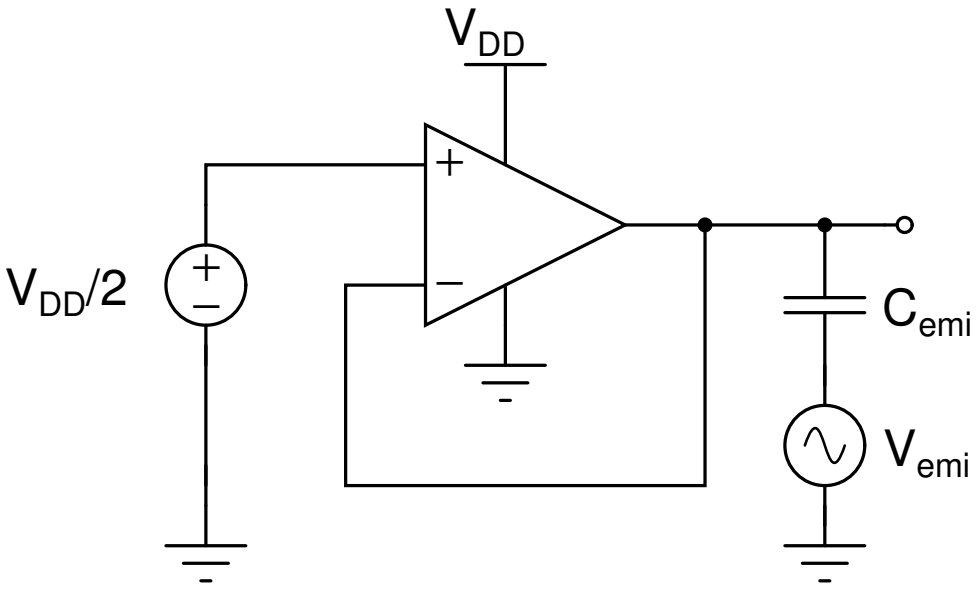
The unwanted RF signals may be transmitted through the ground plane, often shared with other ICs, and can be capacitively coupled to all the pins.

What happens? (I)



For example, this is the output voltage shift caused by EMI coupled to the output pin of a uA741. Susceptibility is also confirmed by simulations on custom integrated amplifiers (UMC180nm)

What happens? (II)

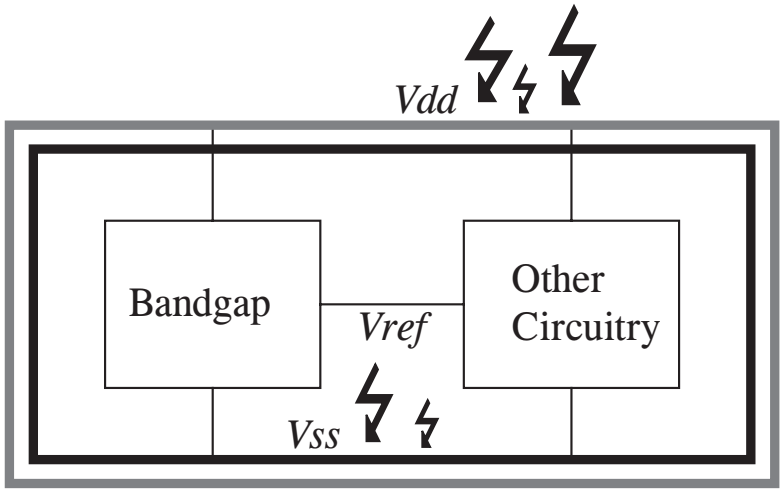


- Cemi is around pF and represents parasitics
- The worst case happens when EMI is coupling from the output pin.

What about Voltage References? (I)

- Their susceptibility less investigated compared to OpAmp
- They share the power lines with other ICs (analog, digital, mixed)
- They have an output pin providing the Vref to the other circuitry

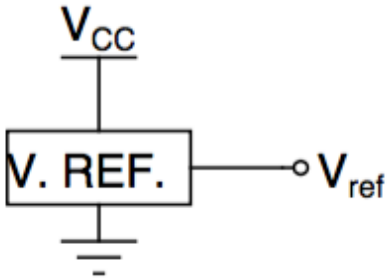
What about Voltage References? (II)

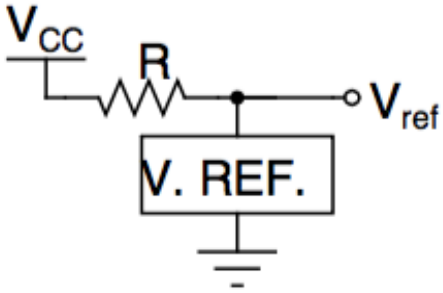


- Susceptibility to EMI directly injected into the power lines has been investigated in CMOS Bandgap Voltage References

What happens in high precision commercial voltage references?
And what about EMI coupling mechanisms?

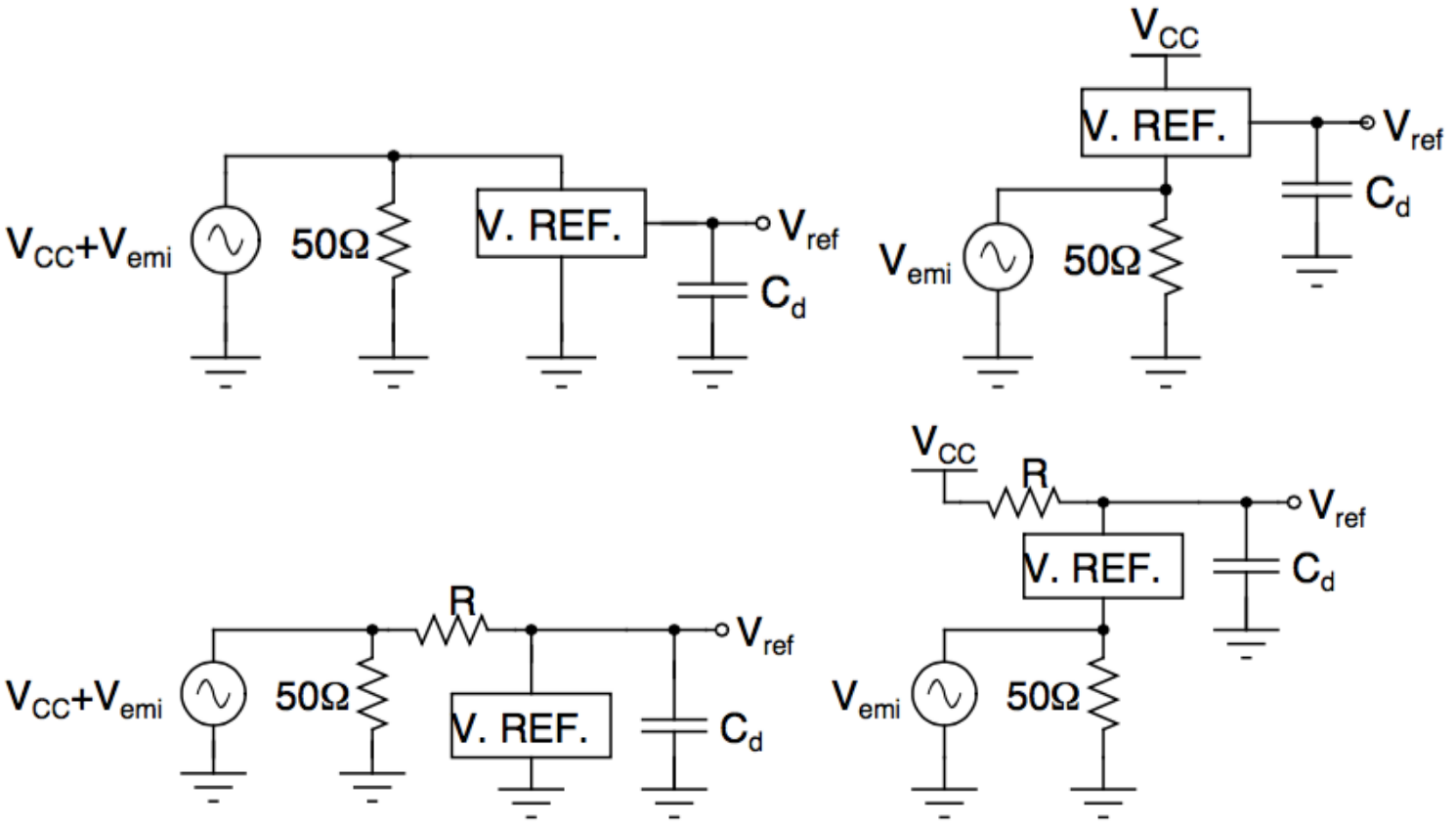
High Precision Voltage References





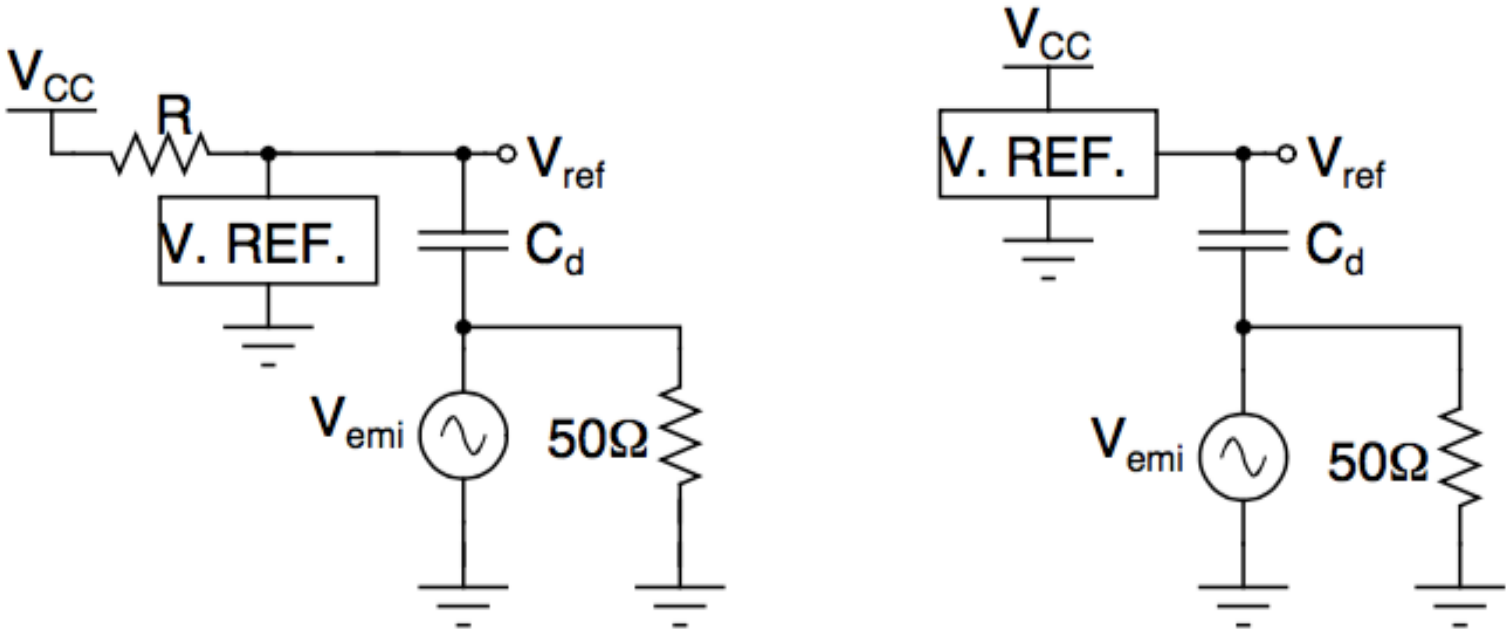
	LT1460	MAX6103	REF3130	LM4040	ZRB500	ADR512
	series	series	series	shunt	shunt	shunt
VDD	5V	5V	5V	10V	10V	5V
Vref	2.5V	3V	3V	5V	5V	1.2V

Measurement Setup (I)



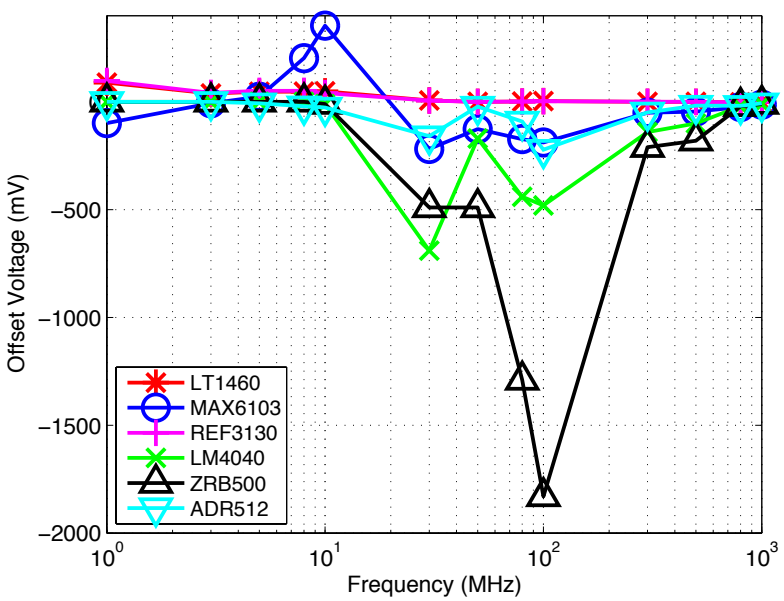
EMI directly injected into the power supply rails.

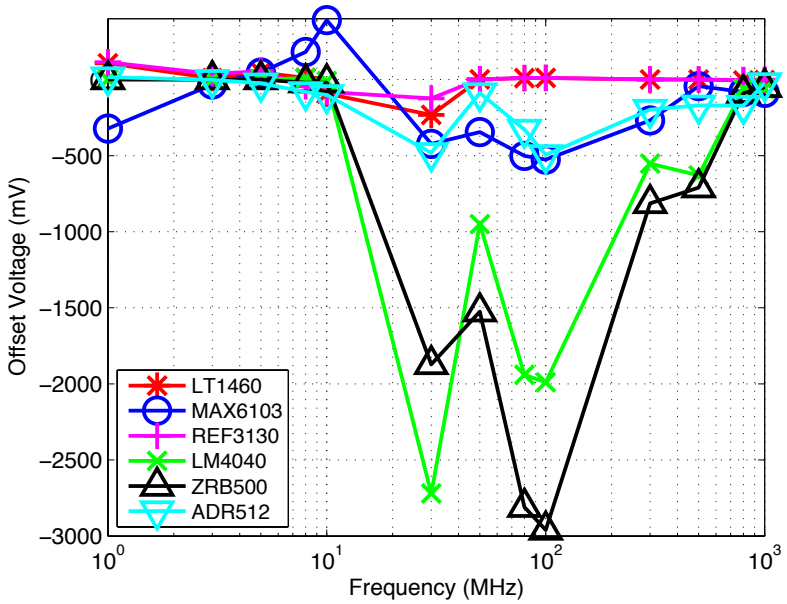
Measurement Setup (II)



EMI capacitively coupled to the output pin.

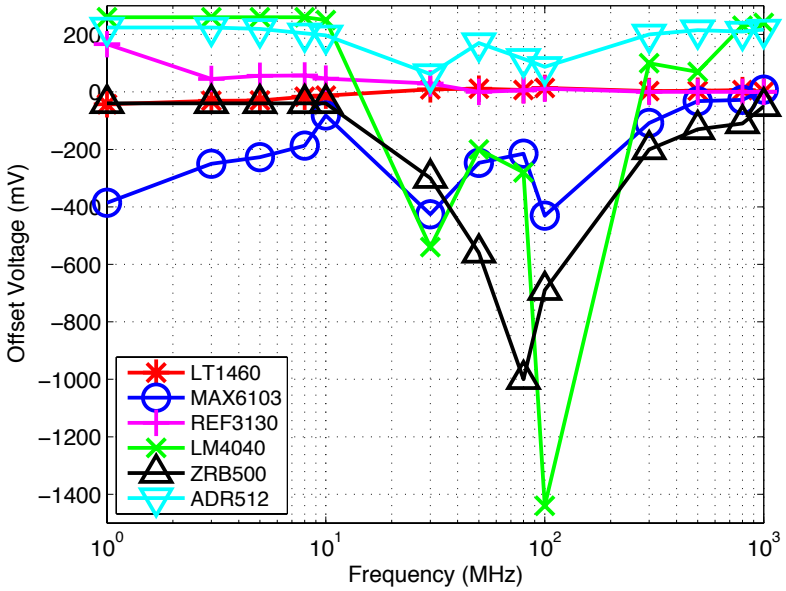
Results (I)

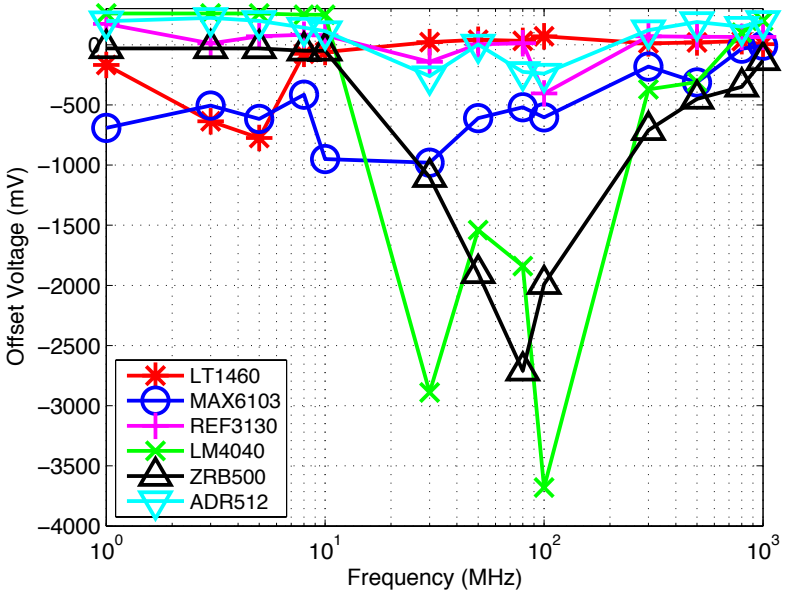




EMI directly injected into the Vdd pin (@1Vpp and @2Vpp).

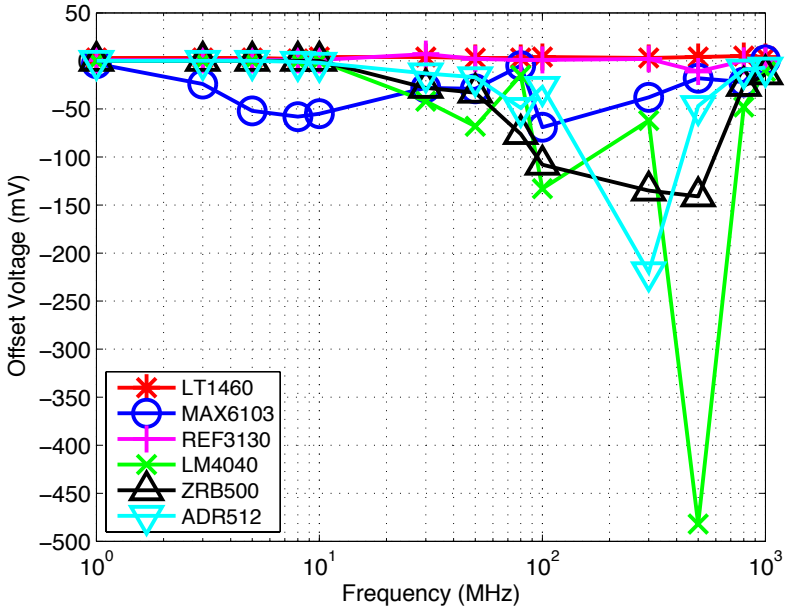
Results (II)

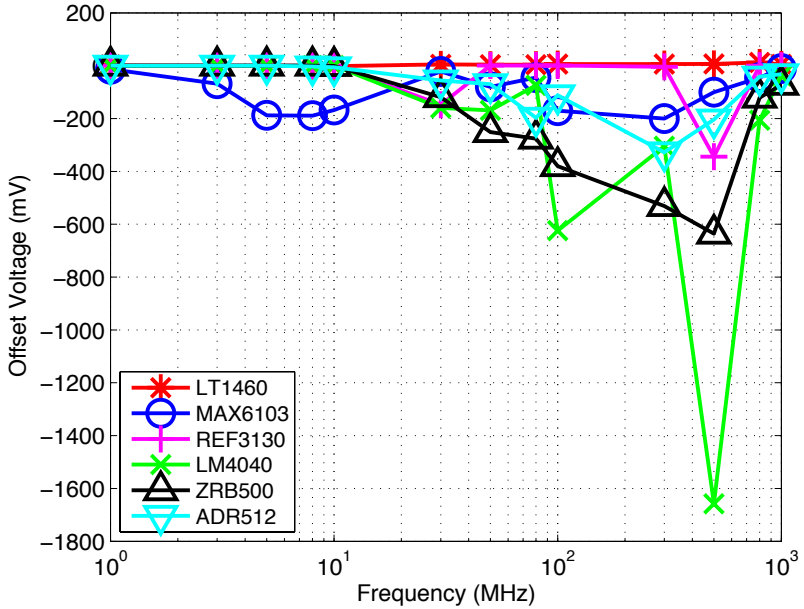




EMI directly injected into the Gnd pin (@1Vpp and @2Vpp).

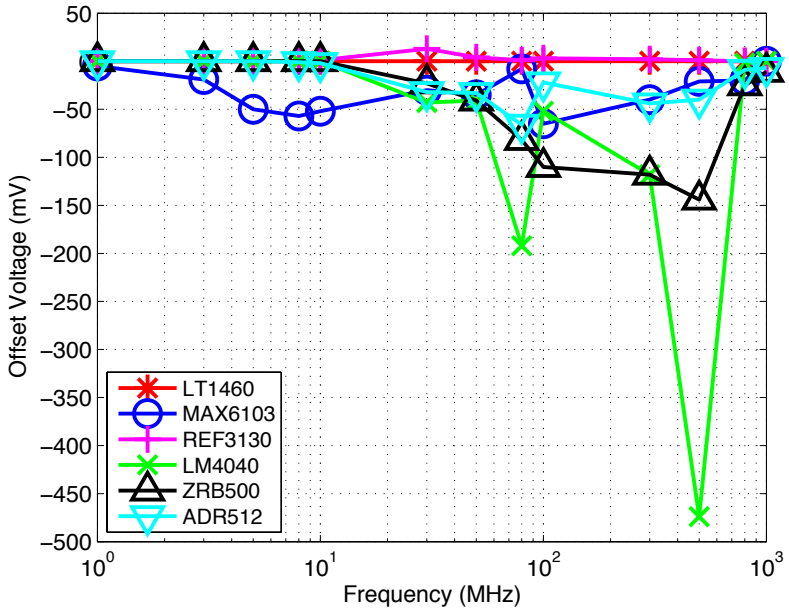
Results (III)

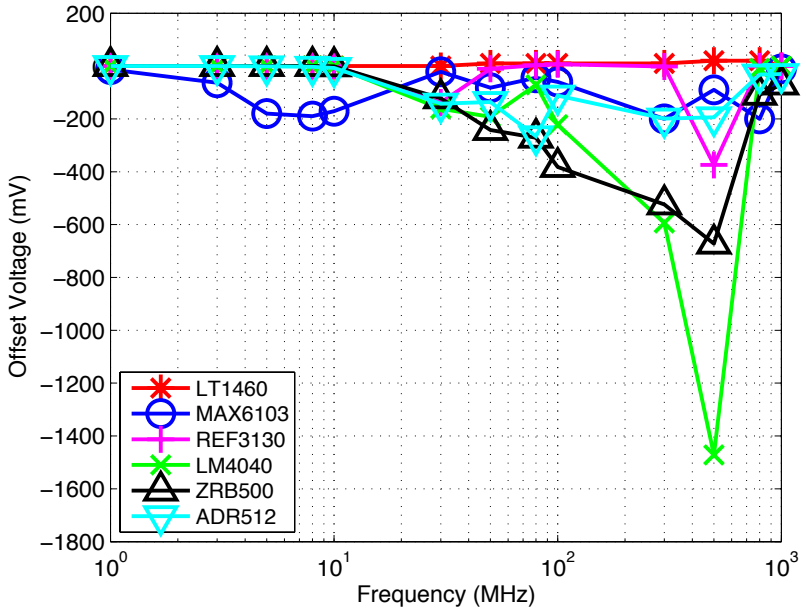




EMI capacitively coupled to the output pin (@1Vpp and @2Vpp).

Results (IV)





EMI capacitively coupled to all the pins (@1Vpp and @2Vpp).

Conclusions

- Direct injection of EMI is the worst case
- BUT…large EMI induced offset also in case of EMI coupled
- Output pin is the most critical
- Shunt voltage references seems more critical than Series
- Offset increases with the EMI amplitude
- Critical frequency of tens-hundreds of MHz (EMI coupled freq>EMI injected freq)