

# EMC and Power Electronics Workshop

## EMI/EMC Debugging with Oscilloscopes

### Part 2: Radiated Emissions

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Organized by:

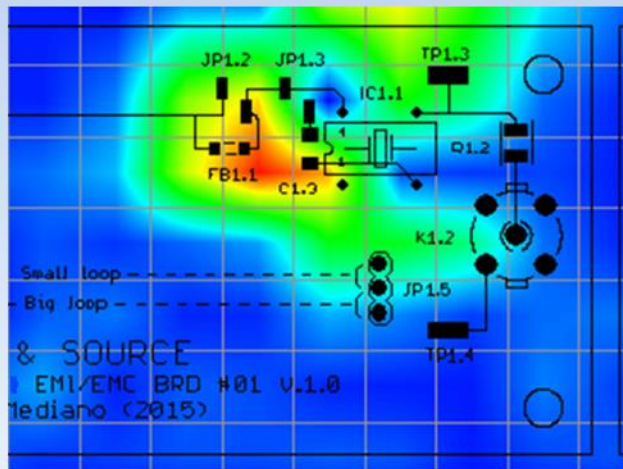


**ROHDE & SCHWARZ**  
Make ideas real

March 2024



# A High Frequency Lab for design, diagnostic, troubleshooting and training



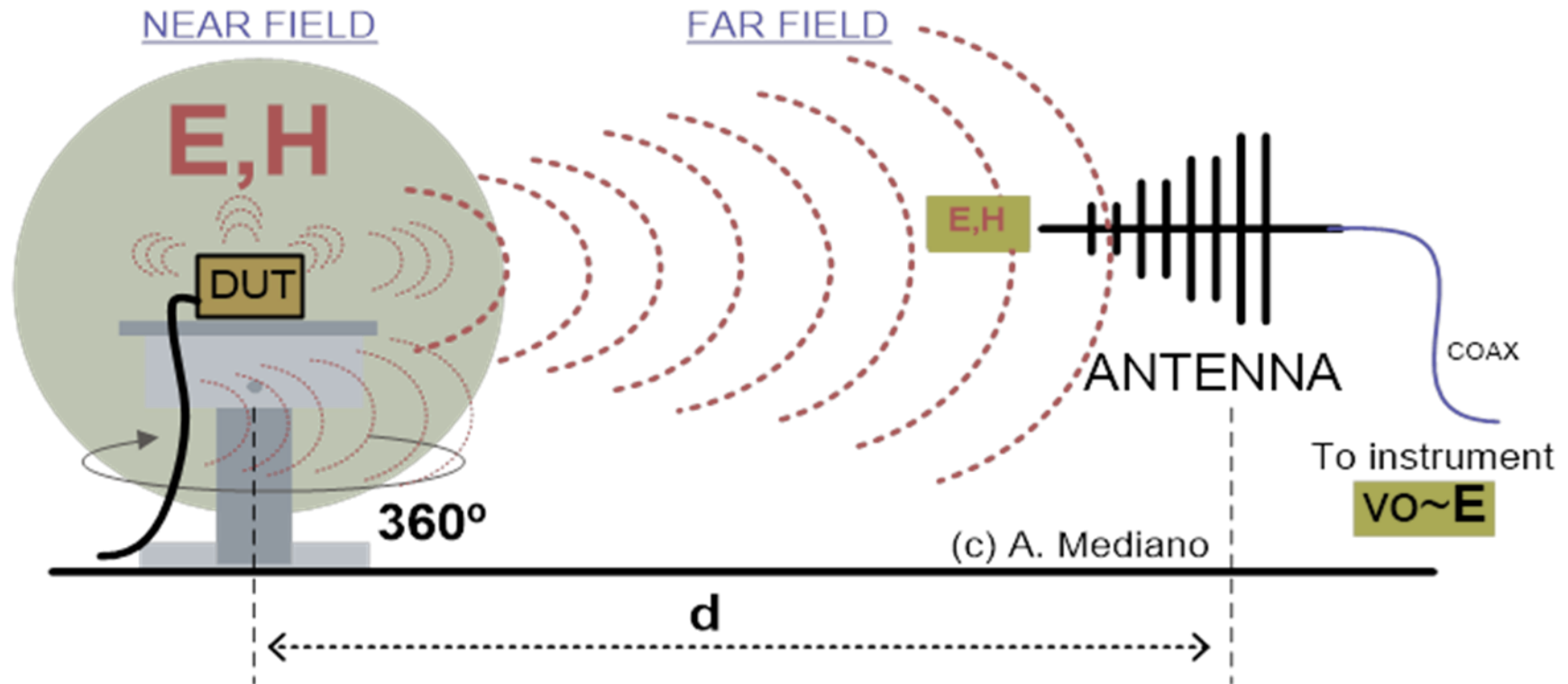
Interferences (**EMI**)  
Electromagnetic Compatibility (**EMC**)  
Signal Integrity (**SI**)  
Radiofrequency (**RF**)

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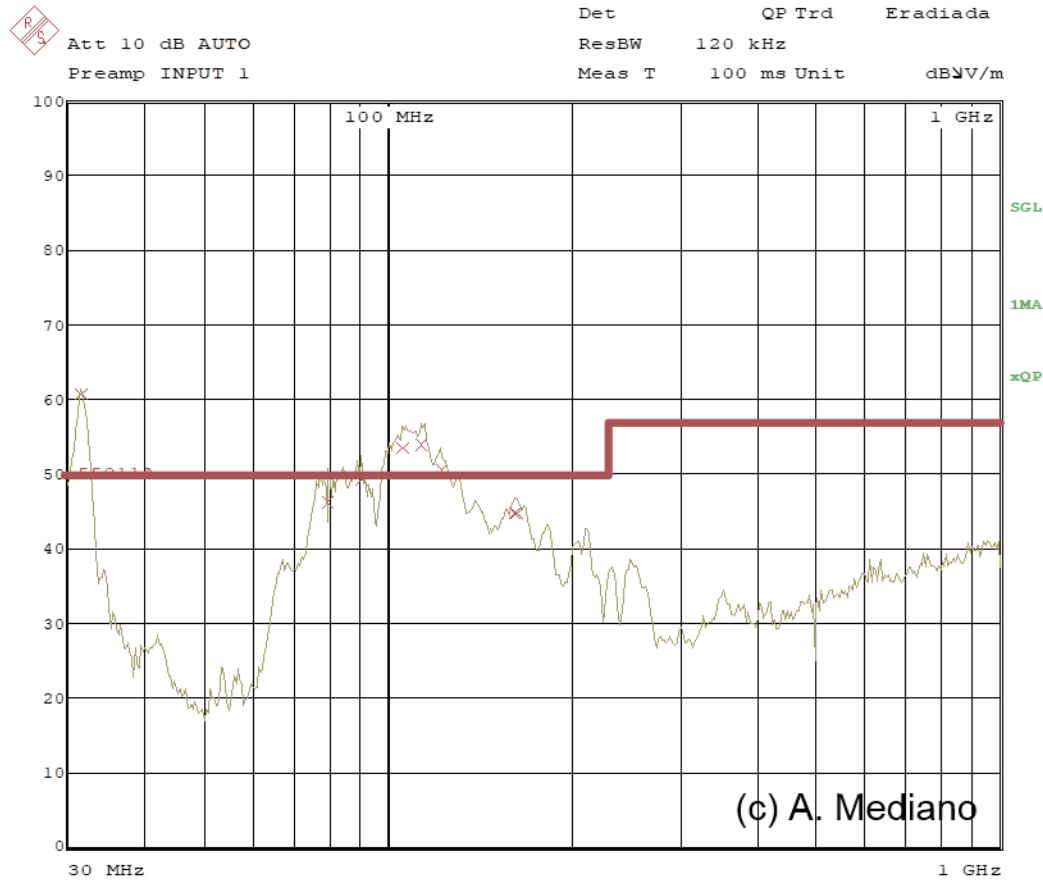
**ASK FOR YOUR FREE CATALOG!**

# **Radiated emissions**

# EMC: fail in radiated emissions

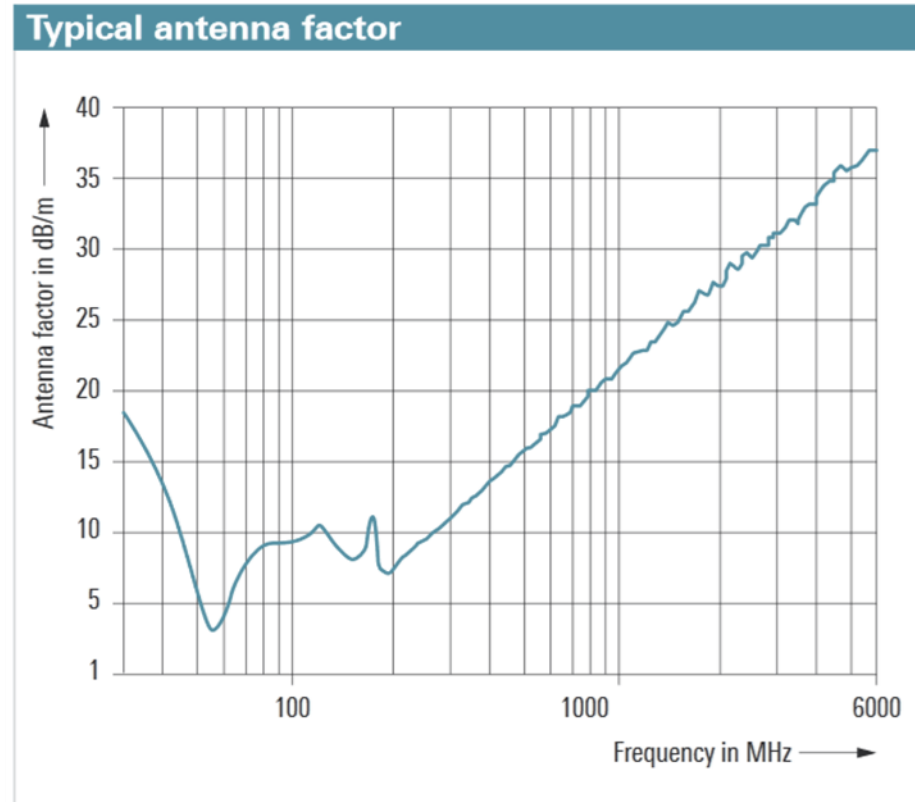


# EMC: fail in radiated emissions



# Testing: R&S HL562E ULTRALOG antenna

30 MHz to 6 GHz

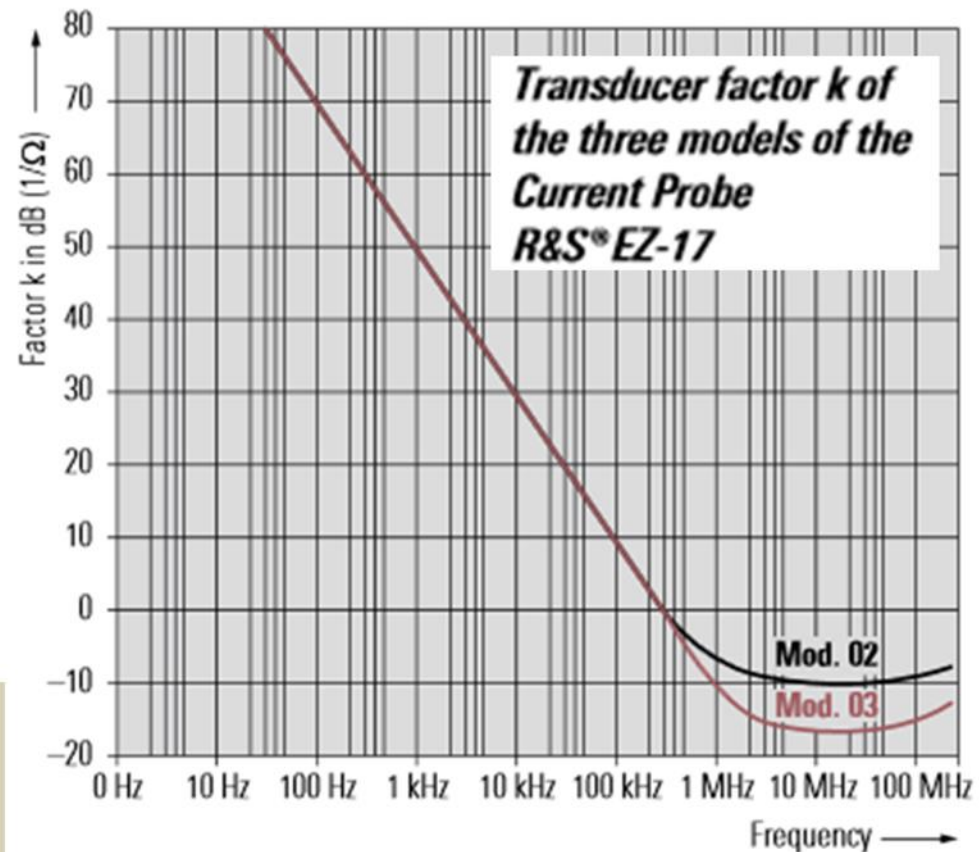


# Testing: R&S EZ-17 current probe

R&S EZ - 17  
Current Probe  
50Hz - 200MHz



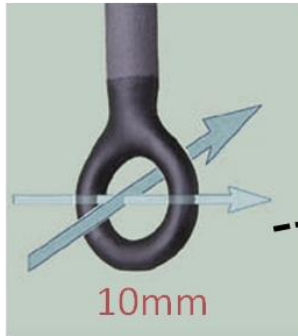
ZT=-10dBΩ (0.3ohm) @ 100MHz  
idBuA = vdBuV - ZdBΩ  
15uA → 25dBuV (17uV)



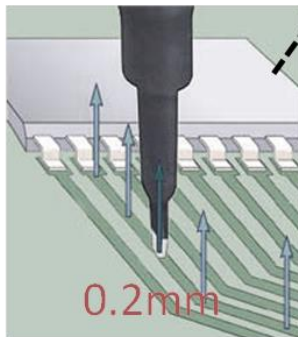


# Testing: R&S HZ-15 Near field probes

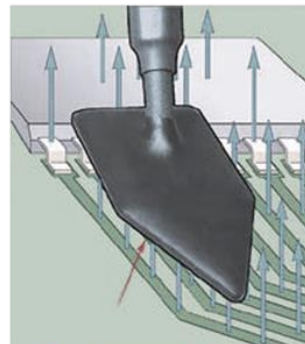
H probe RS H 50-1



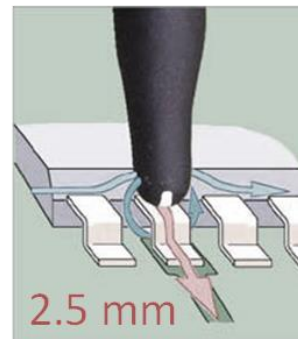
E probe RS E 10



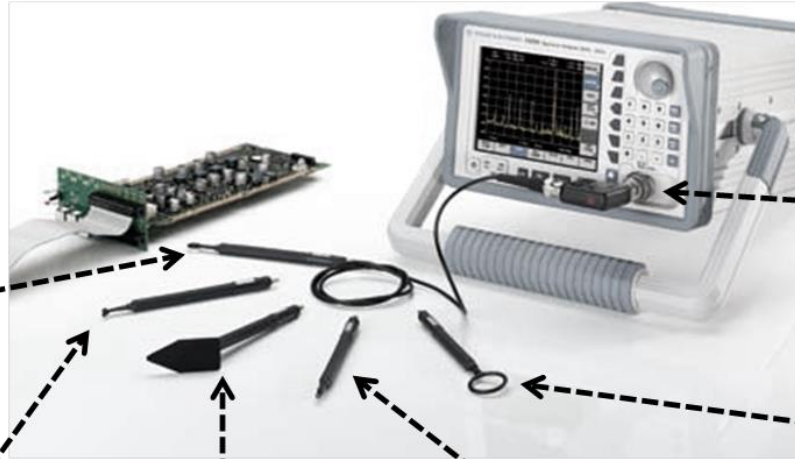
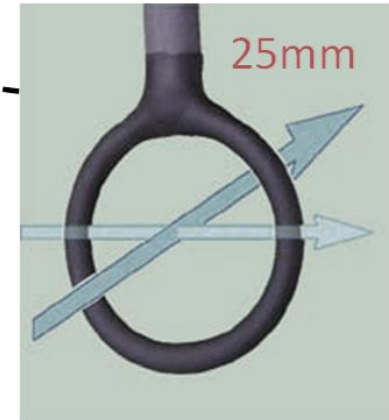
E probe RS E 02



H probe RS H 2.5-2



H probe RS H 400-1



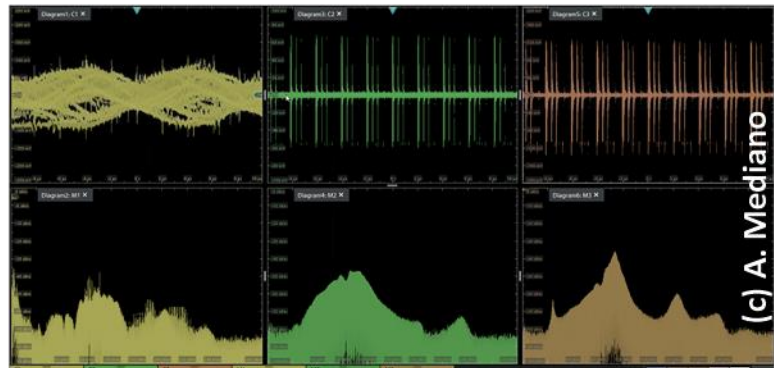
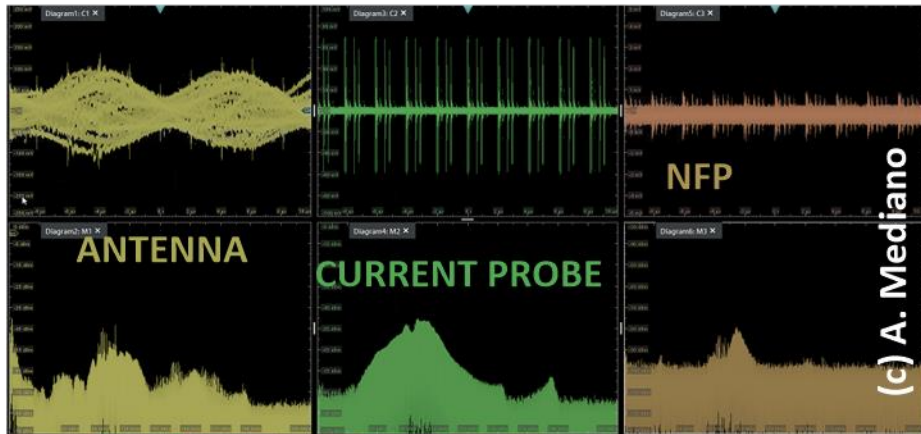
SCOPE OR  
SPECTRUM ANALYZER

Preamp HZ-16



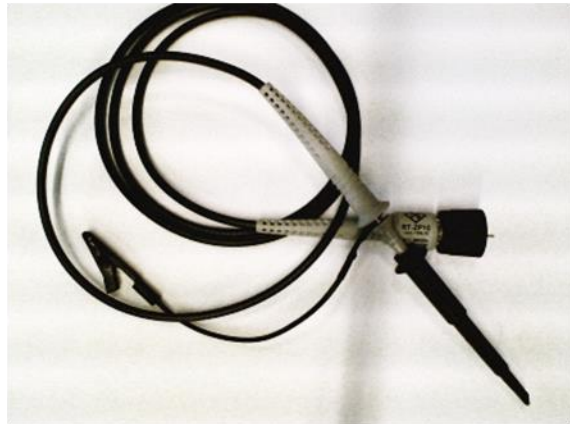
# EMC: debugging radiated emissions

## SCAN WITH NEAR FIELD PROBES



- Explain slots can not radiate EMI (short) at 100MHz.
- They can couple noise to nearby cables running on top of slots

# Testing: R&S RT-ZP10 voltage probe

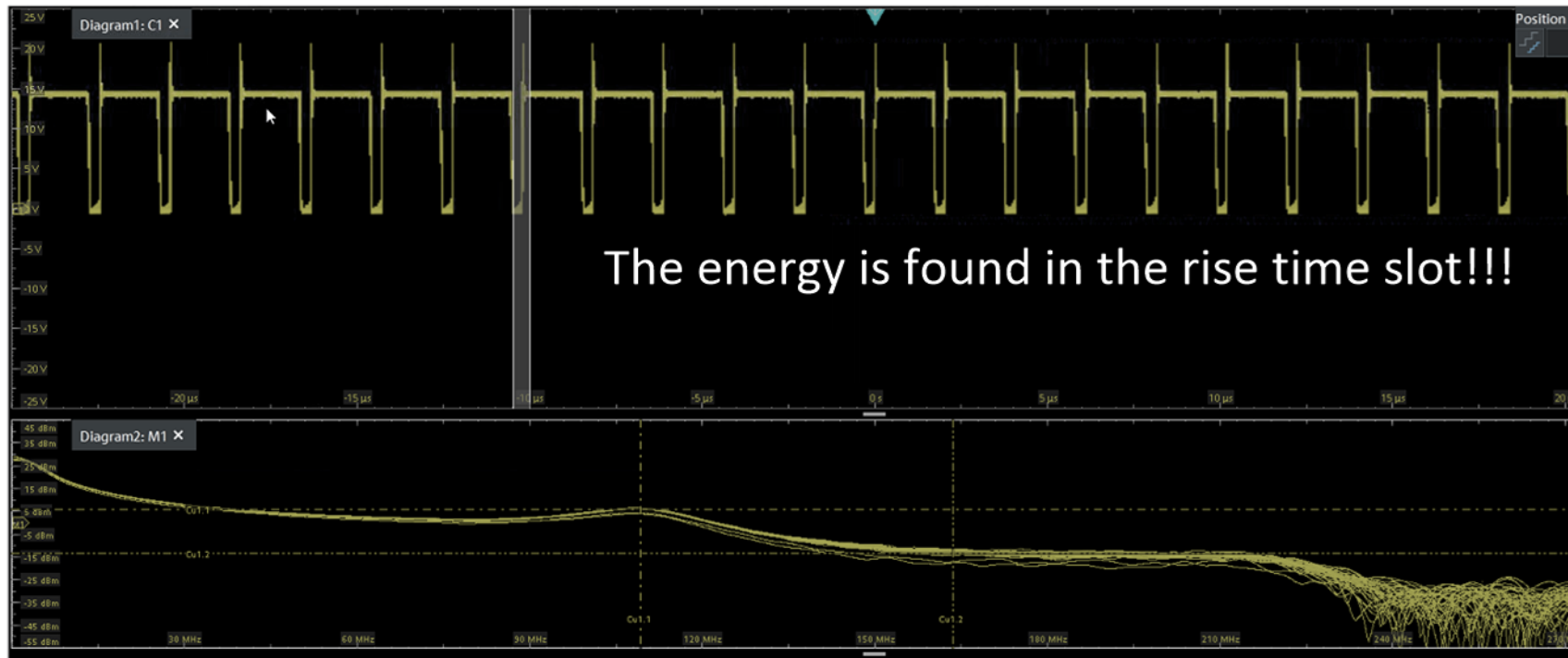


## Electrical Specifications

Attenuation Ratio <sup>(1)</sup>	10:1	± 2 % at DC
Voltage Coefficient	0.0025 %/V	(typical)
System Bandwidth <sup>(1)</sup>	500 MHz	(-3 dB)
Probe Risetime <sup>(1)</sup>	700 ps	(10 % - 90 %) (typical)
Input Resistance (System)	10 MΩ	± 1 %
Input Capacitance (System)	9.5 pF	(typical)
Compensation Range	5 pF - 20 pF	(typical)
Input Coupling of the Measuring Instrument	1 MΩ AC / DC	

# Debugging circuit: GATING

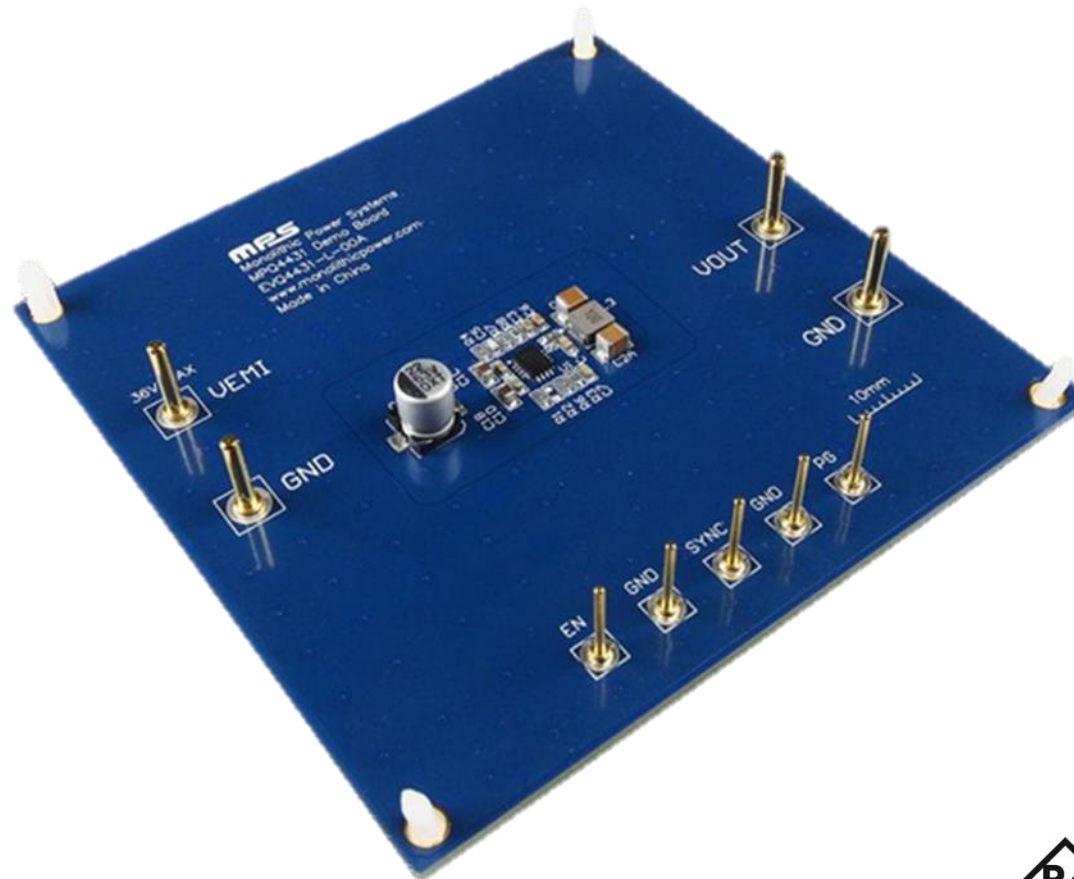
We apply the FFT GATING:

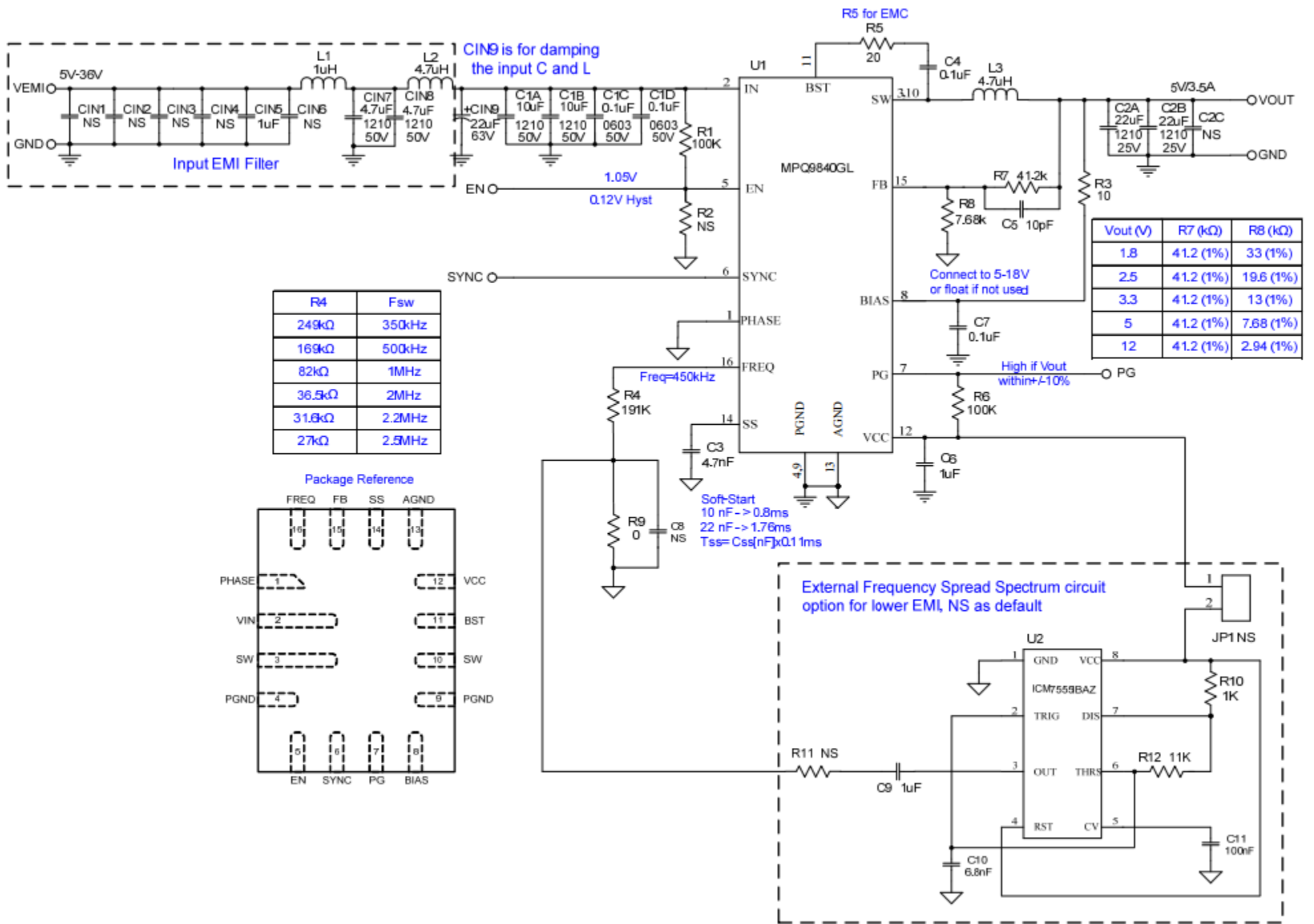


**An optimized  
design  
from MPS**

# MPS Eval board: EVQ4431-L-00A

36V, 1A, Low  $I_Q$ , Synchronous Step-Down Converter Evaluation Board





CIN9 is for damping the input C and L

Input EMI Filter

1.05V

0.12V Hyst

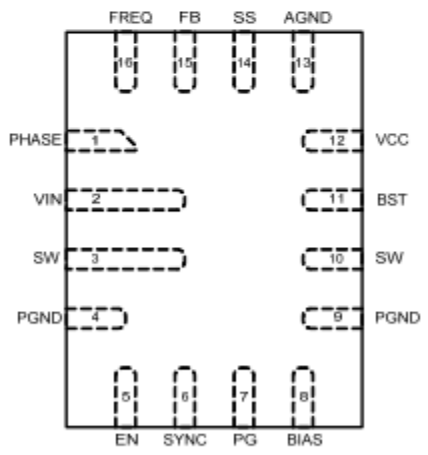
Connect to 5-18V or float if not used

High if Vout within ±10%

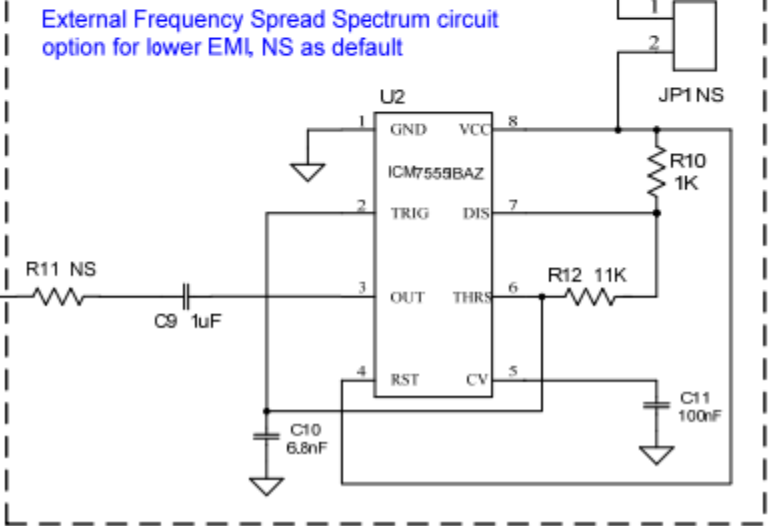
Soft-Start  
 10 nF -> 0.8ms  
 22 nF -> 1.76ms  
 $T_{SS} = C_{SS}(nF) \times 0.1ms$

R4	Fsw
249kΩ	350kHz
169kΩ	500kHz
82kΩ	1MHz
36.5kΩ	2MHz
31.8kΩ	2.2MHz
27kΩ	2.5MHz

Package Reference



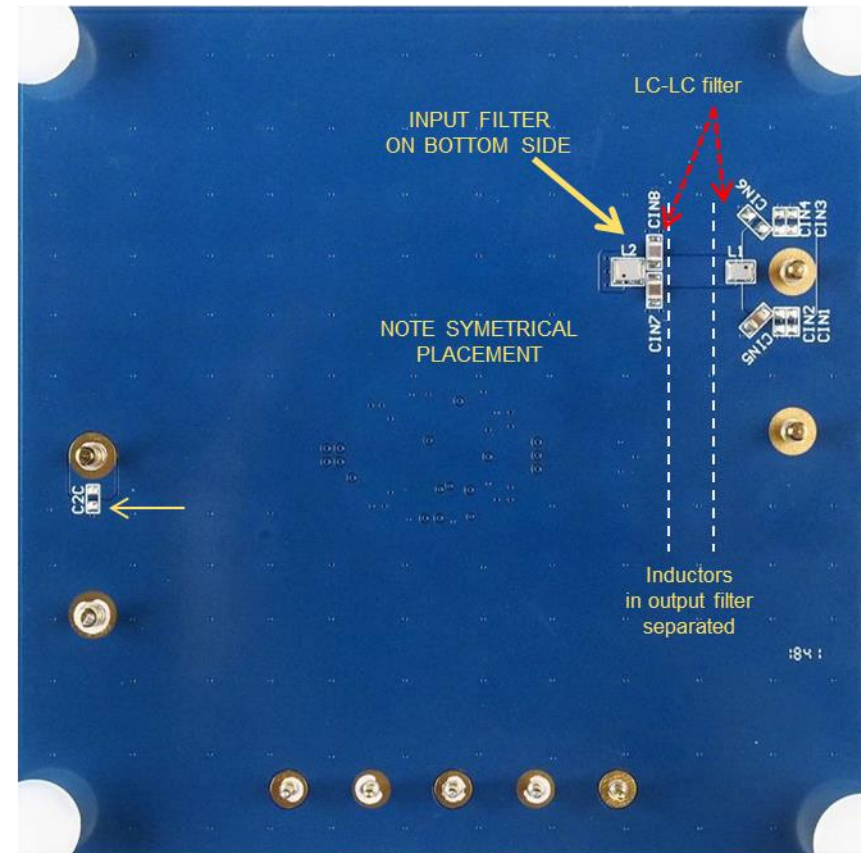
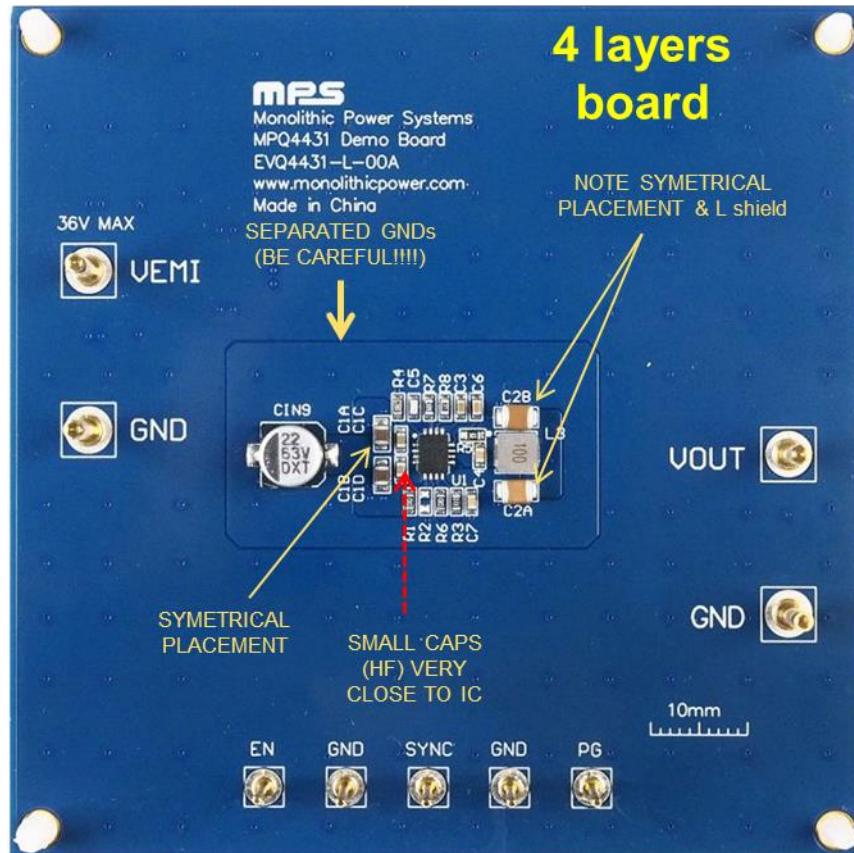
Vout (V)	R7 (kΩ)	R8 (kΩ)
1.8	41.2 (1%)	33 (1%)
2.5	41.2 (1%)	19.6 (1%)
3.3	41.2 (1%)	13 (1%)
5	41.2 (1%)	7.68 (1%)
12	41.2 (1%)	2.94 (1%)



External Frequency Spread Spectrum circuit option for lower EMI, NS as default



# MPS Eval board: EVQ4431-L-00A



Credit for the techniques: MPS

# REFERENCES: ... from MPS

## Datasheets:



**MPQ9840**  
36V, 3.5A, Low I<sub>q</sub>,  
Synchronous Step-Down Converter  
AEC-Q100 Qualified



**EVQ9840-L-00A**  
36V, 3.5A, Low Quiescent Current  
Synchronous Step-Down Converter Evaluation Board

## Presentations:

- *EMI Sources on Step-Down Converters*, Ralf Ohmberger, MPS Staff Apps Engineer, Jun 2023.
- *Automotive EMI Demystified: Part 1. Black Magic Busted*, Christian Kueck, Oct. 2018.
- *Automotive EMI Demystified: Part 2. Pursuing an Ideal Power Supply Layout*. Jens Hedrich, Senior FAE, Central Europe MPS, Dec. 2018

# THANK YOU!



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