

Pros of having an In-House EMC Testing Lab in your pocket

EMCLIVE[™]
TESTING

Ed Sveda

EMC Technologist/Spectrum Control

EMC Technologist for Spectrum Control assisting manufacturers in attaining EMC compliance for their products. iNARTE certified EMC Technician since 1989, iNARTE certified EMC Engineer since 1997, and 36 years of experience in Electromagnetic Compatibility testing.

Presentation Overview

- EMI/RFI filter overview
- Low-pass filters for power and signal applications
- In-house EMC lab with semi-anechoic chamber
- Evaluate and tune installed filter performance
- Case studies
 - LED headlamp with discrete feedthrough filters
 - Shipboard electronics system with filtered connectors, terminal blocks, and multi-section input power filter
 - Ultra-low leakage current medical grade power filter
 - Military avionics filter for 400Hz three-phase power

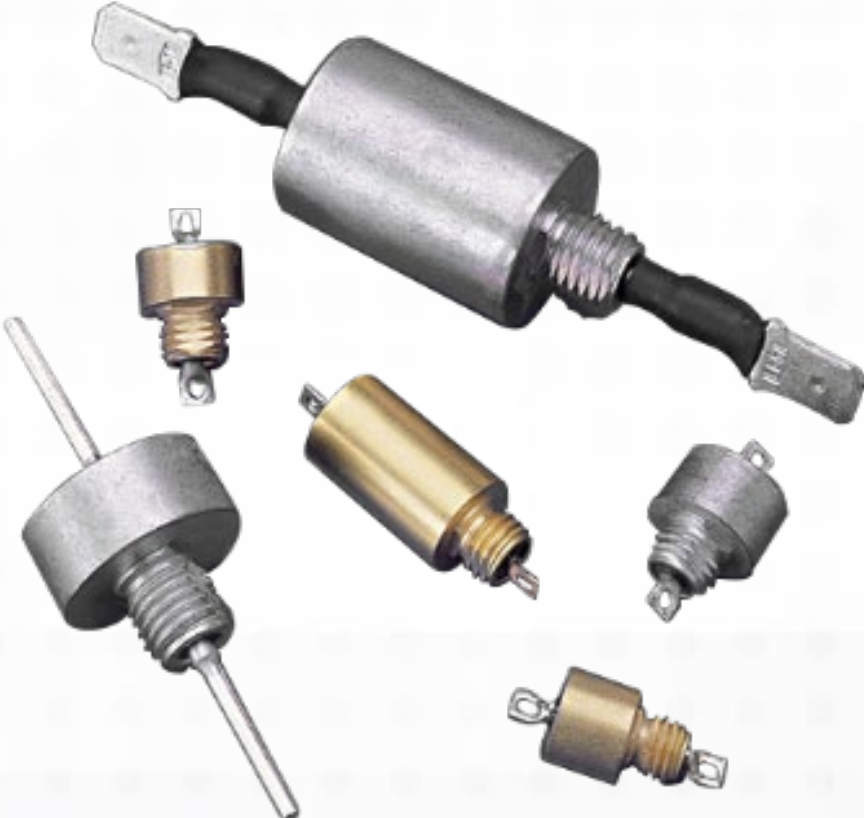
Coaxial / Discrete Filter Overview

- Discrete, threaded body, single line, feedthrough filter
- Coaxial ceramic capacitor
- Self-resonant frequency above 1GHz
- Near ideal capacitor impedance vs. frequency response
- Requires mounting to shielded enclosure for maximum attenuation and isolation input to output

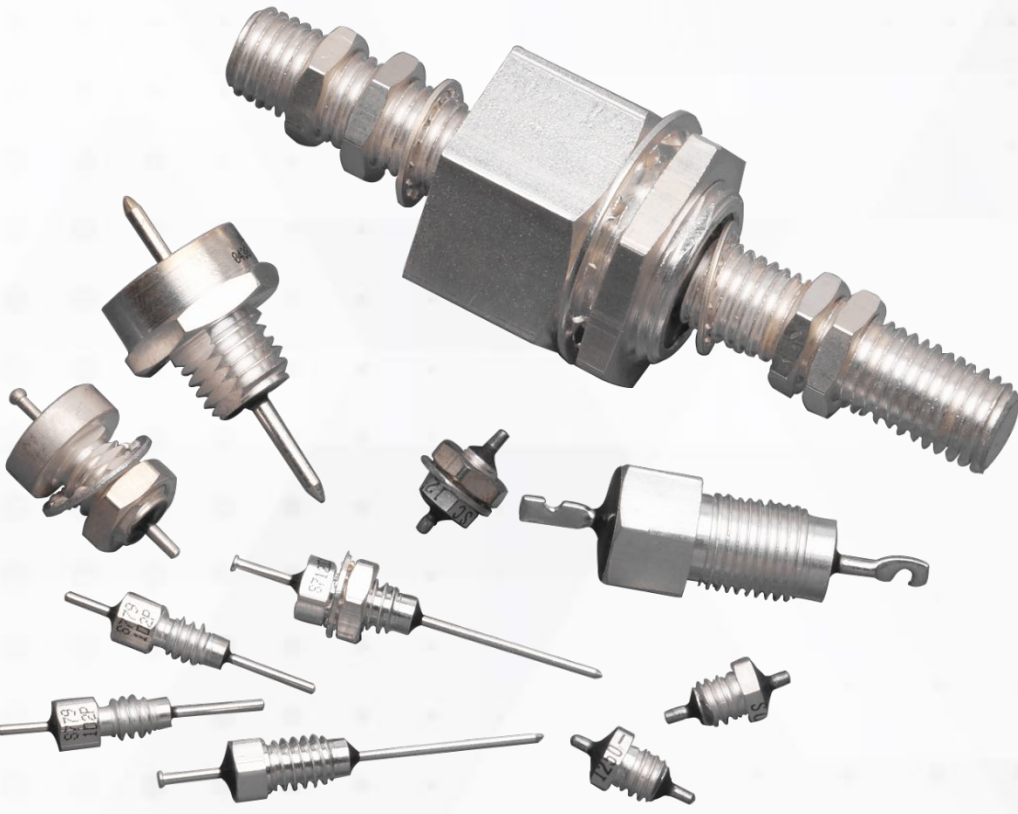
Discrete / Coaxial Products



Solder-In Filters

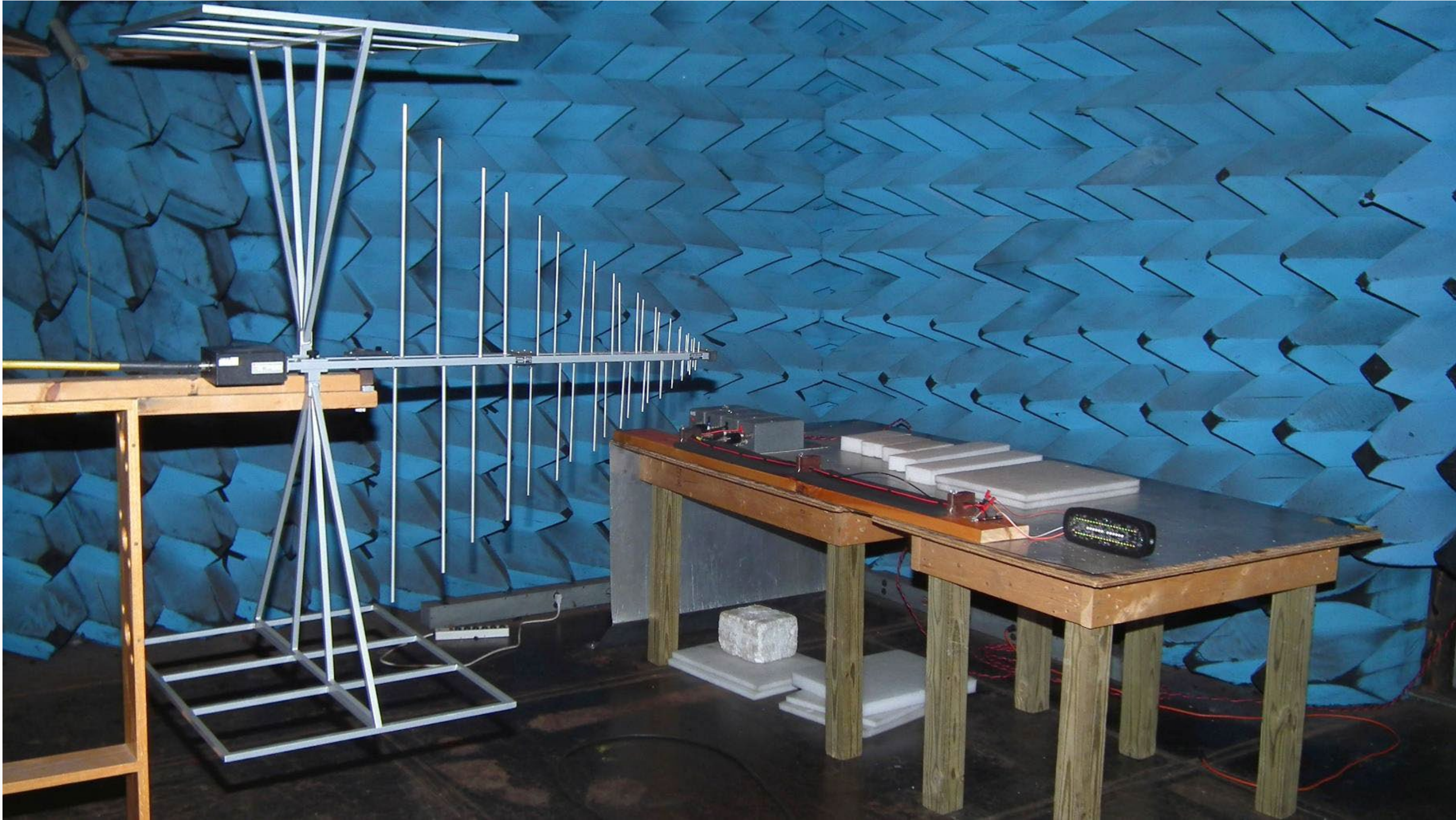


Hermetically Sealed Filters



Resin Sealed Bolt-In Filters

28V LED Headlamp Test per MIL-STD-461 RE102



LED Headlamp

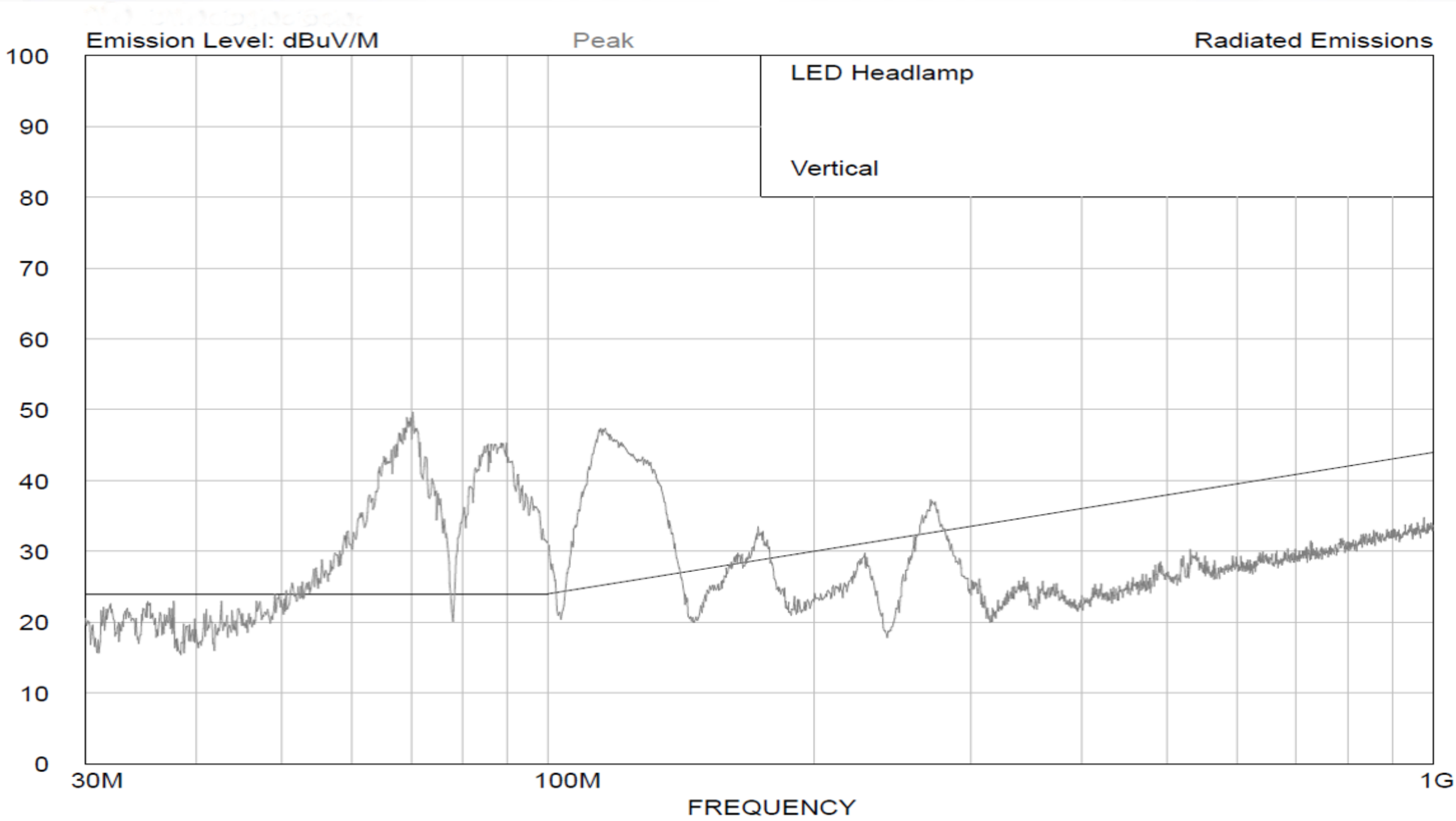
Problem:

- Radiated emissions out of spec
- Limited time before production
- Existing inventory of circuit boards

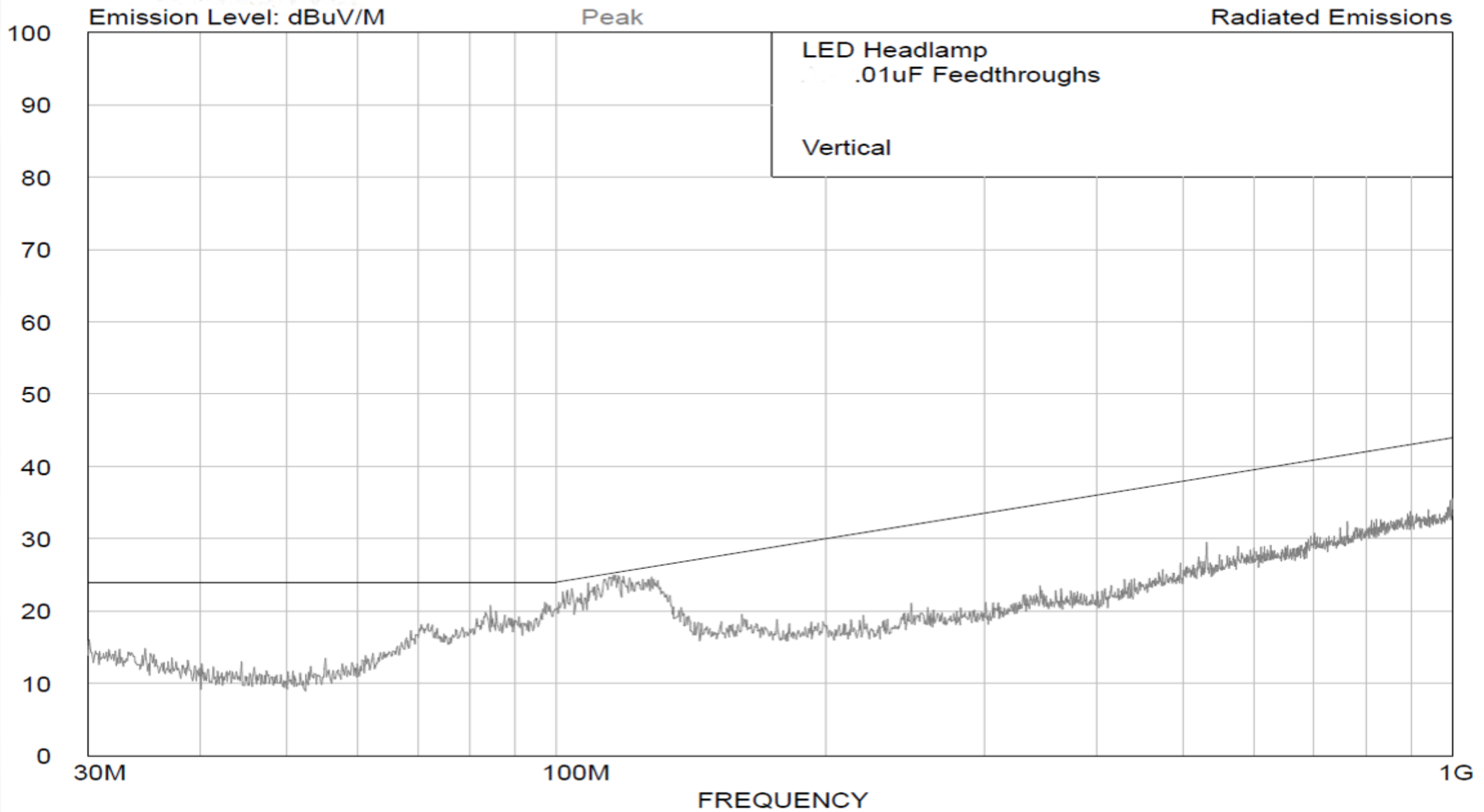
Design considerations:

- MIL-STD-461 RE102 compliance required
- Use off-the-shelf filters

Initial Radiated Emissions Data



Radiated Emissions with 10nF Feedthrough Filters



LED Headlamp Solution Timeline

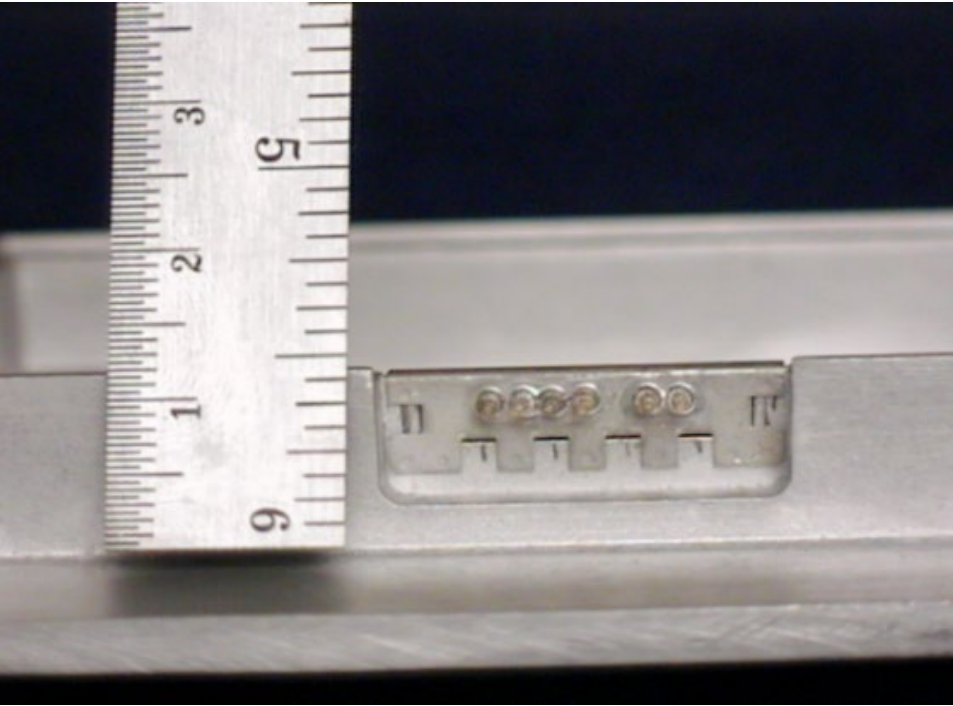
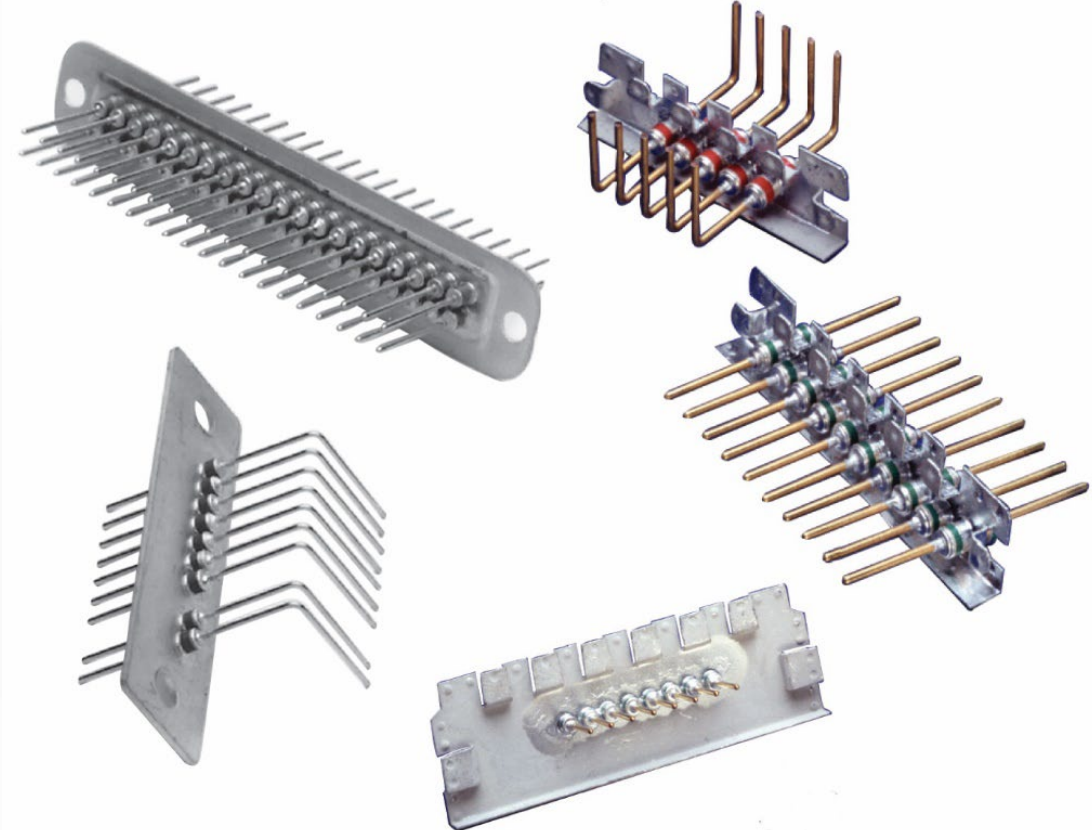
Recap:

- Initial testing – 2 hours
- 10nf off the shelf feedthrough filters installed – 2 hours
- Design verification – 2 hours

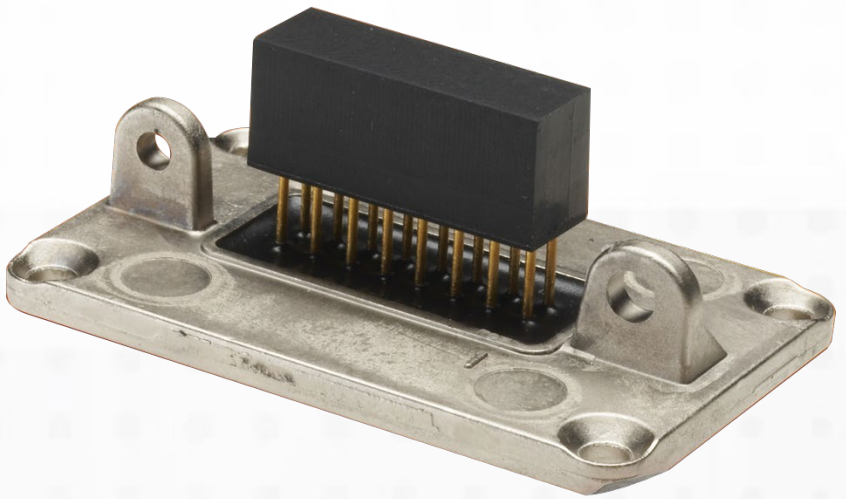
Interconnect and Array Overview

- Multiple coaxial ceramic feedthrough capacitors in one assembly
- Requires mounting to shielded enclosure for maximum attenuation and isolation input to output
- Does not require extra space on or modifications to circuit boards
- Can be implemented in different connector housing styles
- Filter plates / arrays
- D-sub Connectors
 - Low profile
 - High density
 - High performance
- Custom connector styles
- Specialty circular connectors

Interconnects and Filter Arrays



Filter Plates & Arrays



D-Sub Filtered Connectors

Interconnects and Filter Arrays



Hot Shoe Connectors



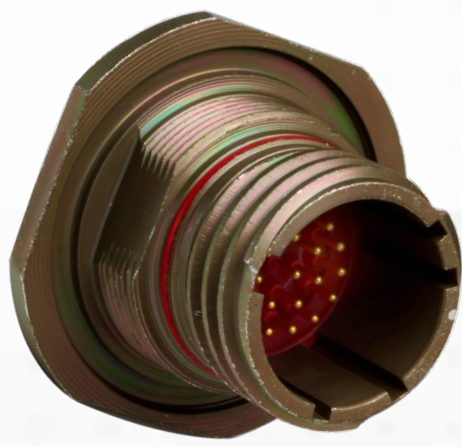
Audio Connectors



Micro-D Connectors



Terminal Blocks



Specialty Circular Connectors

Shipboard Electronics Radiated Emissions per ABS



Shipboard Electronics System

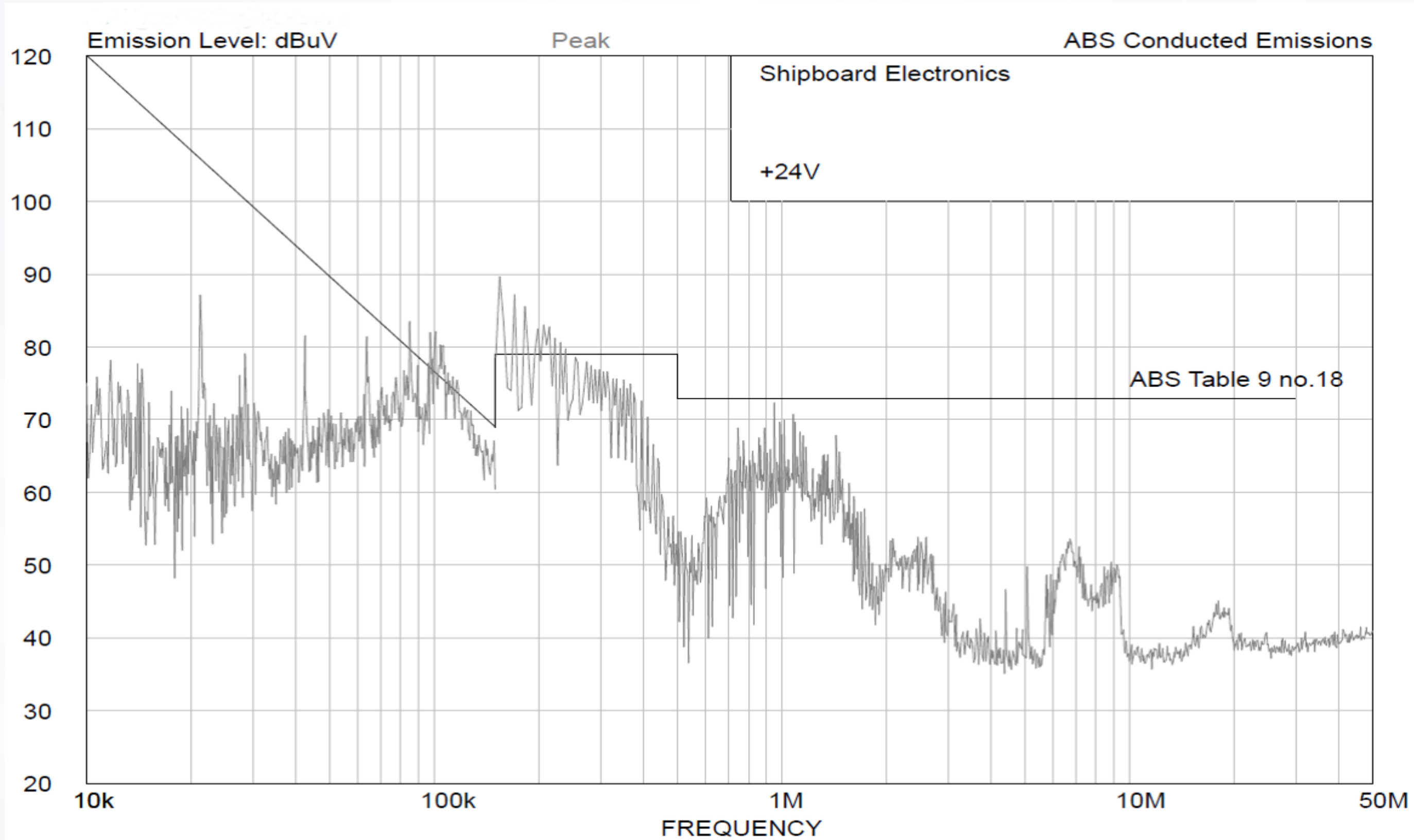
Problem:

- Conducted emissions out of spec
- Radiated emissions out of spec
- Limited time before production

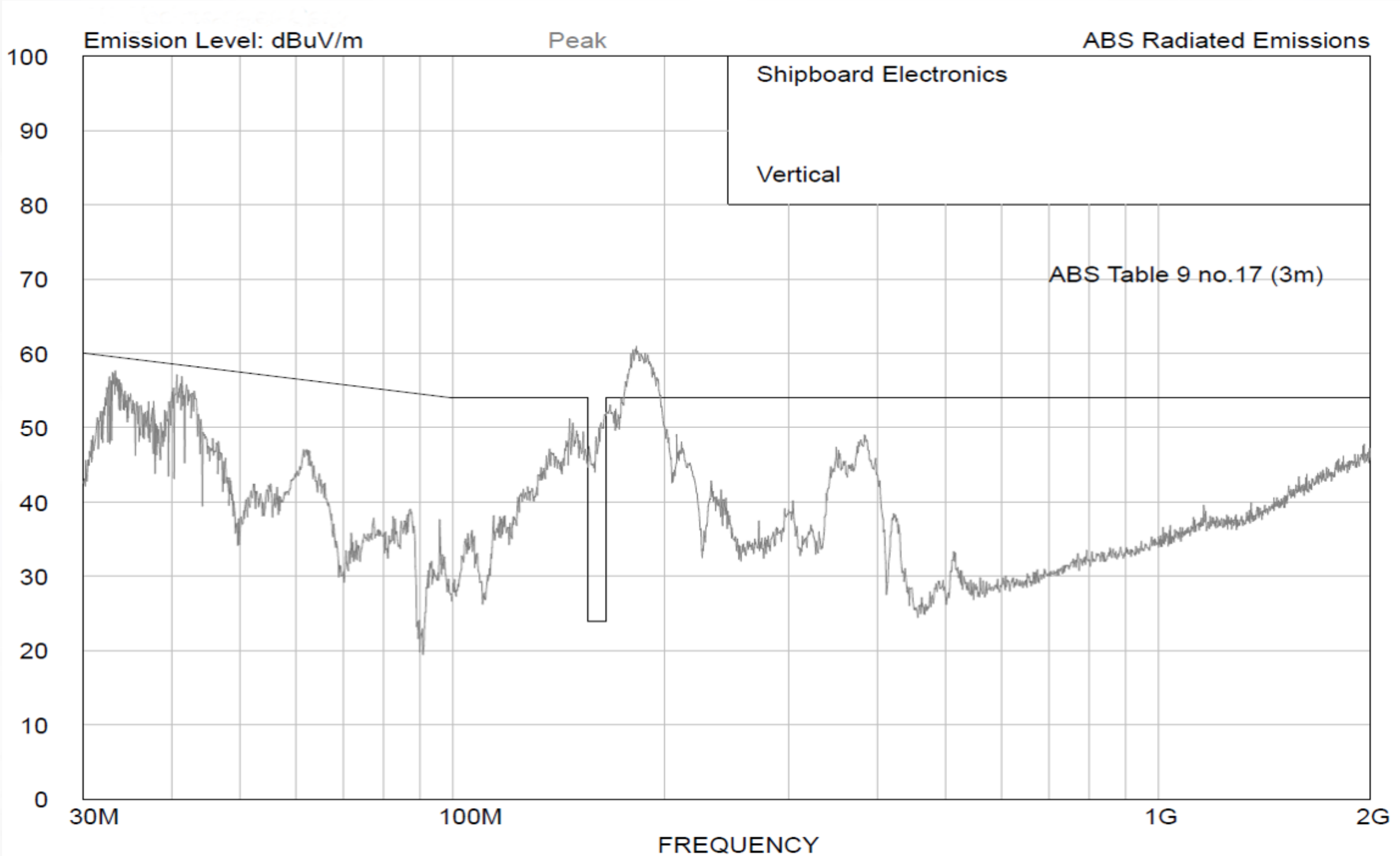
Design considerations:

- Compliance with American Bureau of Shipping emission limits
- Improve immunity of low-level analog sensor inputs
- Use of off-the-shelf filters

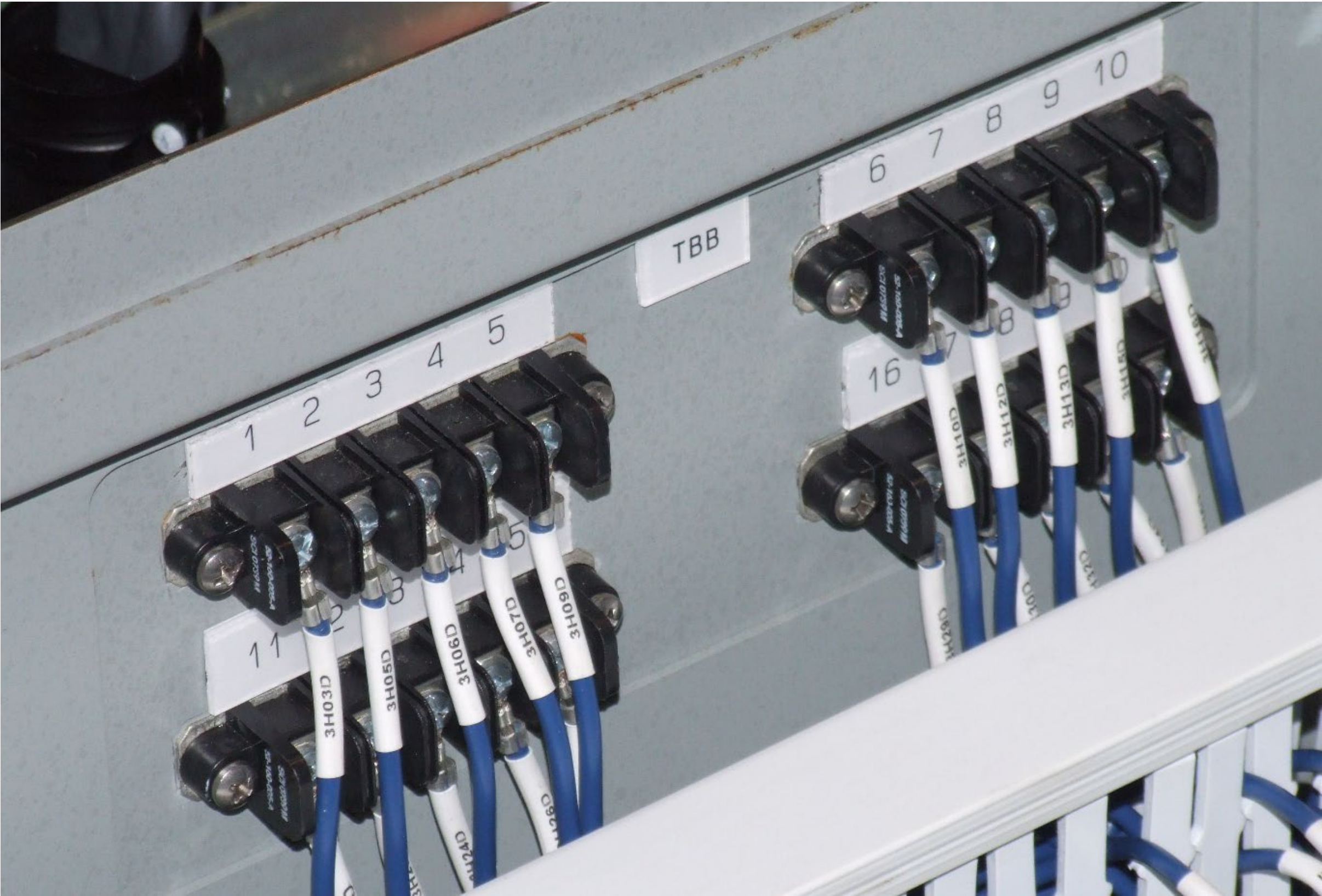
Initial Conducted Emissions Data



Initial Radiated Emissions Data



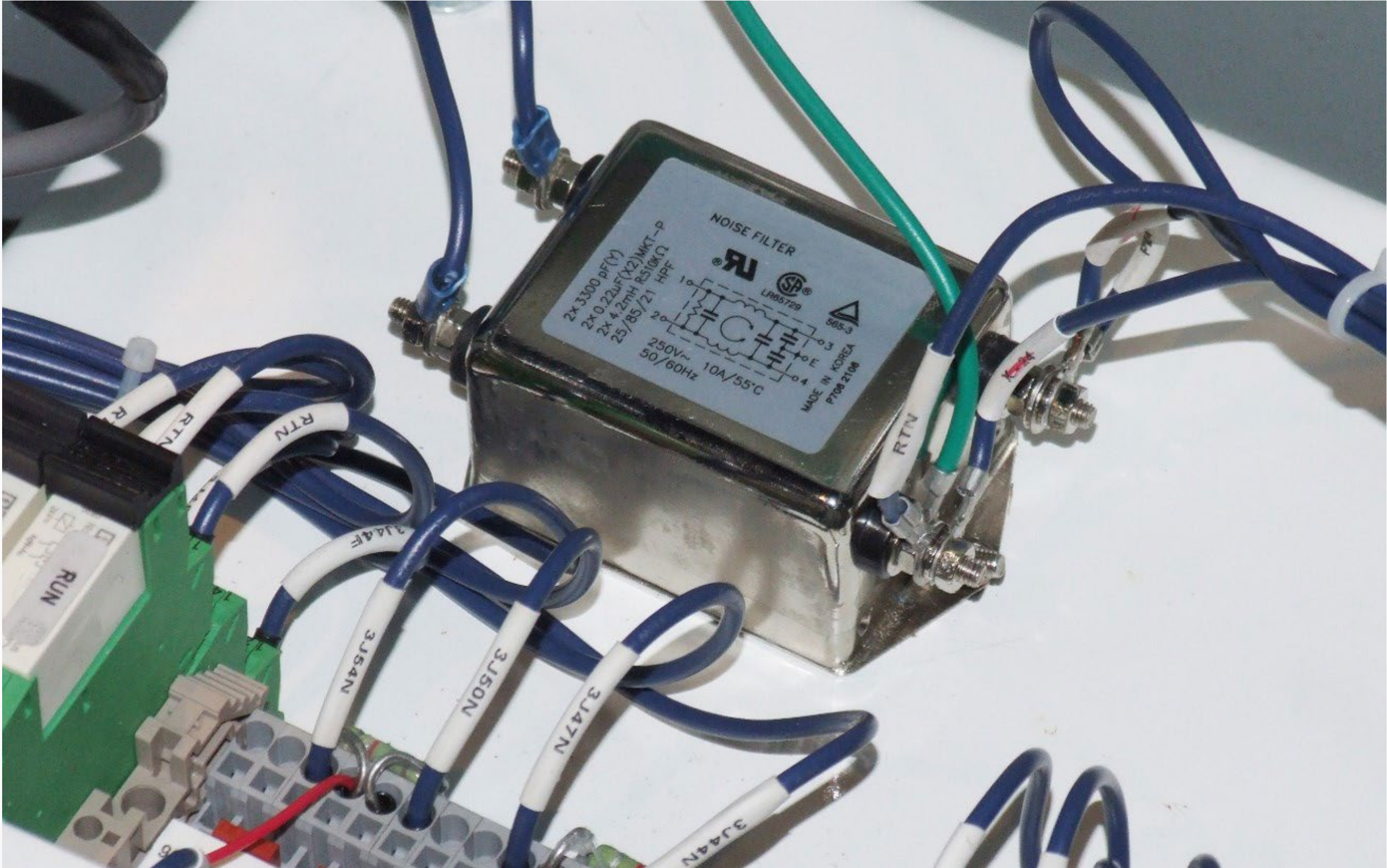
Filtered Terminal Blocks Used on DC I/O Lines



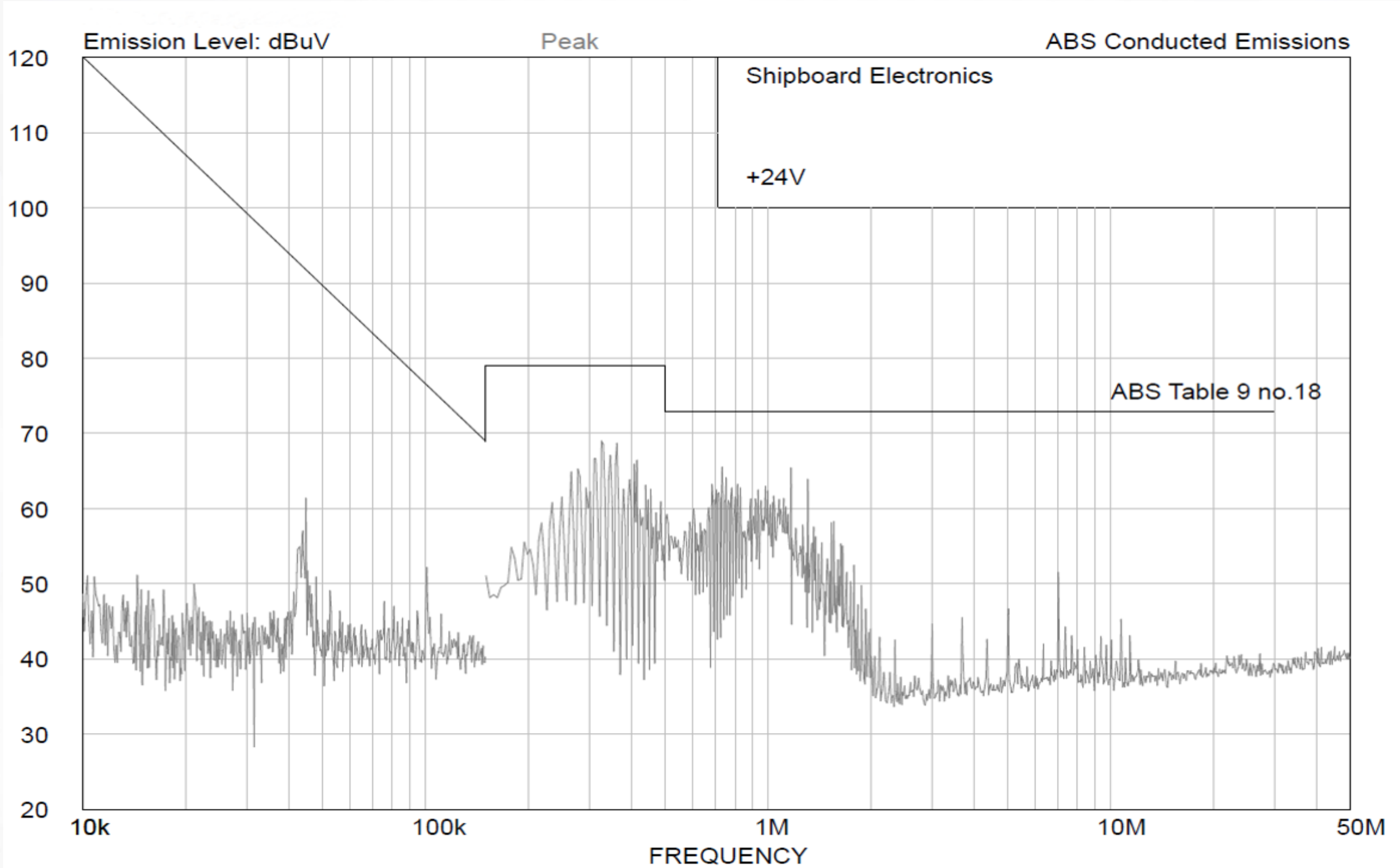
Filtered D-Subs Used on Digital I/O Lines



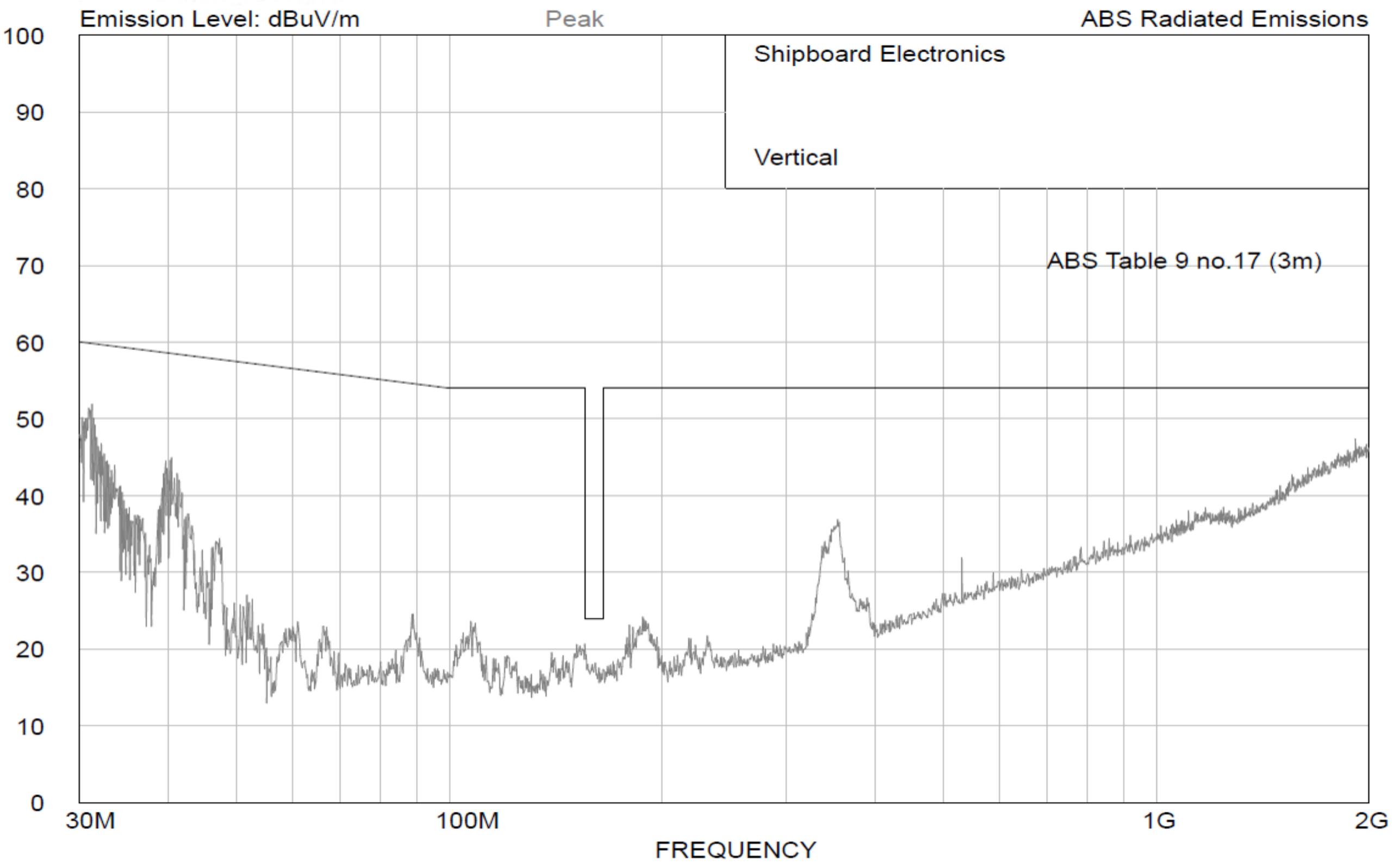
Power Line Filter Installed



Final Conducted Emissions Data



Final Radiated Emissions Data



Shipboard Electronics Solution Timeline

Recap:

- Initial testing – 1 day
- Filter installation time – 30 days
- Design verification – 3 days
- Initial production – 6 weeks

Ultra Low Leakage Power Line Filter Overview

- Multi-section power line filter
- Ultra low leakage current requirement for medical equipment
- Line-to-ground capacitance limited to minimize shock hazard
- System leakage current near limit before power line filter installation
- Conducted emissions out of spec
- EFT Burst immunity meets spec but customer wants improvement
- Multiple common-mode inductor design increases attenuation bandwidth without increased line-to-ground capacitance
- Ferrite beads added to input ground wires provide increased common-mode attenuation and improve EFT immunity

Power Line Filters



Power Entry Modules



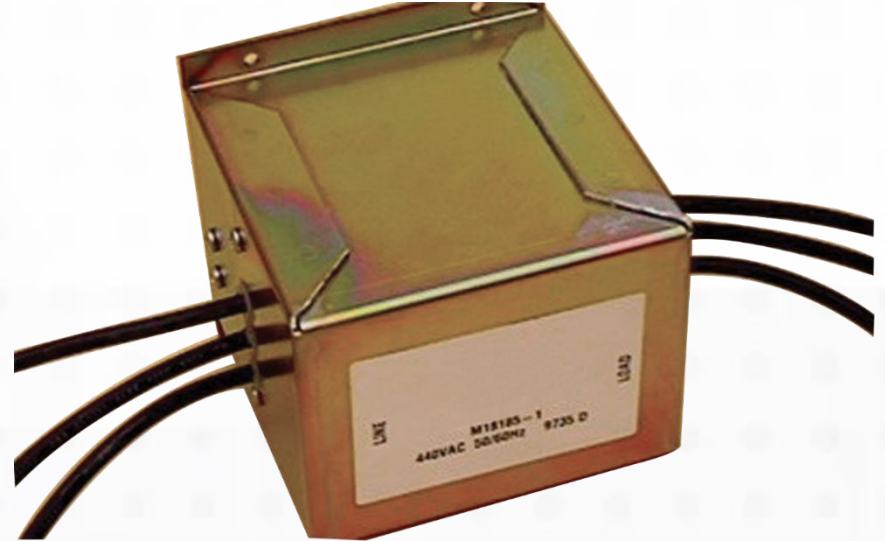
Power Line Filters



Single Line Feedthrough Filters



Custom Power Filters



Portable Medical Equipment

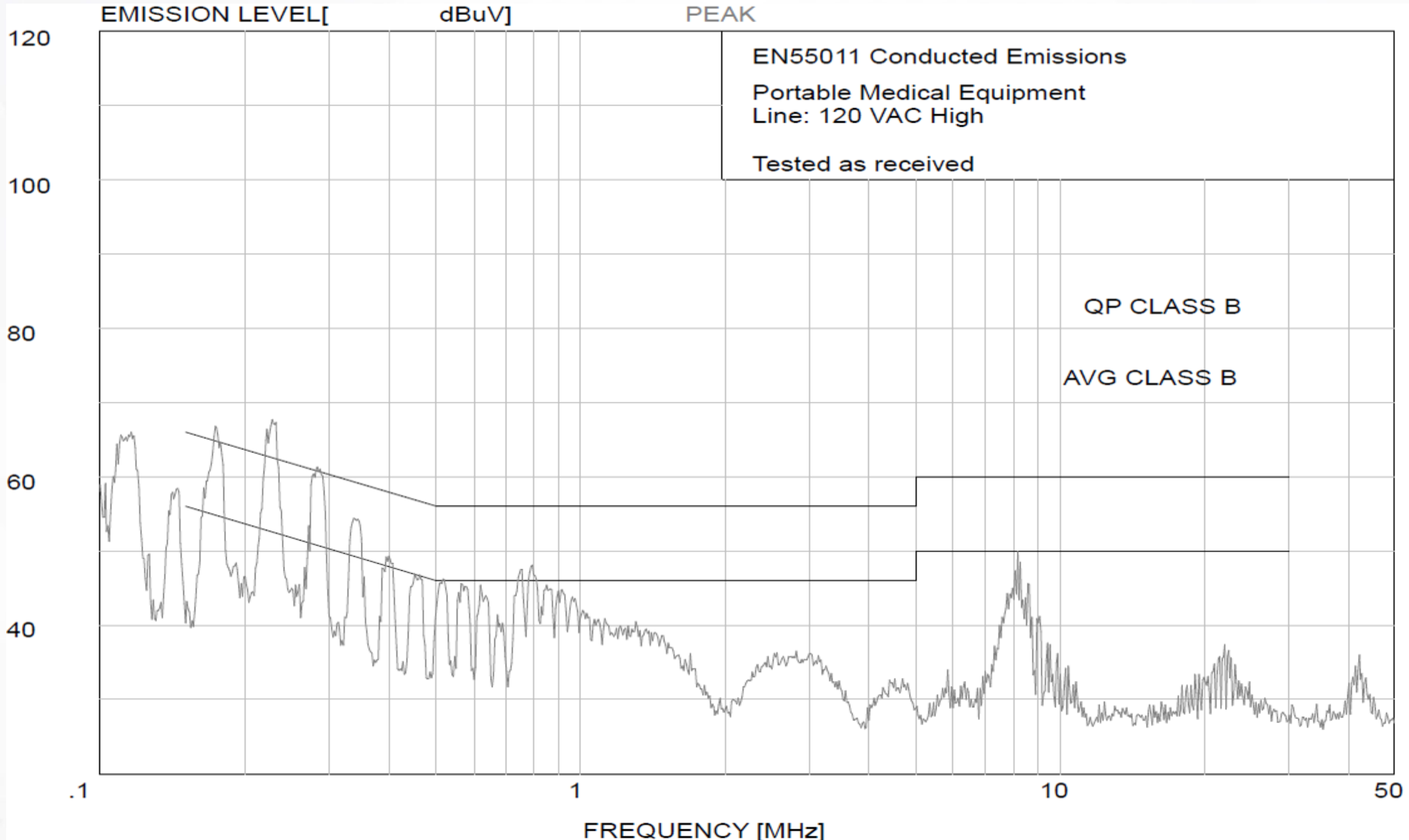
Equipment:

- Portable medical equipment
- 120 VAC power input
- Replace the current off the shelf low leakage current power filter with a custom filter that has increased attenuation and lower capacitance to ground

Application standards:

- EN55011 Emissions
- EN61000-4-4 Electrical Fast Transient Burst

Initial Conducted Emissions with Off-the-Shelf Filter



Portable Medical Equipment

Problem:

- Conducted emissions exceed EN551011 limits
- Customer wants increased EFT Burst immunity

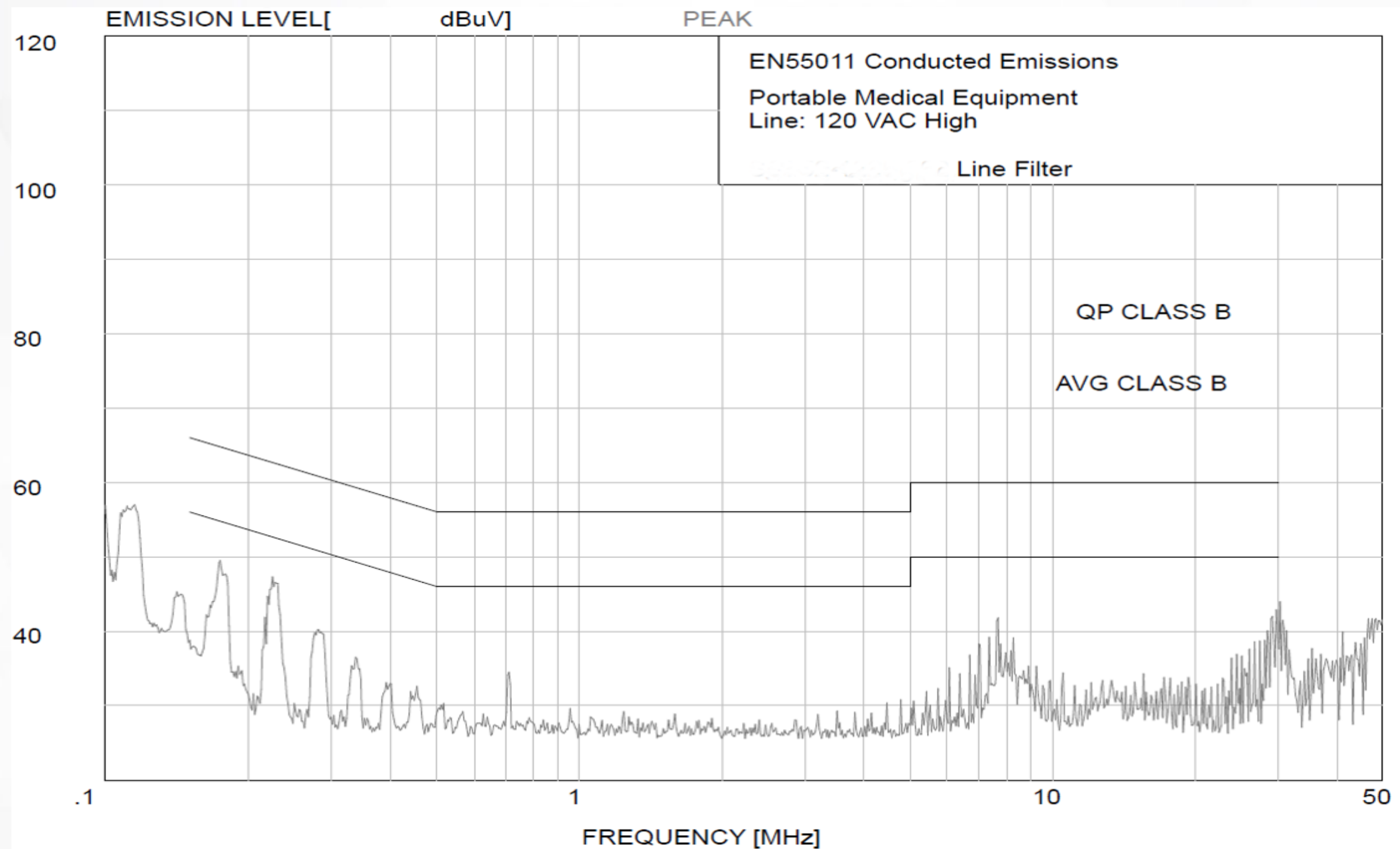
Design considerations

- System level leakage current limit 500uA
- Target filter leakage current 100uA
- Rapid verification of filter design
- Fast prototypes meet mechanical footprint

Low Leakage Current Custom Power Filter Prototype Build



Custom Ultra Low Leakage Current Medical Filter Installed



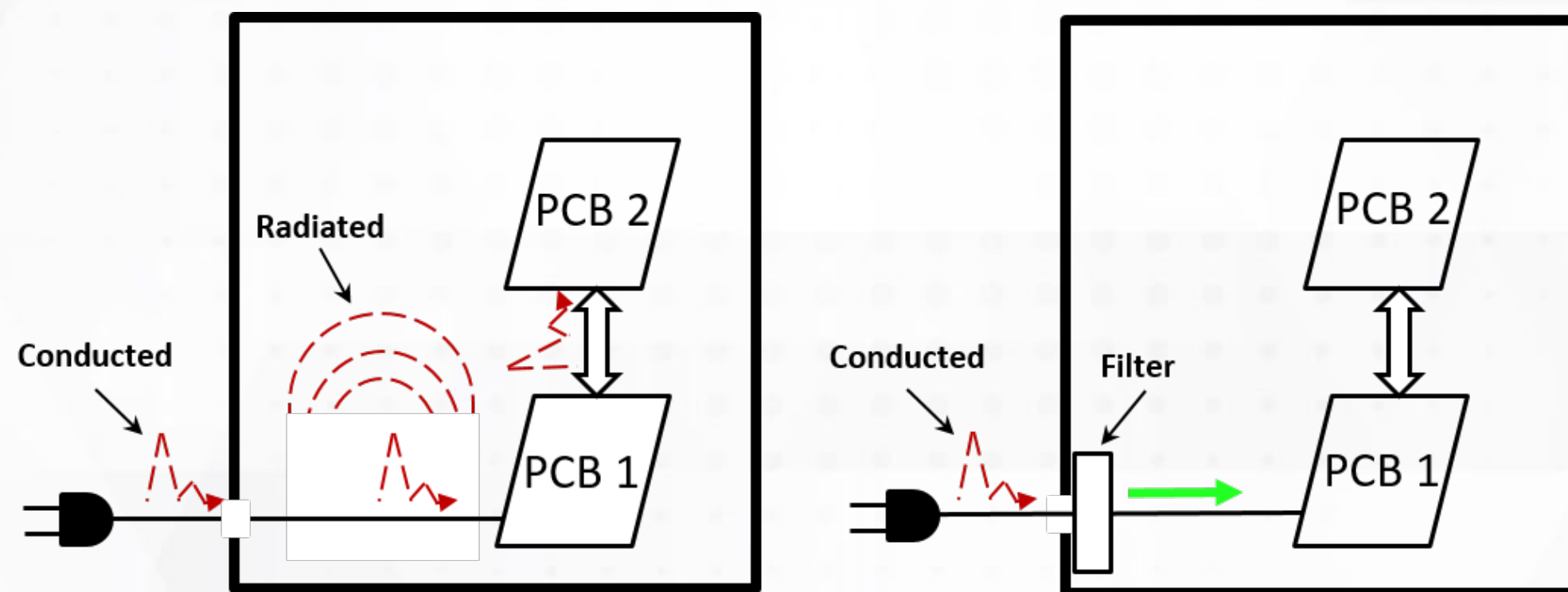
Custom Ultra Low Leakage Current Medial Filter Timeline

Recap:

- Initial testing – 4 hours
- Filter design and prototype build – 2.5 days
- Design verification – 4 hours
- Sample prototypes shipped – 2 weeks
- Initial production – 3 weeks

Best Filter Performance Requires Correct Installation

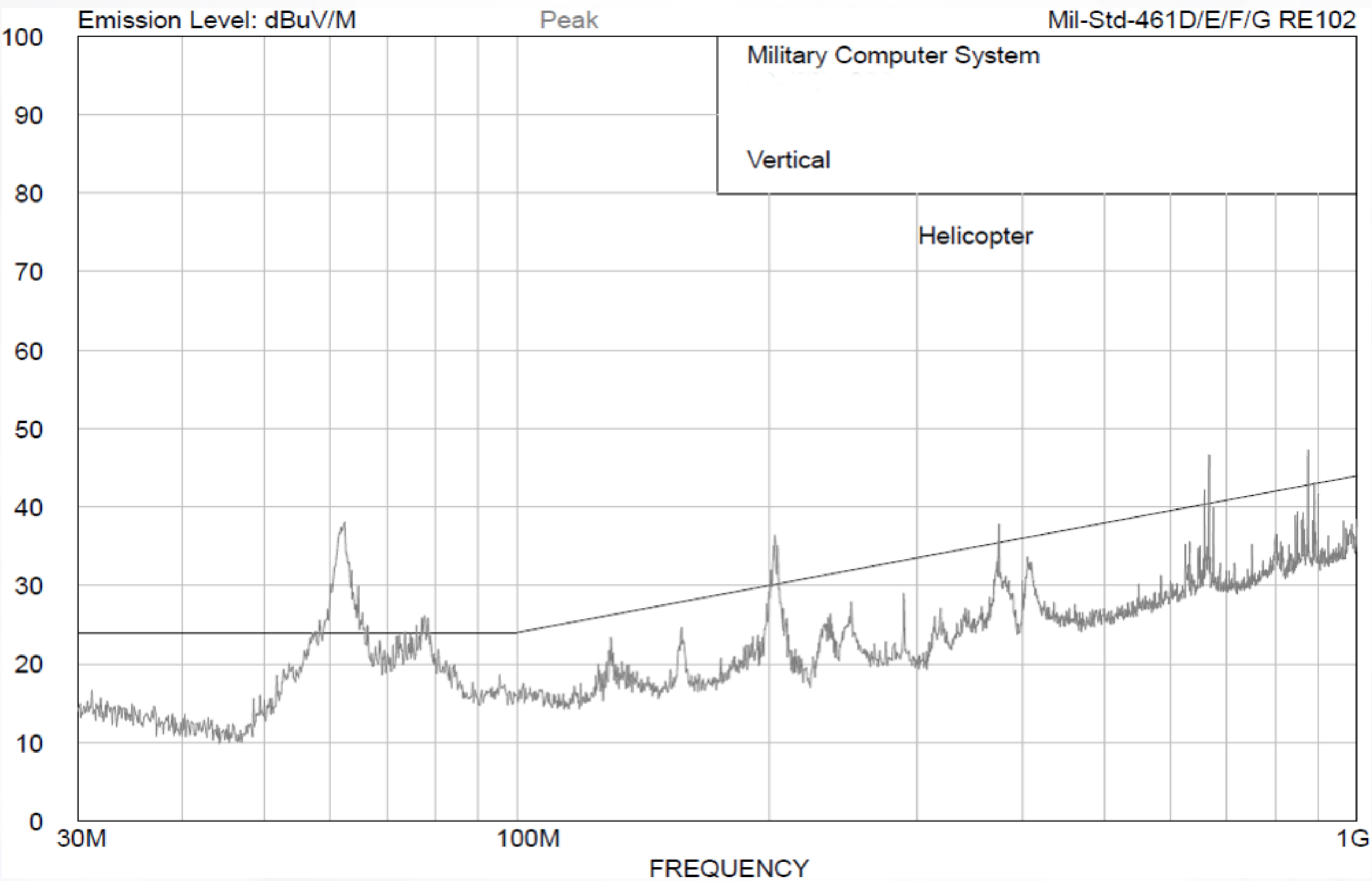
- Filters are only the first step in meeting radiated emissions requirements
- Filters must be mounted at point of entry otherwise they lose effectiveness
- Filters require low impedance ground contact
- Filter input and output lines should be shielded from each other
- Remember that EMI found on the input power cabling, especially the ground conductor, can sometimes be a return path for emissions sourced from other system cables



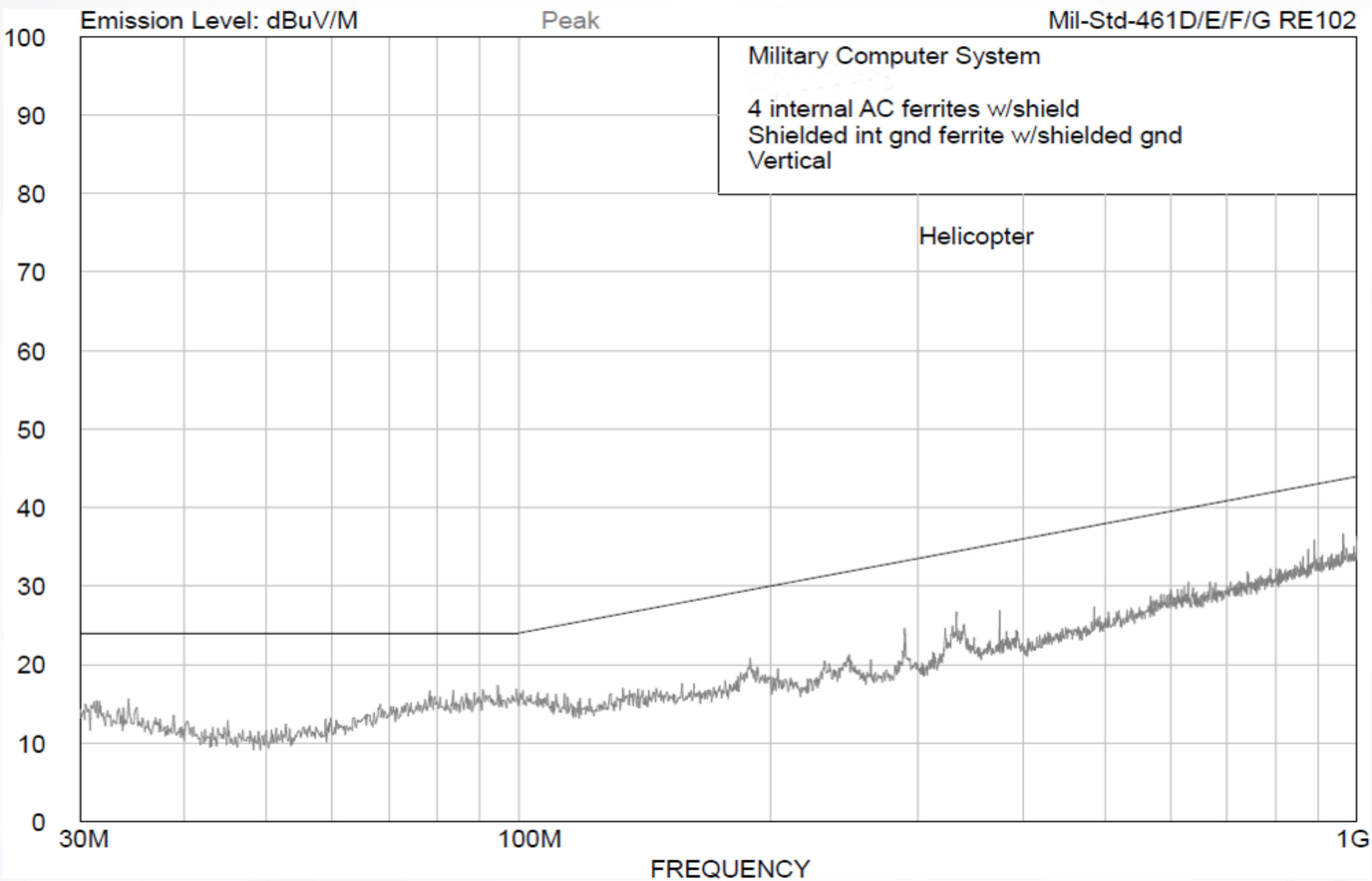
Military Computer System with Power Filter



Poor Installation Causes Poor Performance



Proper Installation Allows Maximum Performance



In-House EMC Lab Summary

- Having an in-house EMC lab gives APITech a unique competitive edge designing and installing high performance RFI filters that provide real world EMC solutions
- Spectrum Control manufactures the broadest line of EMC compliance products in the industry and knows how to effectively implement those products to ensure our customers meet their system level EMC requirements





Thank you for attending!

Mark your calendars for **EMC LIVE: Automotive – June 8, 2021**