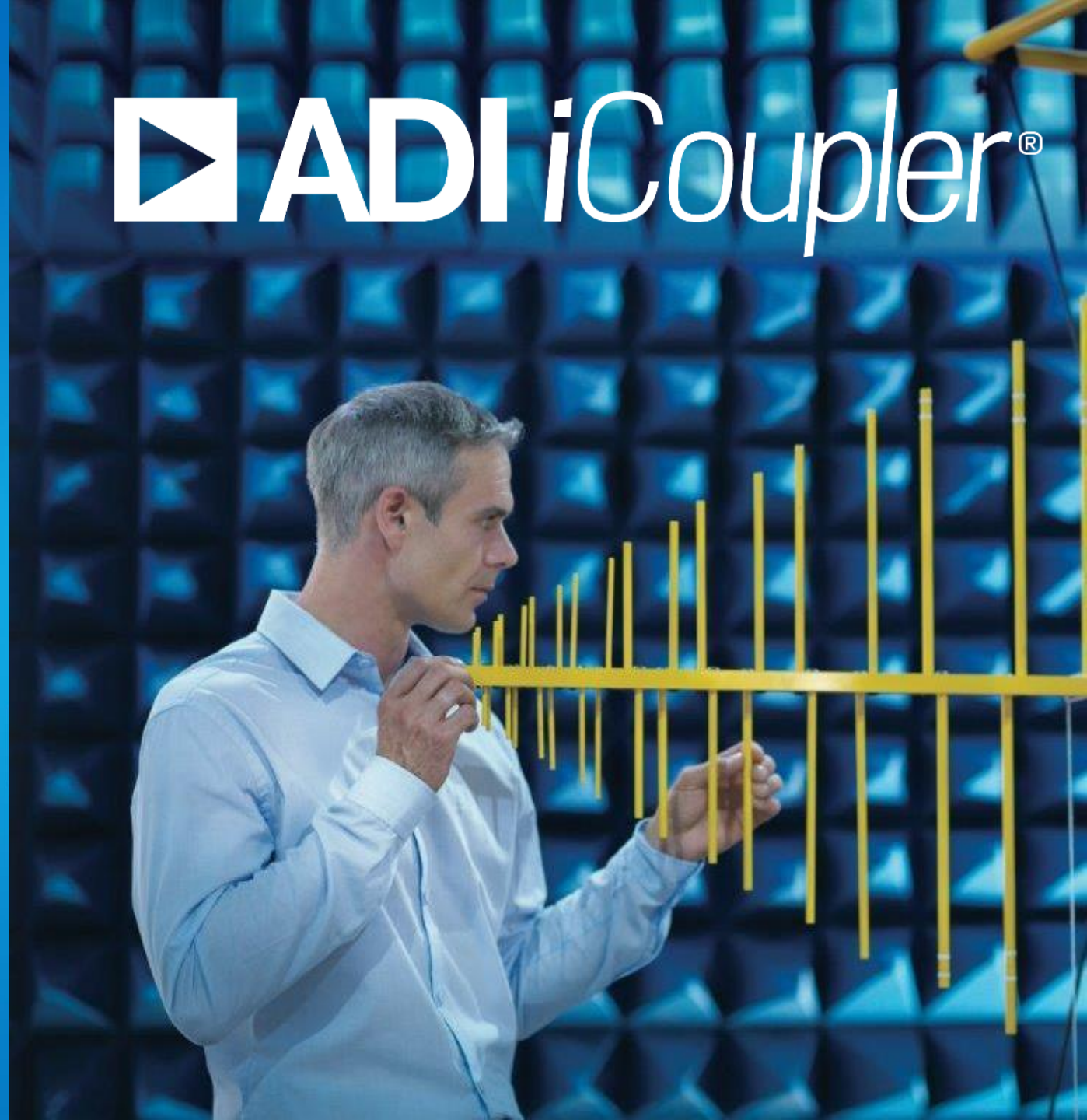
Got EMI! Fix it with the latest *iso*Power



Presenter

James Scanlon

EMC Applications Engineering

Interface and Isolation Products

Agenda

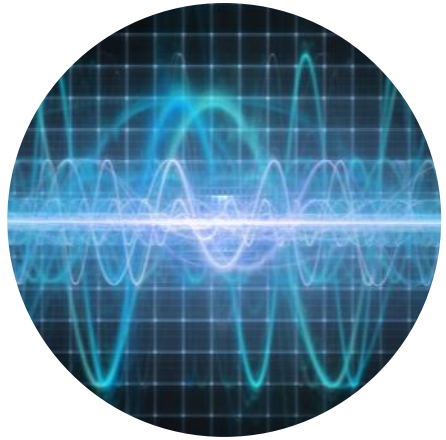
- The Problem with EMI
- Isolation landscape — integrated power and data
- The EMI challenge and current methods to solve it
- The need for a new approach
- Next-generation *iso*Power® and isolated data technology overview
- What is EMI testing
- EMI results for *iso*Power® and isolated data
- Expected Benefits and Next Steps
- Q&A

Market Trends: Smaller and Lighter Electronic Systems

Forces trade-offs in performance and functionality, may impact schedule due to limited availability of solutions

- Increased density in factory automation, instrumentation and medical
- Electronics must shrink
  - More functionality
  - More integration
  - Smaller packaging
  - Smaller PCBs, higher density

The Problem with EMI

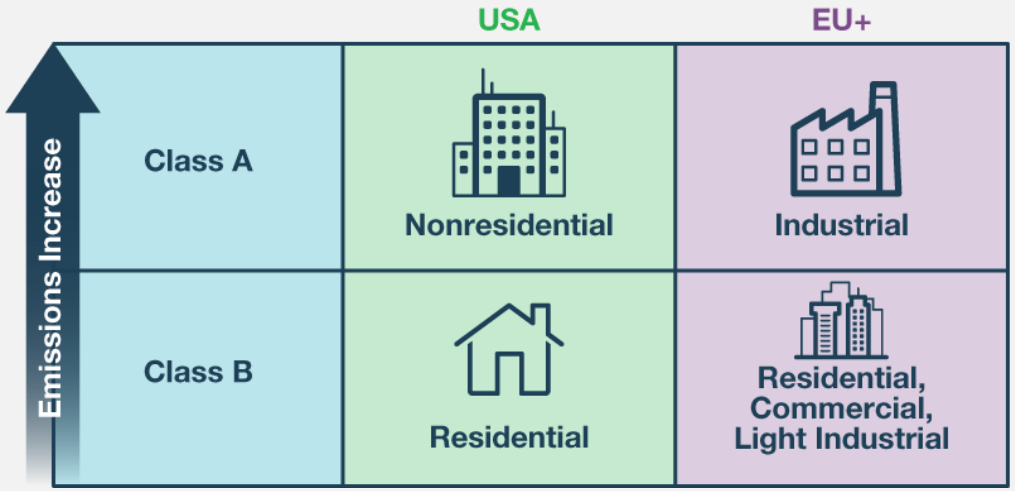


- EMI issues
  - Regulatory compliance
  - RF spectrum pollution
  - Compatibility within circuits
  - System disturbance or malfunction
  - Damage and liability

- Designing for compliance can have a steep learning curve
  - Components
  - PCB (printed circuit board) layout
  - Signal integrity
  - Cables
  - Enclosure and shielding
  - Software and firmware

~50% of designs fail EMI tests the first time

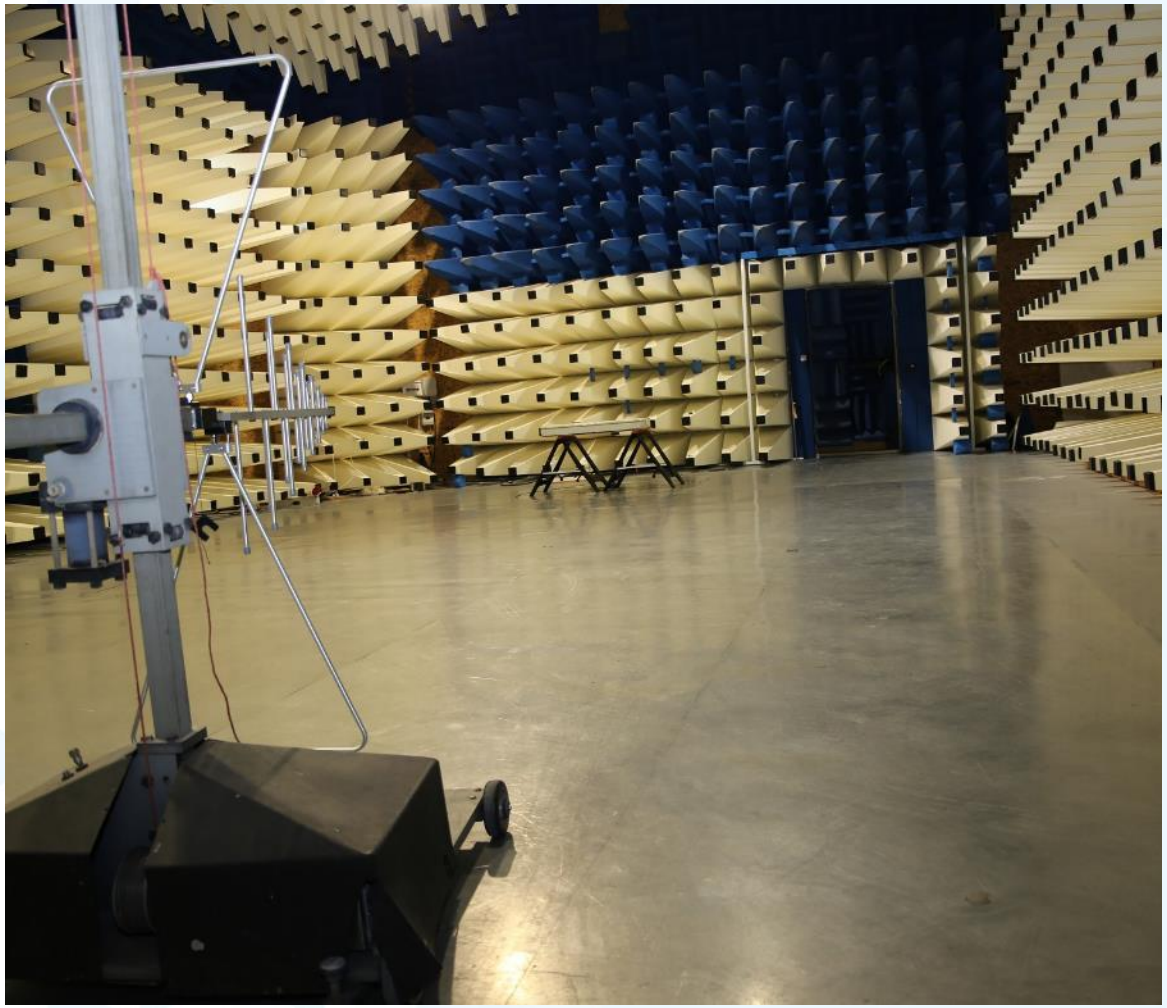
Source: Intertek



A Hidden Cost: EMI

EMI mitigation techniques add to component count, extend the design, and may require multiple board spins to meet targets

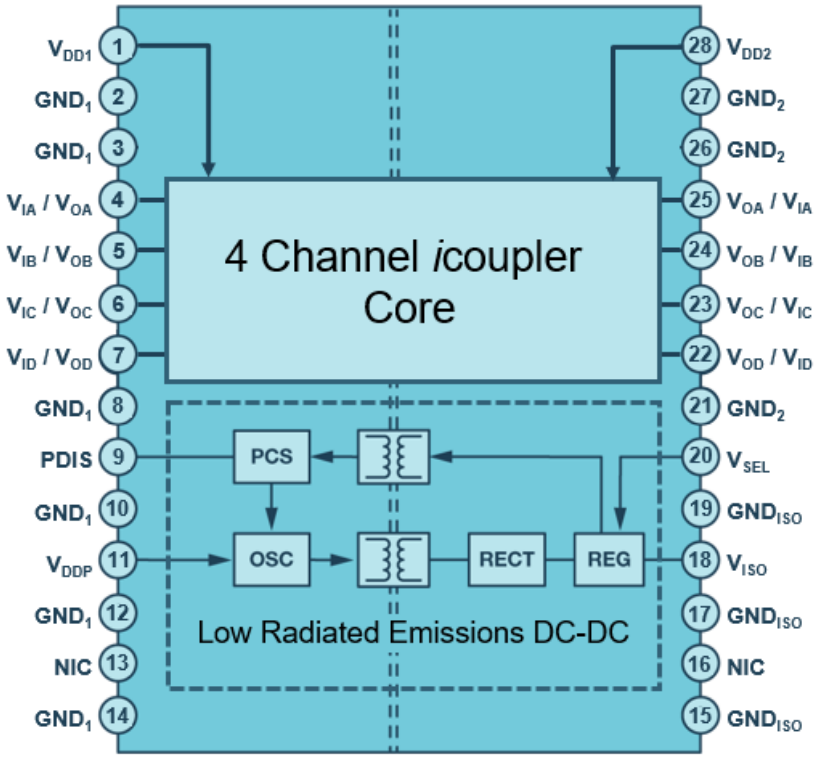
- Classic EMC mitigation techniques
  - Clamp Ferrites
  - Capacitors (decoupling and cross-barrier)
  - Ferrite Beads
  - Metal shields/enclosures
- Smaller and more dense PCBs
  - Less space for mitigation
- Mitigation is often implemented by trial and error
  - Tests are lengthy and expensive
  - Reduces Time to Revenue



Isolation Landscape: *iso*Power® with Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Small, Simplified Design for Reduced Component Count



Small 28-Lead Fine Pitch Wide-Body SOIC

Analog Devices— first to market #1

Advantages

Optimized solutions—no need to design a power supply

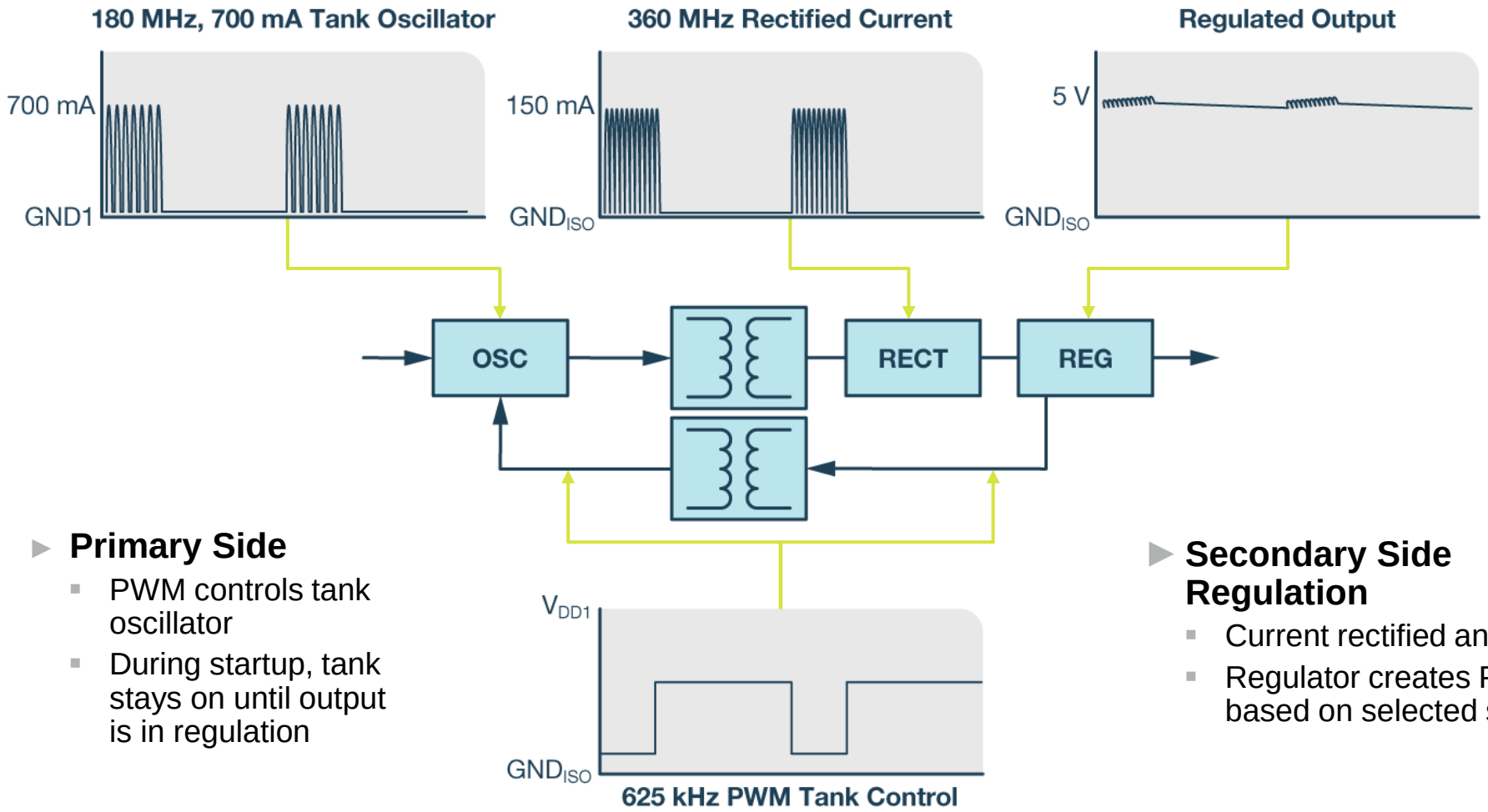
Reduced size—with small component count

Innovation—space constrained applications can pack more isolated supplies in a small system

ADI iCoupler®

Isolated Power Technology: How It Works

High frequency operation for small size of transformer coils

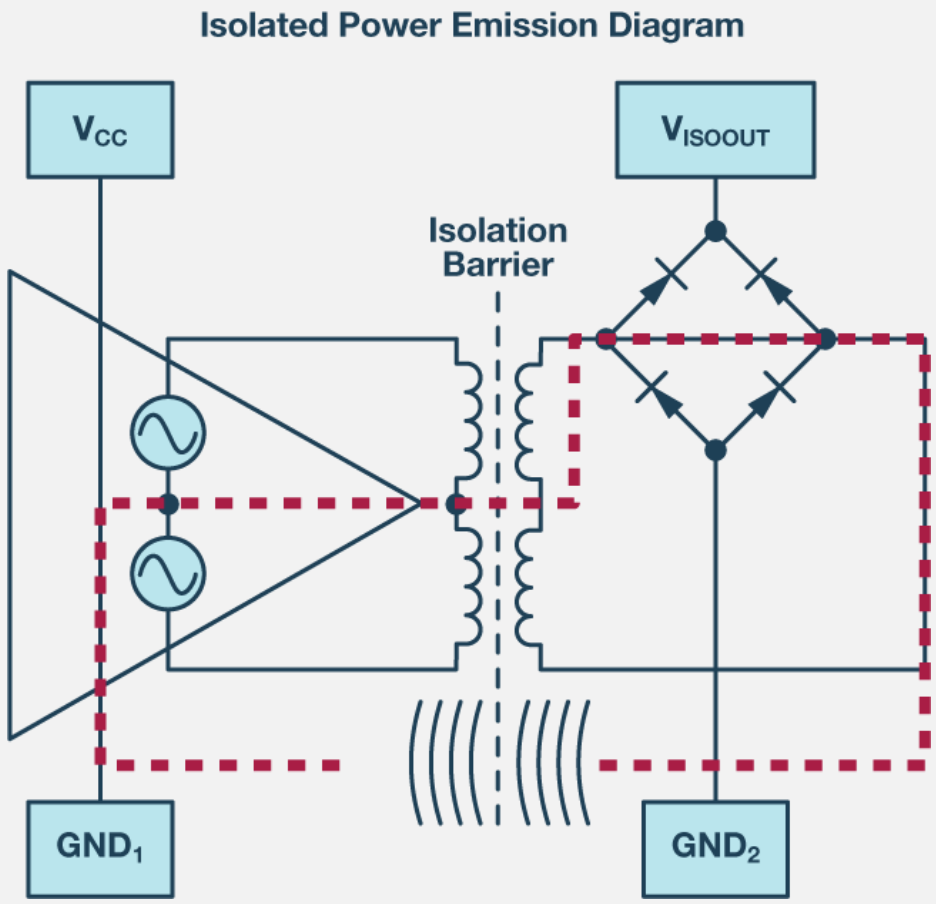


- **Primary Side**
  - PWM controls tank oscillator
  - During startup, tank stays on until output is in regulation

- **Secondary Side Regulation**
  - Current rectified and filtered
  - Regulator creates PWM based on selected set point

The Challenge: Increased Radiated Emissions

- Using 50 MHz to 200 MHz frequencies to obtain small transformer size comes with increased radiated emissions
  - **Common-Mode Current**: Parasitic currents are coupled through the transformer to the secondary side
  - **No Return Path:** No physical path across the isolation barrier for these currents to return creates a dipole antenna that can radiate
  - **Loop Area:** $V_{ISO\ OUT}$ and GND_2 pins connected to planes increase the loop area and the emissions
  - **Stitch Capacitance:** To reduce the dipole emissions, a low impedance return path for the high frequency common-mode currents is needed



Current Solutions: Mitigate EMI at the Board Level

Tackling emissions **at the board/applications level**, various methods can be effective, but may be difficult or costly to implement

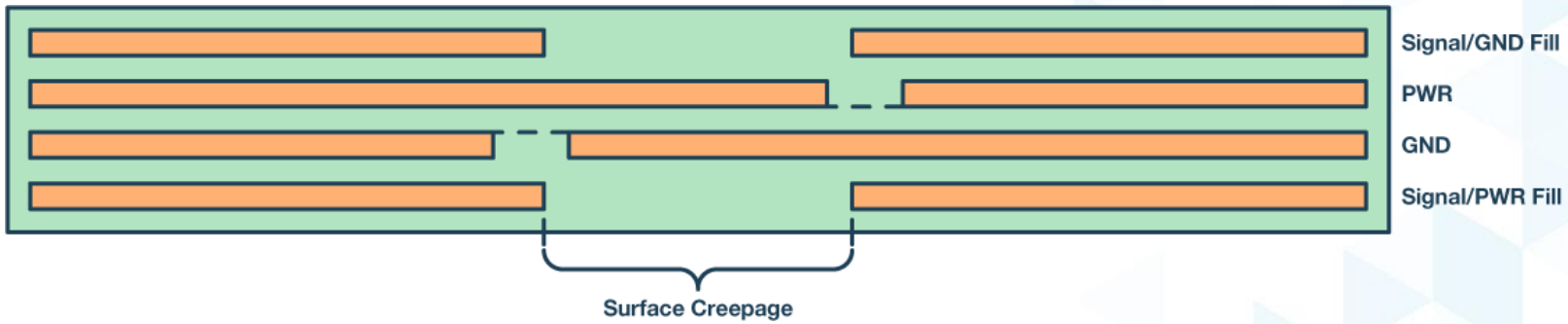
Solution
Stitching Capacitance

Discrete Stitching Capacitor

Disadvantages
Multiple layers, more cost
Difficult to lay out
Increased design/test time
Adds unwanted leakage current

Large and expensive

Overlap Stitching Capacitor for Multilayer PCB
2 Layers of Power plus 2 Layers of Signal



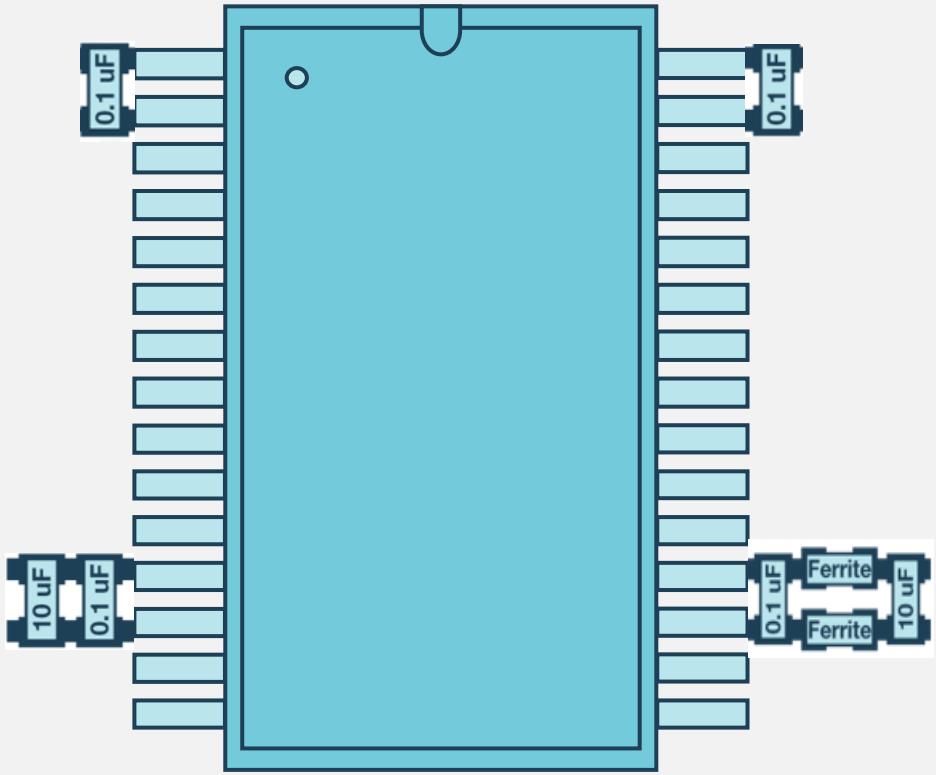
High Voltage Discrete Stitching Capacitor

A New Solution – ADuM6421A

- We need a solution **at the component level** that avoids generating high emissions
  - Improved coil design and coil driver circuits
  - Spectrum techniques to reduce the quasi-peak levels
  - Small inexpensive ferrite beads are used to block the high frequency common-mode currents on the secondary supply connections in order to reduce the dipole emissions further

Capable of passing CISPR 22 Class B emissions standard without the use of stitching capacitance on a 2 layer PCB

The New *iso*Power® with 4-Channels of Isolated Data

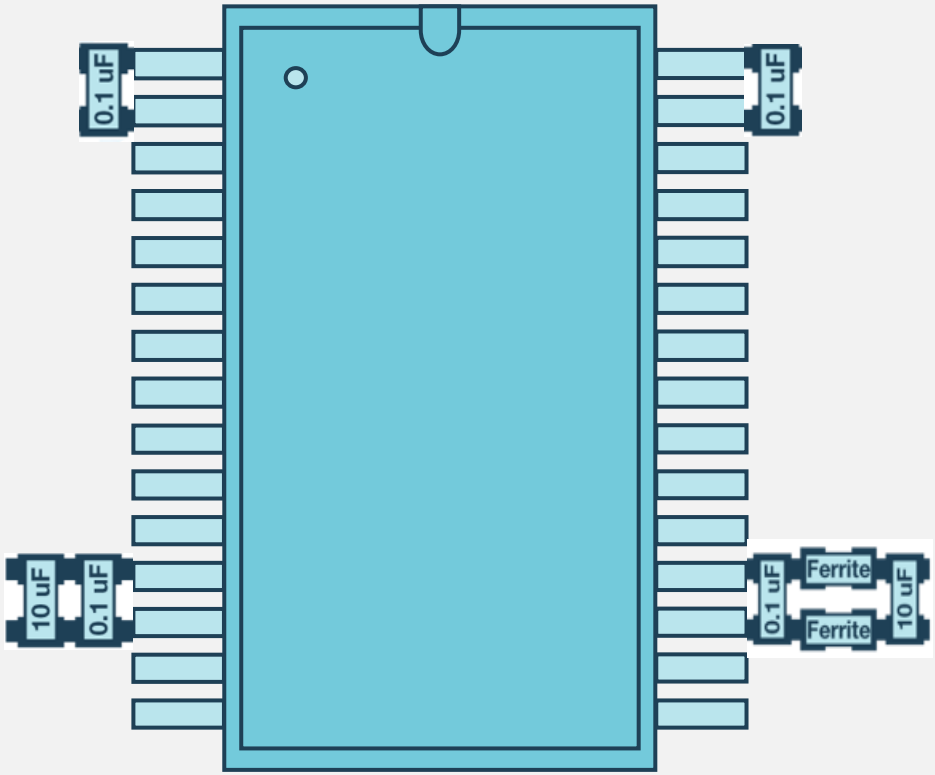


A New Solution – ADuM6421A

Low Emissions *iso*Power® Integrated,
Isolated DC-to-DC Converters
With 4 – Channels of Isolated Data

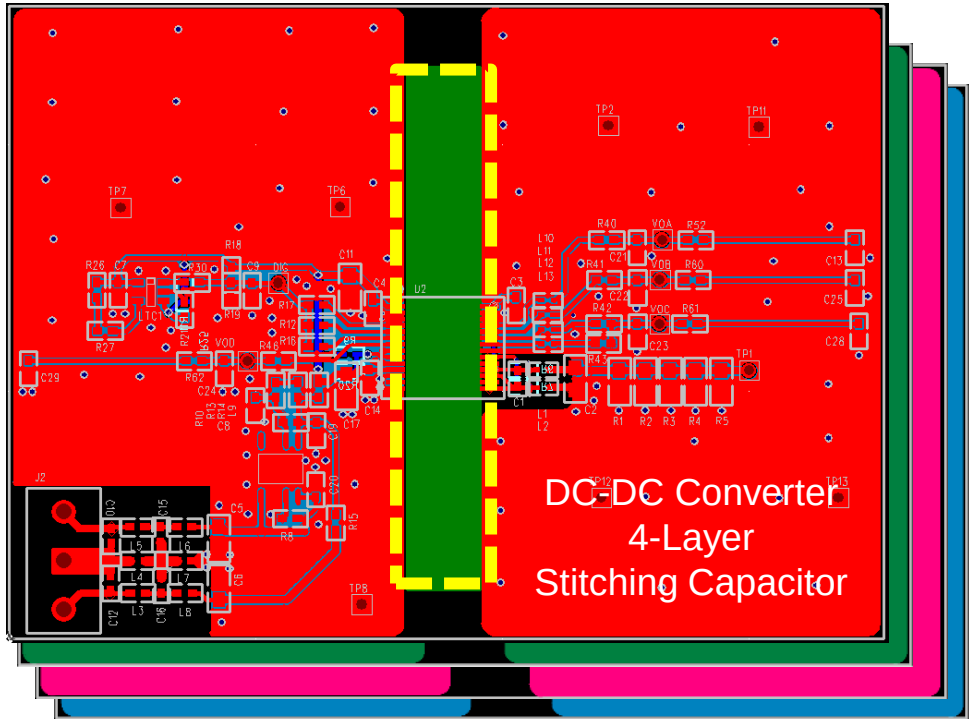
- Simplified EMC certification
  - Below EN 55022/CISPR 22 Class B emissions limits at full load on a 2 layer PCB
- Chip-scale package size
  - 28-lead Fine Pitch SOIC package with 8.3 mm minimum creepage
  - Same PCB real estate as 16 pin SOIC_W
- 500 mW integrated isolated output power
- Data isolation
  - Four High Speed Data Channels with high 100 kV/µs CMTI and high immunity to electrical noise and magnetic interference for robust performance in harsh environments
- Safety Certifications

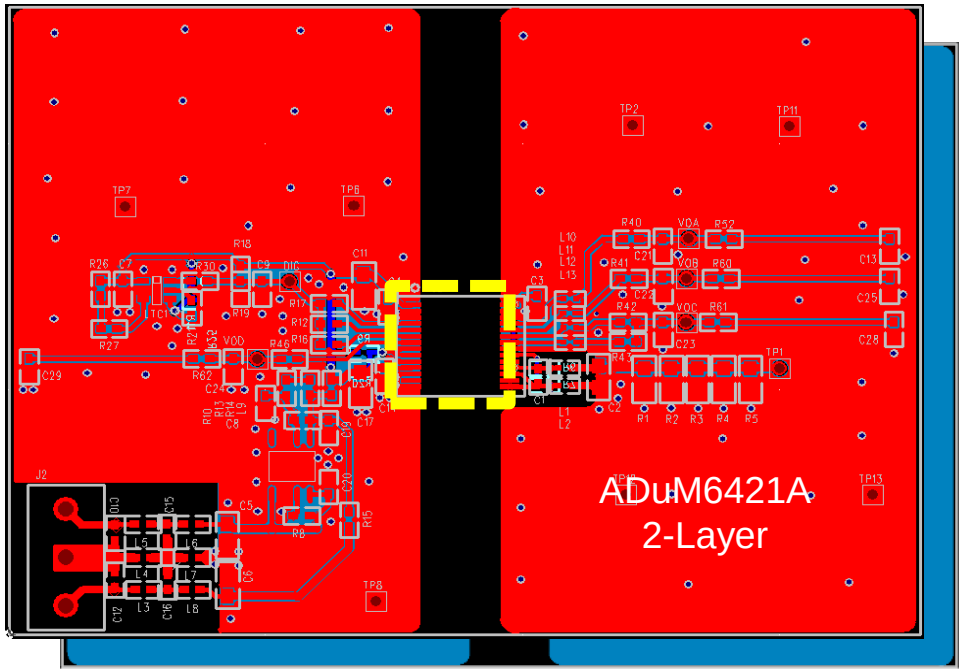
The ADuM6421A builds upon ADI's pioneering expertise in isolated data and power solutions



ADI iCoupler®

The Advantage: Simple and Small 2-Layer PCB



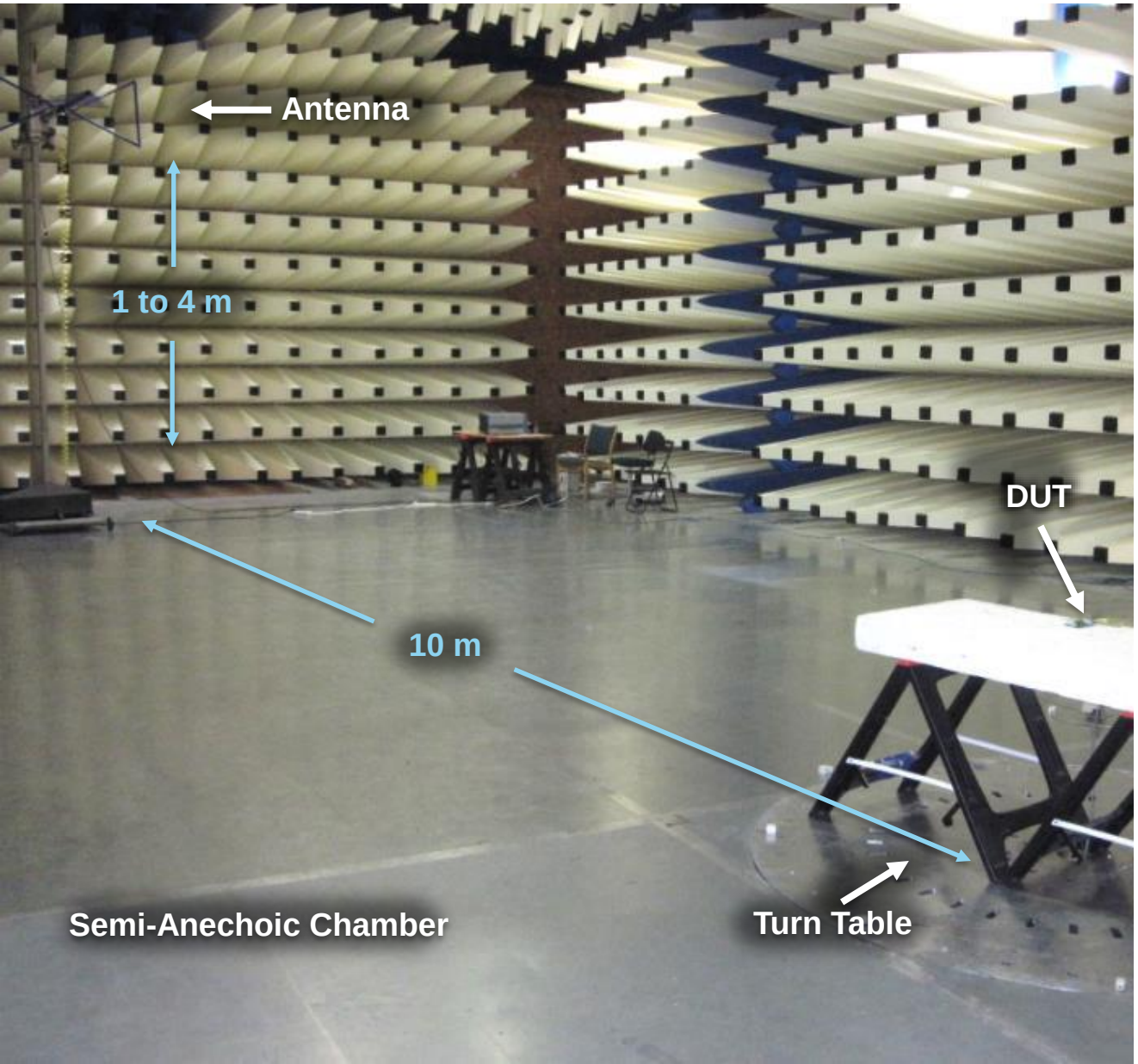


Space Savings
More than 70% PCB area savings

Lower Material Cost
Up to 30% on a 2-layer PCB

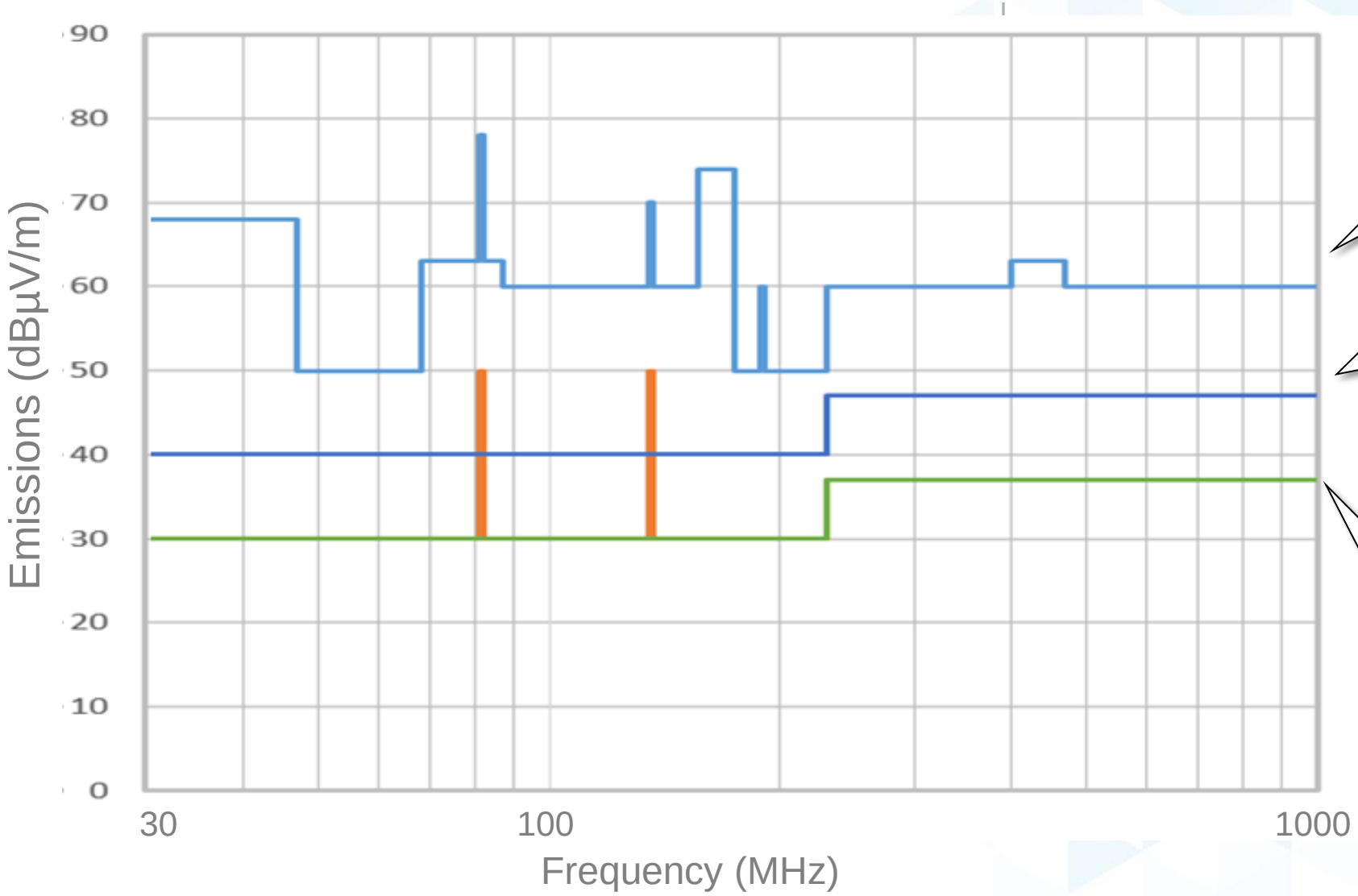
CISPR 32 Test Set-up

CISPR 32: Test Chamber Setup



- **Device under test (DUT)** in semi-anechoic chamber
  - Our evaluation board or
  - Customer board/module
- DUT/PCB on a nonconductive turntable
  - Non-floor standing DUTs must be 0.8 m above the horizontal ground reference plane
- Antenna detects emissions
  - 10 m from DUT
  - 1 m to 4 m height
  - Horizontal or vertical
- Auxiliary equipment placed outside the chamber

Summary of Radiated Emissions Limits

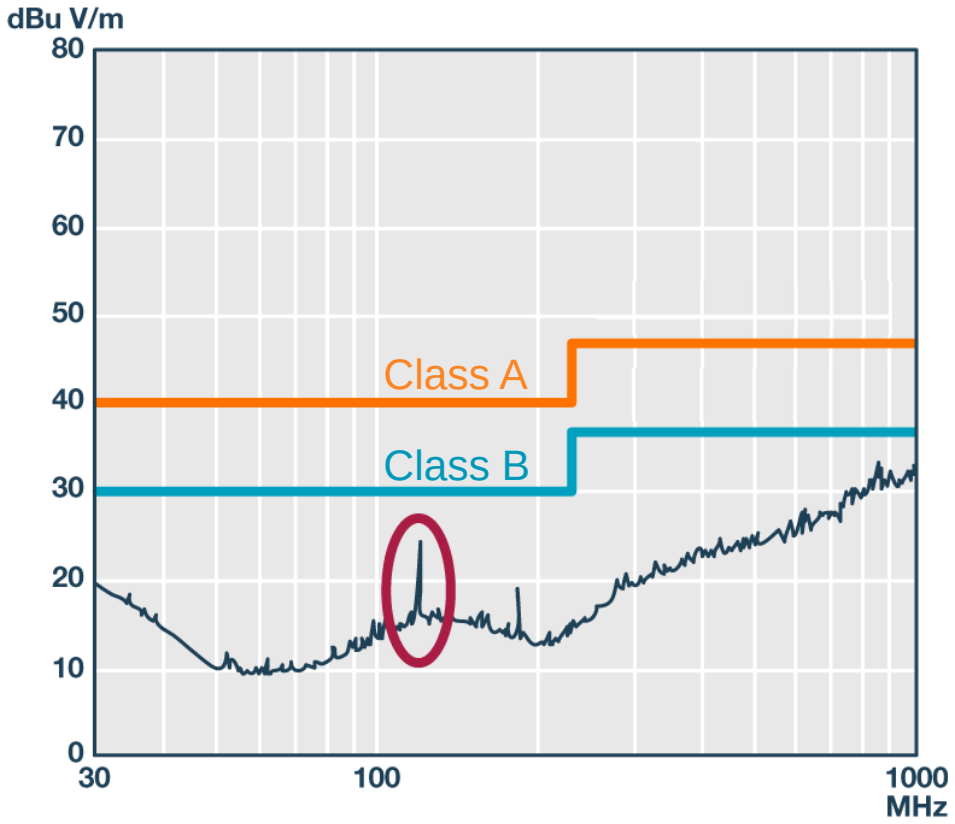


CISPR 11 - Group 2-Class A

CISPR 11 - Group 1-Class A
CISPR 22 - Class A
CISPR 32 - Class A

CISPR 11 - Group 2 - Class B
CISPR 11 - Group 1 - Class B
CISPR 22 - Class B
CISPR 32 - Class B

CISPR 32: Test Procedure



CISPR 32 Class A and Class B Limits from 30 MHz to 1 GHz

Step 1: Find the peak emissions with a spectrum analyzer

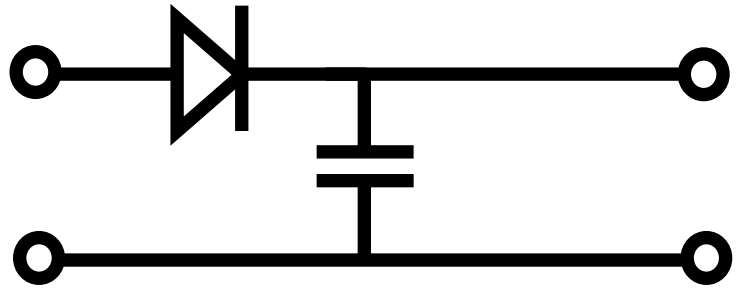
Step 2: Capture quasi-peak measurement

Step 3: Use a full rotation of turntable and vary antenna height from 1 m to 4 m

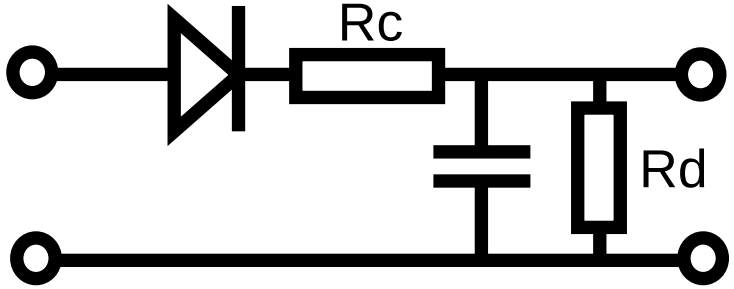
Step 4: Antenna used in horizontal and vertical orientations

Peak versus Quasi-Peak?

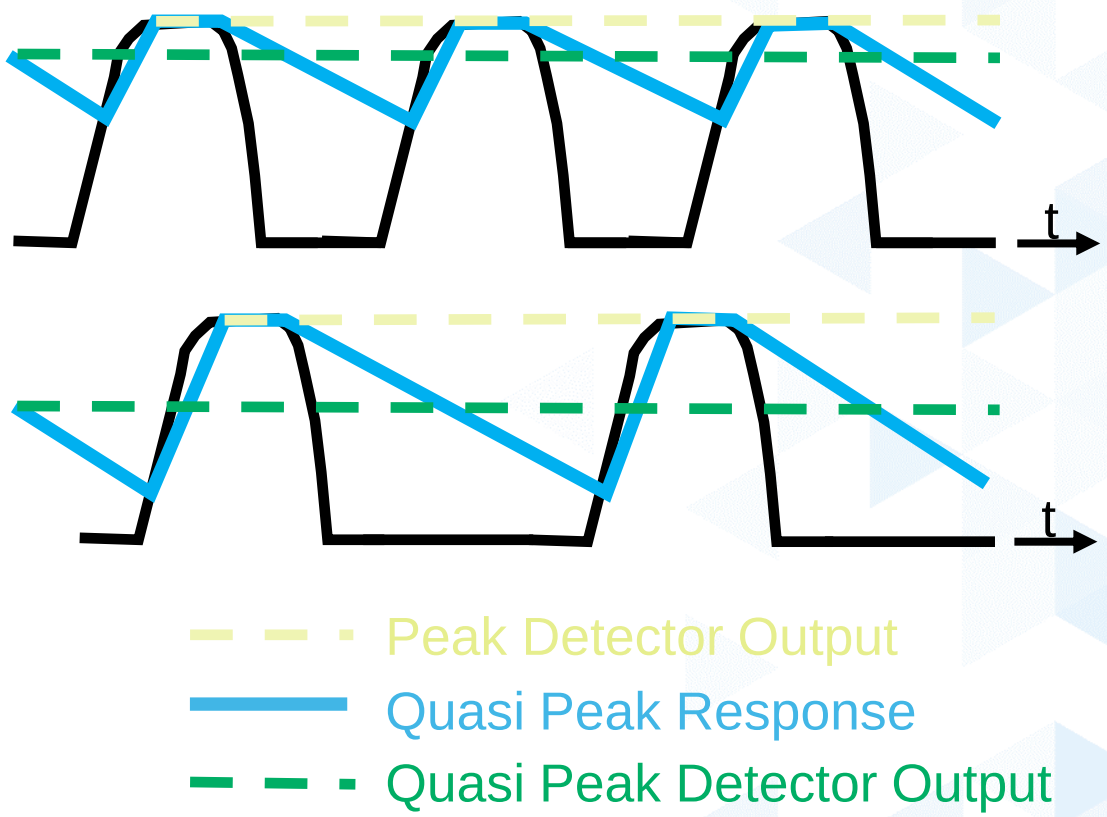
Peak Detector



Quasi Peak Detector



Peak and Quasi–peak versus impulse rate



Both Peak and Quasi peak measurements allow compliance to CISPR 32

Why do you Need Margin for Radiated Emissions?

1. Quality of Semi Anechoic Chamber

   The quality of the ground plane and how well reflections are controlled, Uncertainty: ±2 dB

2. Accuracy and Calibration of Equipment

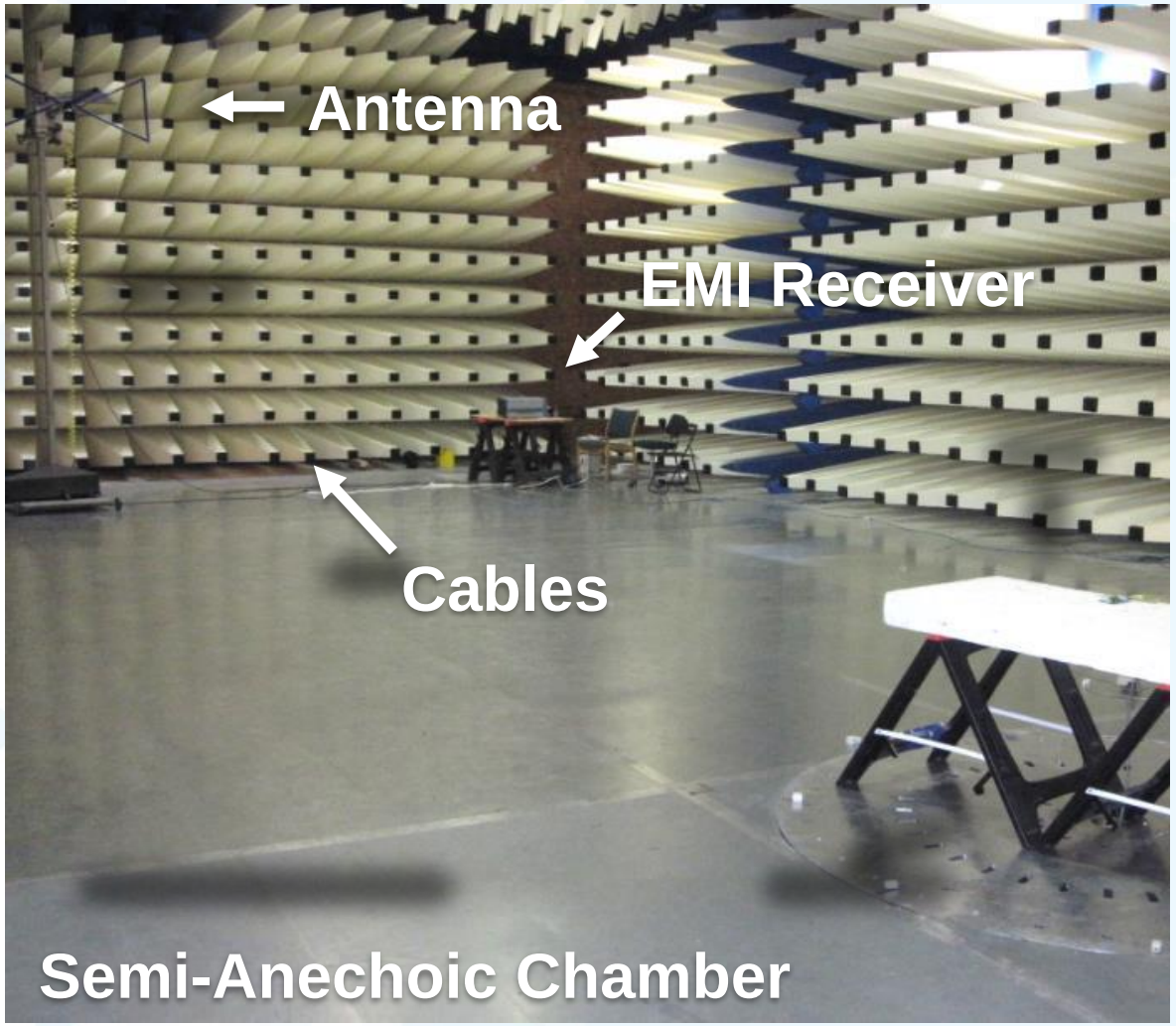
   a) Spectrum analyser, Uncertainty: ±1.5 dB

   b) Antenna calibration, Uncertainty: ±2 dB

   c) Cable inaccuracies, Uncertainty: ±0.5 dB

   d) Use of a pre-Amplifier, Uncertainty: ±1.5 dB

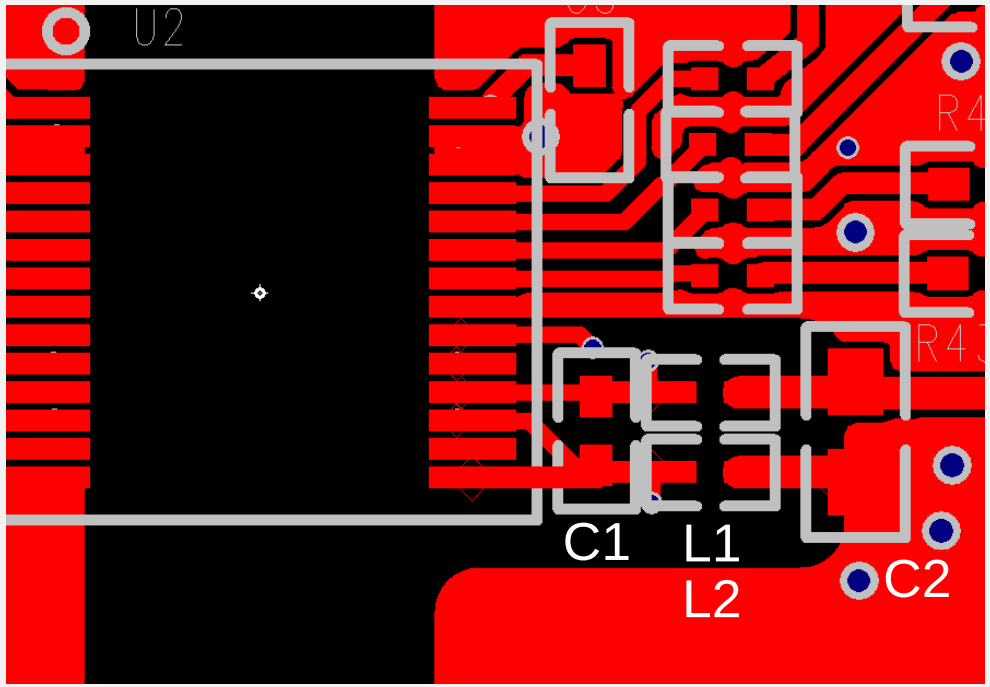
Uncertainty Approximately ±3 dB



EMI Test Results

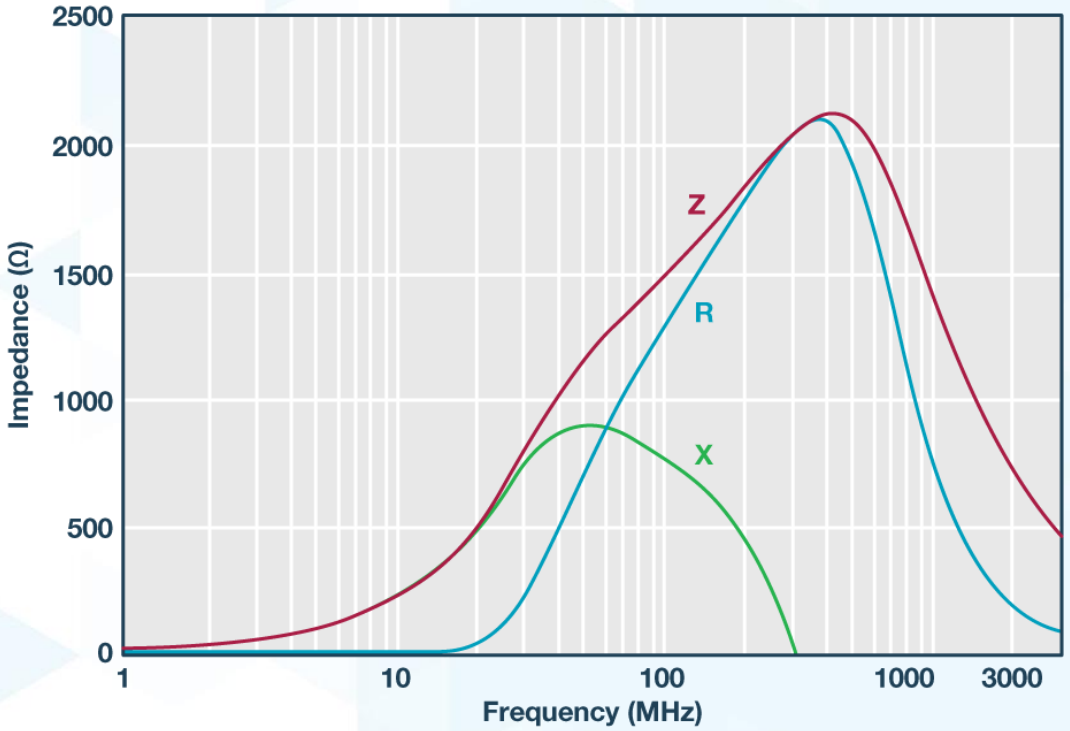
Simplified 2 Layer PC Board Layout

ADuM6421A populated on a 2 layer PCB, meets CISPR 32 Class B using ferrites on V_{ISO} and GND_{ISO}, but without stitching capacitance



Example of ADuM6421A 28-lead Fine Pitched SOIC Layout around the integrated circuit

Ferrites L1, L2 and Bypass Capacitors C1, C2

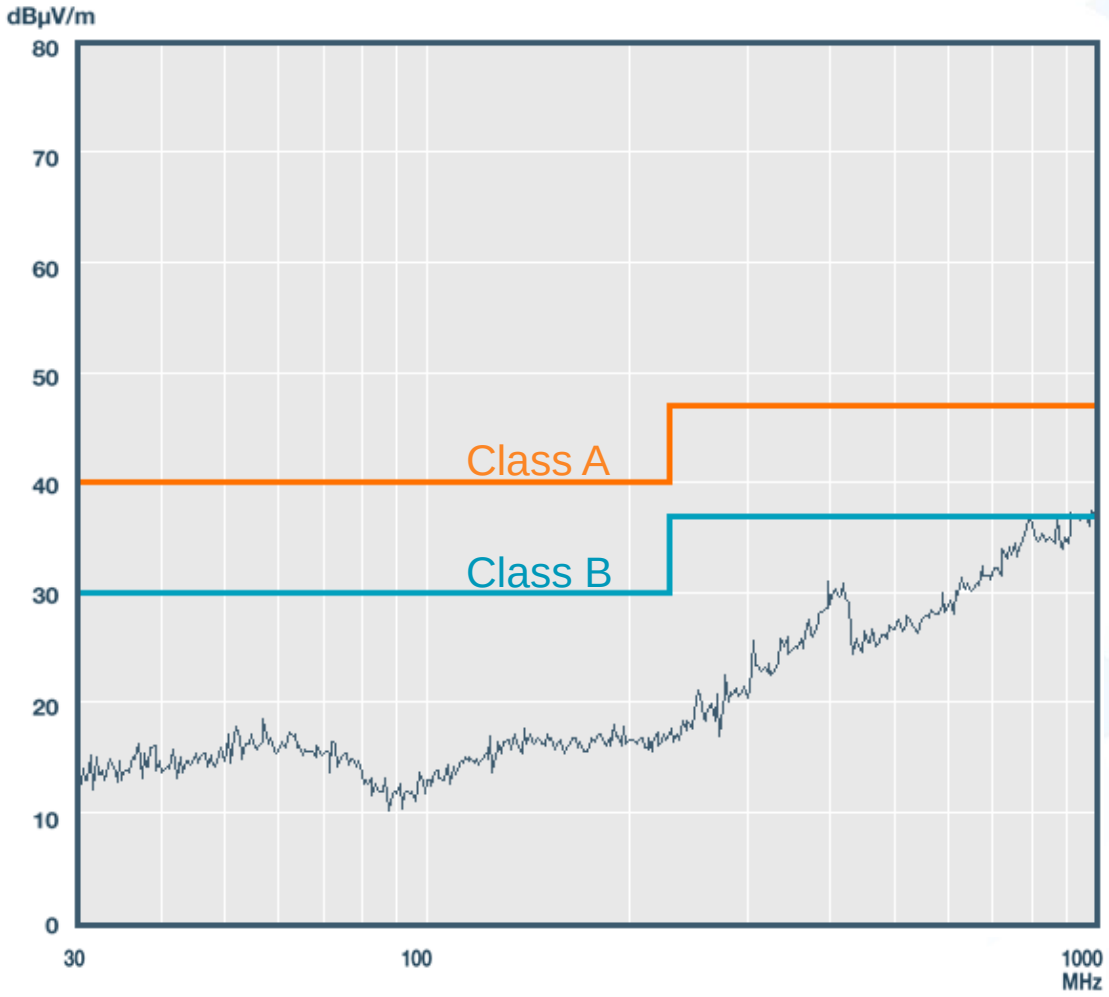


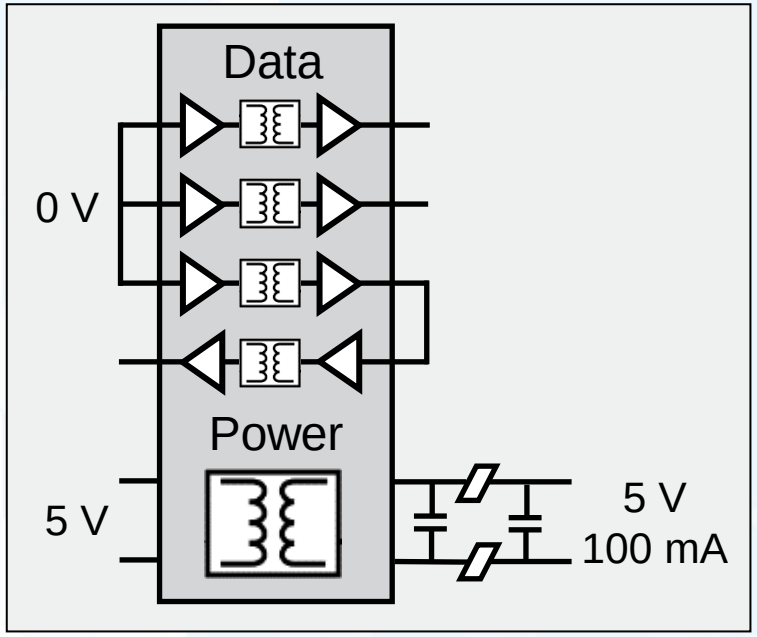
Ferrites L1, L2

Murata BLM15HD182SN1

Impedance of 1500 Ω from 100 MHz to 1000 MHz

ADuM6421A: Meeting CISPR 32 Class B

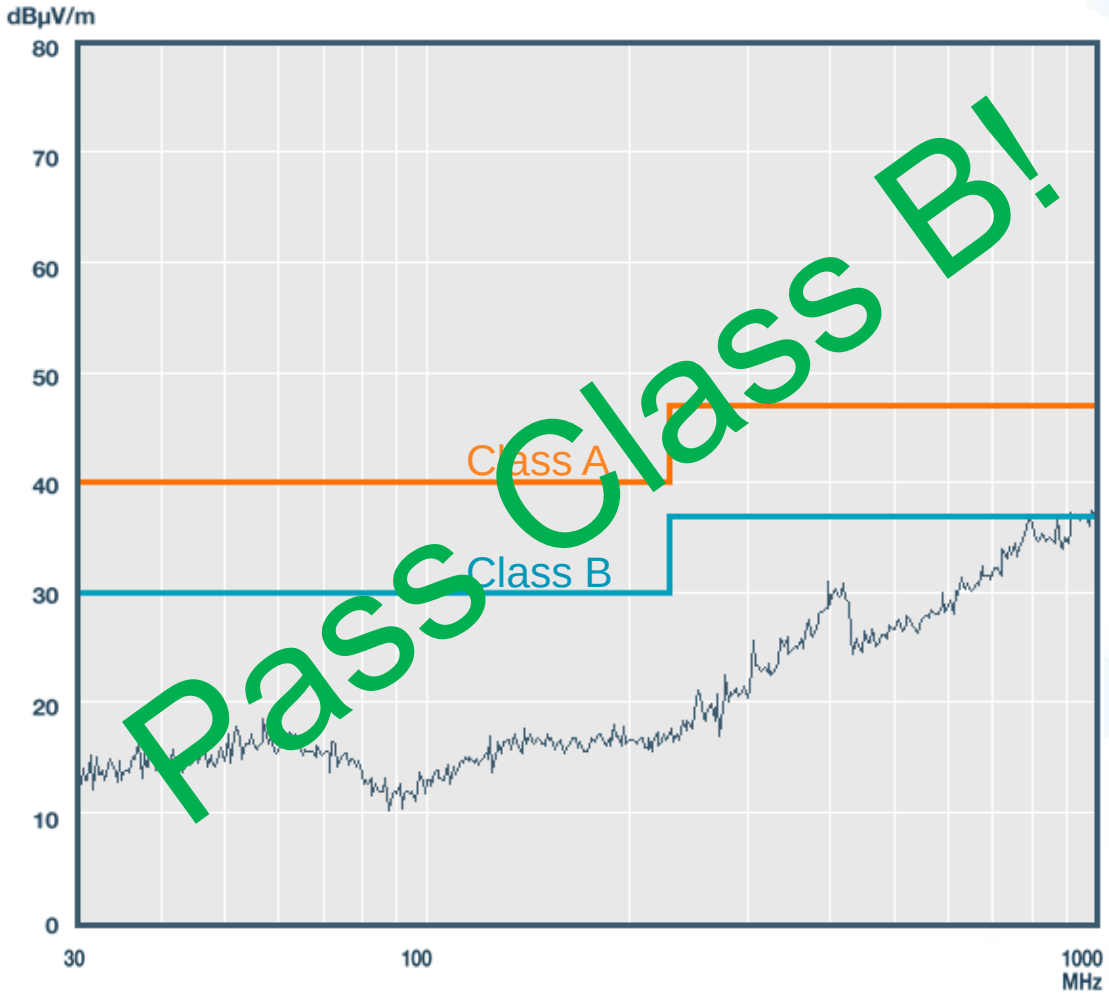


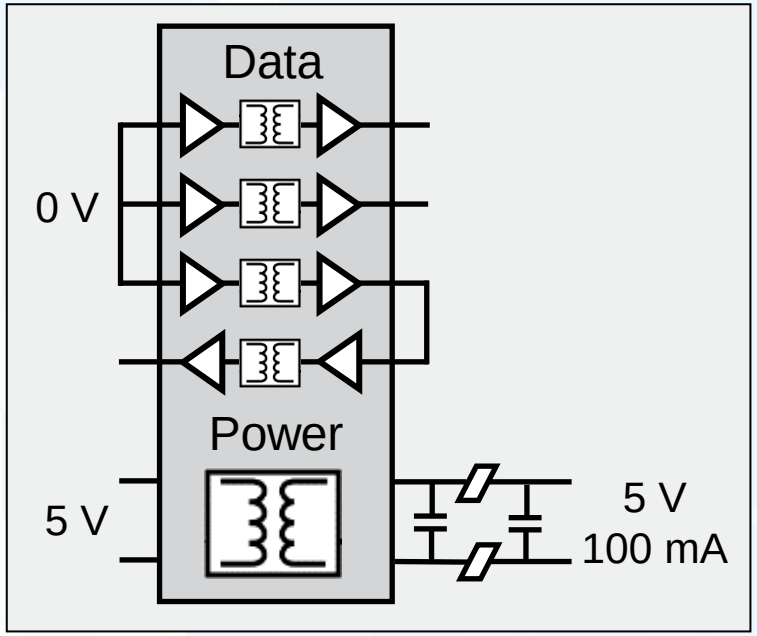


Frequency (MHz)	Quasi Peak (dBuV/m)	Margin to Class B (dB)
307.224	27.3	-9.7
397.09	30.2	-6.8
417.9	26.5	-10.5
791.467	32	-5
919.068	33.4	-3.6

Using 2 Layer PCB: Quasi-peak meets CISPR 32 Class B by 3.6 dB Margin

ADuM6421A: Meeting CISPR 32 Class B





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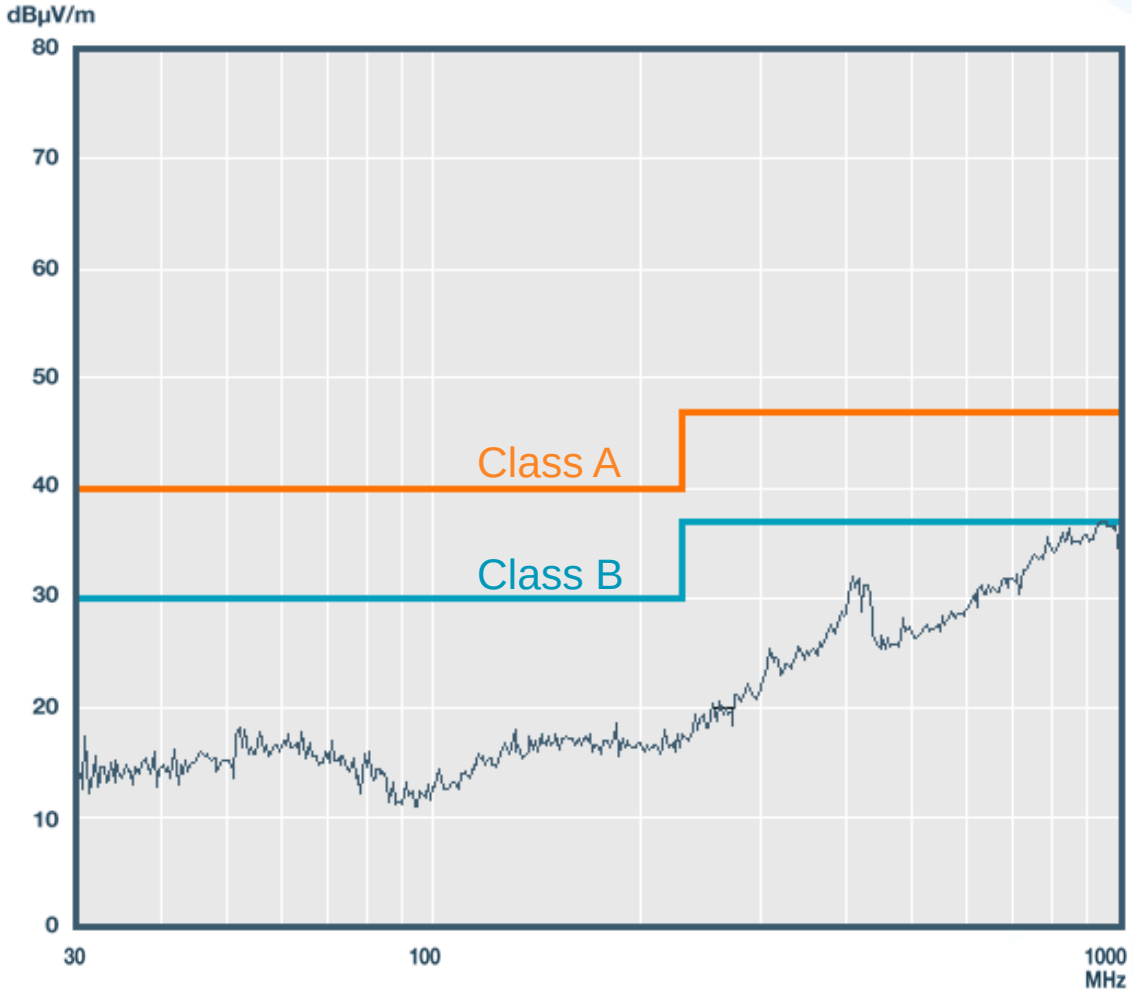

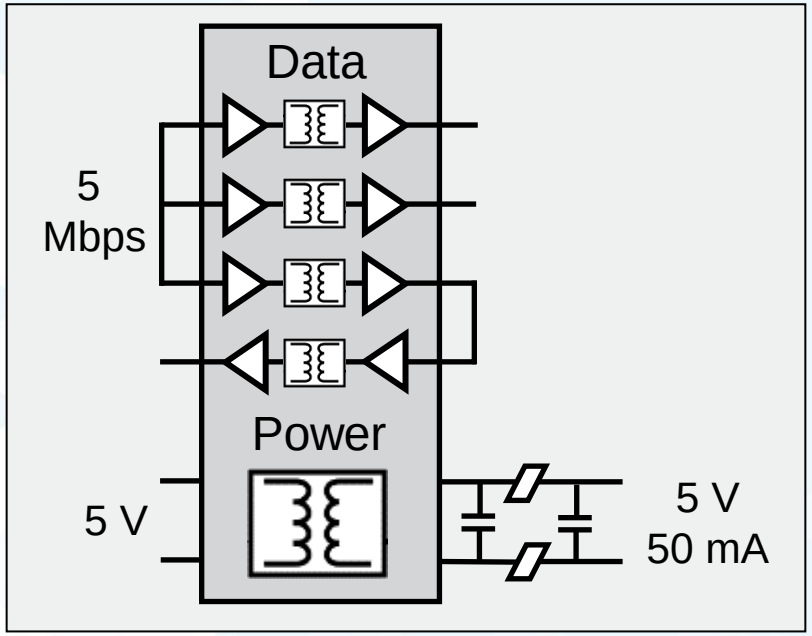

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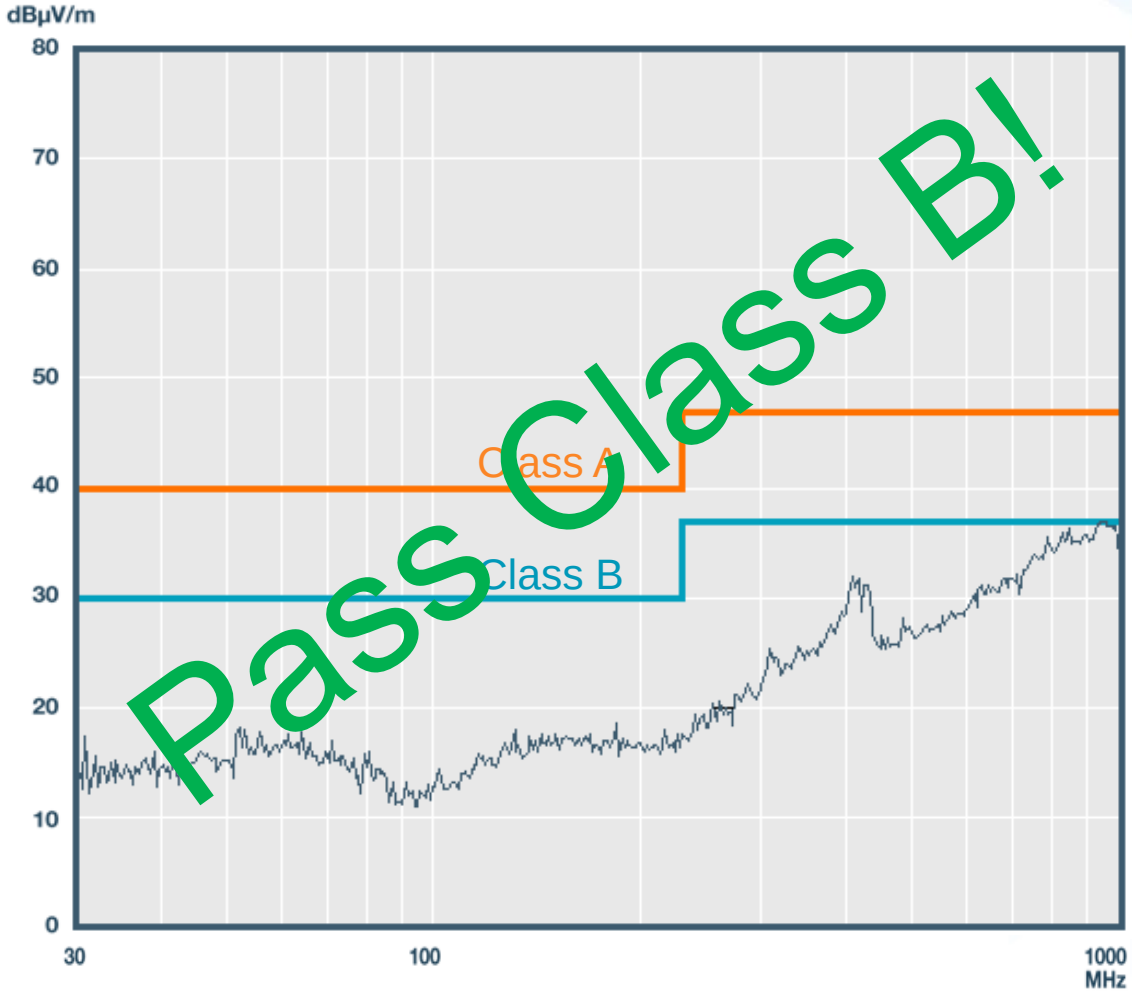
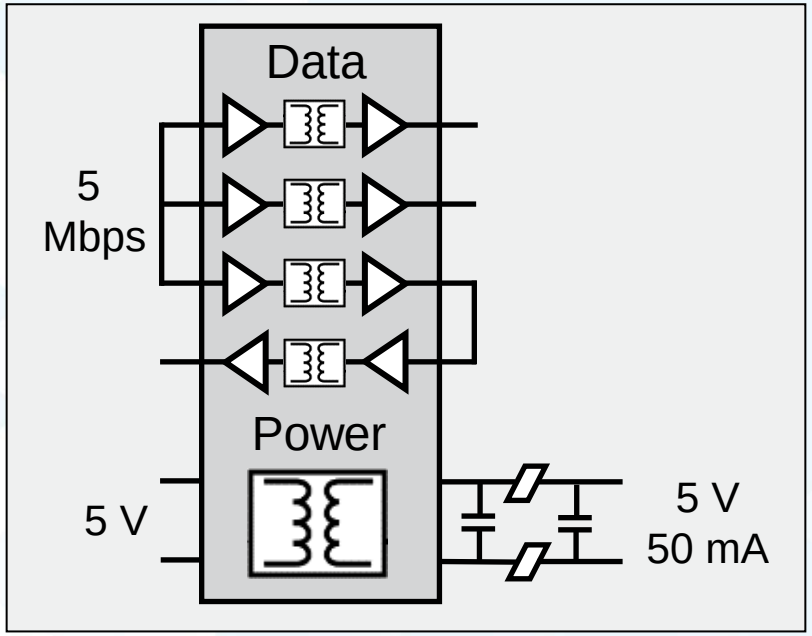
847.032	31	-6

Using 2 Layer PCB: Quasi-peak meets CISPR 32 Class B by 6 dB Margin

ADuM6421A: Meeting CISPR 32 Class B





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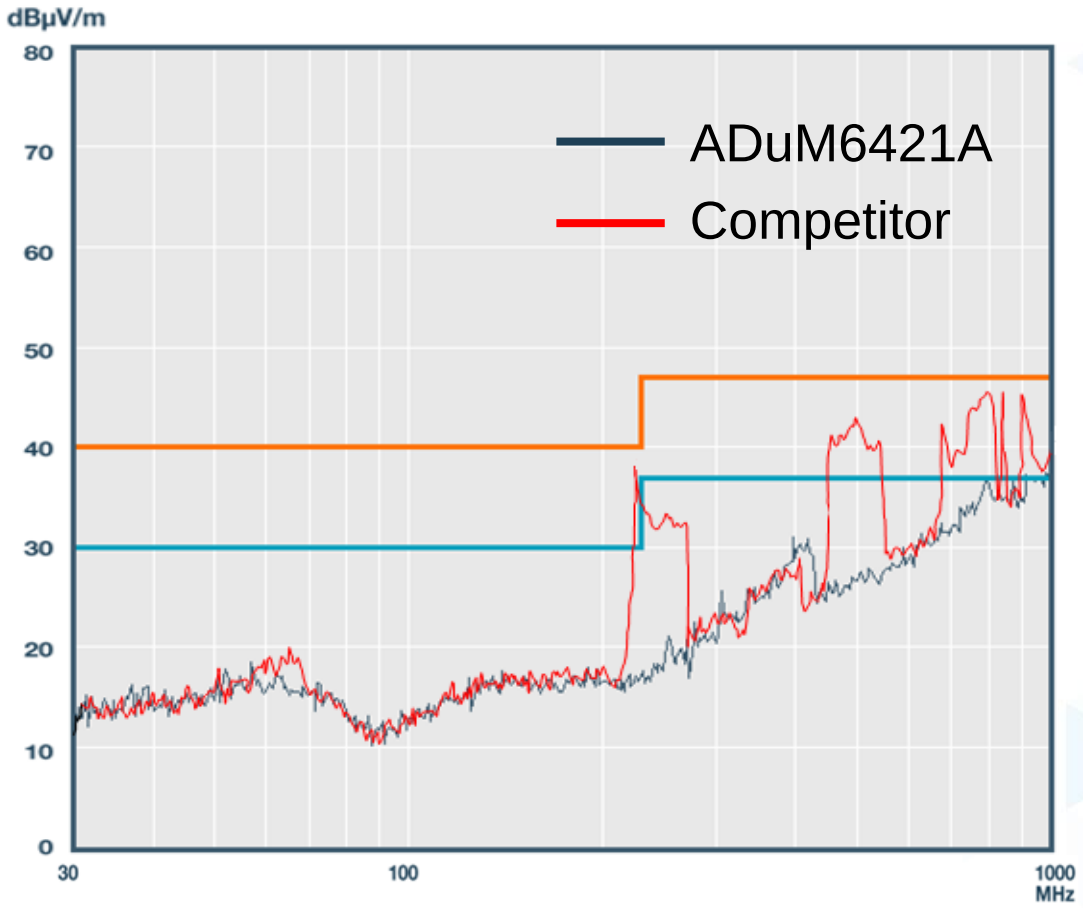
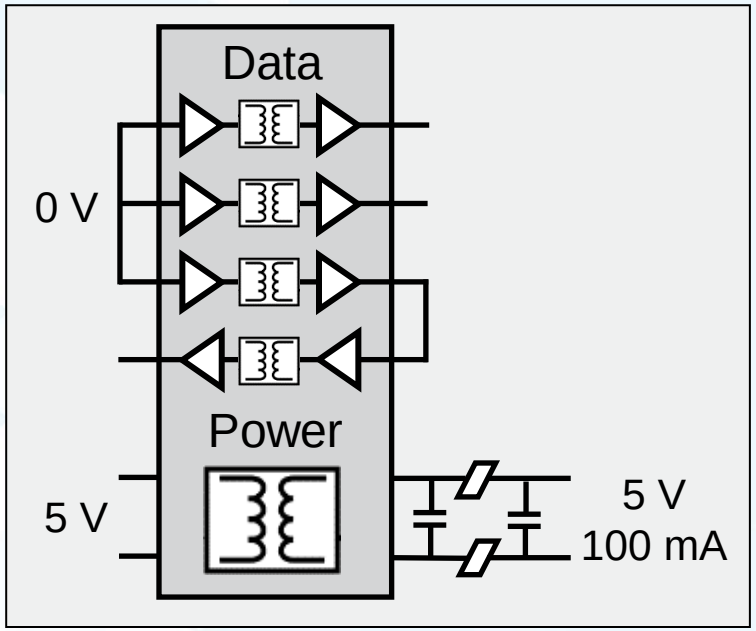
Using 2 Layer PCB: Quasi-peak meets CISPR 32 Class B by 6 dB Margin

ADuM6421A: Best in Class EMI Performance





	Frequency (MHz)	Quasi Peak (dBuV/m)	Worst Case Margin to Class B (dB)
Competitor	225.58	42	+12
ADuM6421A	919.068	33.4	-3.6

- Comparison of chip scale solutions available in the market.
- Both devices tested under same conditions.

Using 2 Layer PCB:
ADuM6421A superior performance over chip scale competitor devices

Expected Benefits and Next Steps

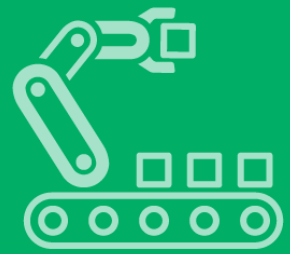
New *iso*Power® with 4-channels of Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

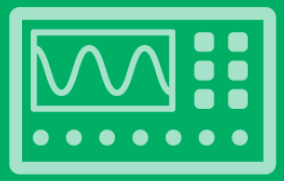
Compact, High Density, High Voltage Emerging Applications

- **Regulatory Compliance**
  Meets CISPR 22 Class B standards

Battery Monitoring and Inverters



Programmable Logic Controller (PLC)



Precision Measurement

Vital Signs Monitoring

ADI iCoupler®

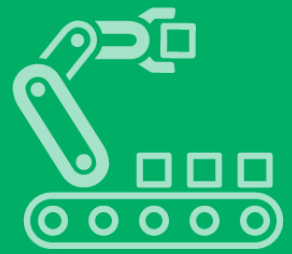
New *iso*Power® with 4-channels of Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Compact, High Density, High Voltage Emerging Applications

- **Reduced Complexity**
  No stitching capacitance needed

Battery Monitoring and Inverters



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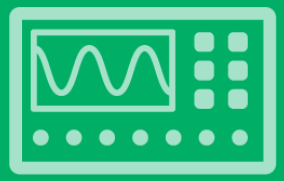


Precision Measurement

Vital Signs Monitoring

ADI iCoupler®

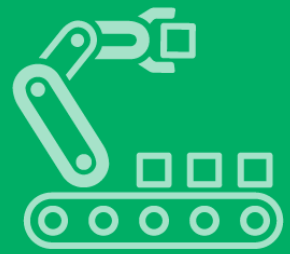
New *iso*Power® with 4-channels of Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Compact, High Density, High Voltage Emerging Applications

- **Lower Material Cost**
  Up to 30% on a 2-layer PCB

Battery Monitoring and Inverters



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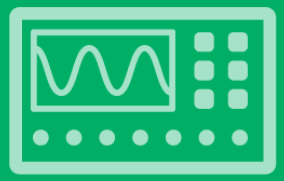


Precision Measurement

Vital Signs Monitoring

ADI iCoupler®

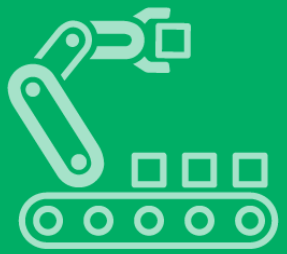
New *iso*Power® with 4-channels of Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Compact, High Density, High Voltage Emerging Applications

- **Smaller Application Size**
  Up to 70% PCB space savings

Battery Monitoring and Inverters



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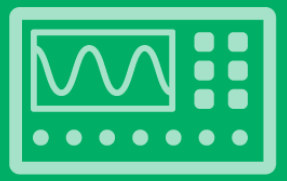


Precision Measurement

Vital Signs Monitoring

ADI iCoupler®

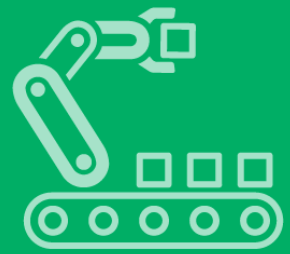
New *iso*Power® with 4-channels of Isolated Data

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

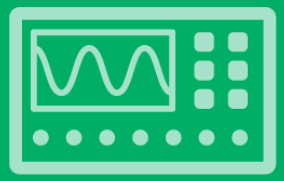
Compact, High Density, High Voltage Emerging Applications

- **Faster Time to Market**
  Reduced PCB design and test time

Battery Monitoring and Inverters



Programmable Logic Controller (PLC)



Precision Measurement

Vital Signs Monitoring

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Next Steps with ADuM6421A

Visit analog.com/ADuM6421A for more resources

Order an eval board EVAL-ADuM6421AEBZ with user guide containing layout and emissions data

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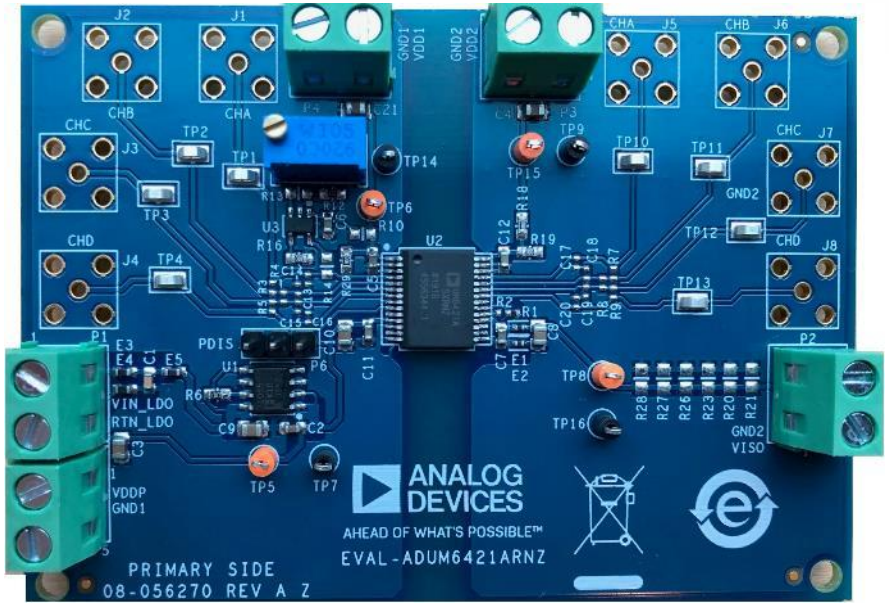

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