



Introduction/Summary

- Filtered MIL-DTL-38999 style circular connector
- Configurable size, finish and circuits
- 12-week lead time (50% less than industry standard)
- Novel design approach

Outline

1. Why is an EMI Filter Needed?

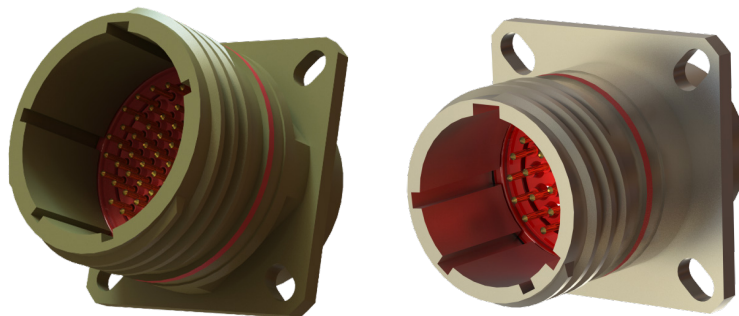
- a. What is EMI
- b. Common sources
- c. Insertion loss
- d. Application example

2. Designing for Performance

- a. Ideal capacitor versus reality
- b. ESR/ESR impacts
- c. Mitigation options
- d. Connector express design elements

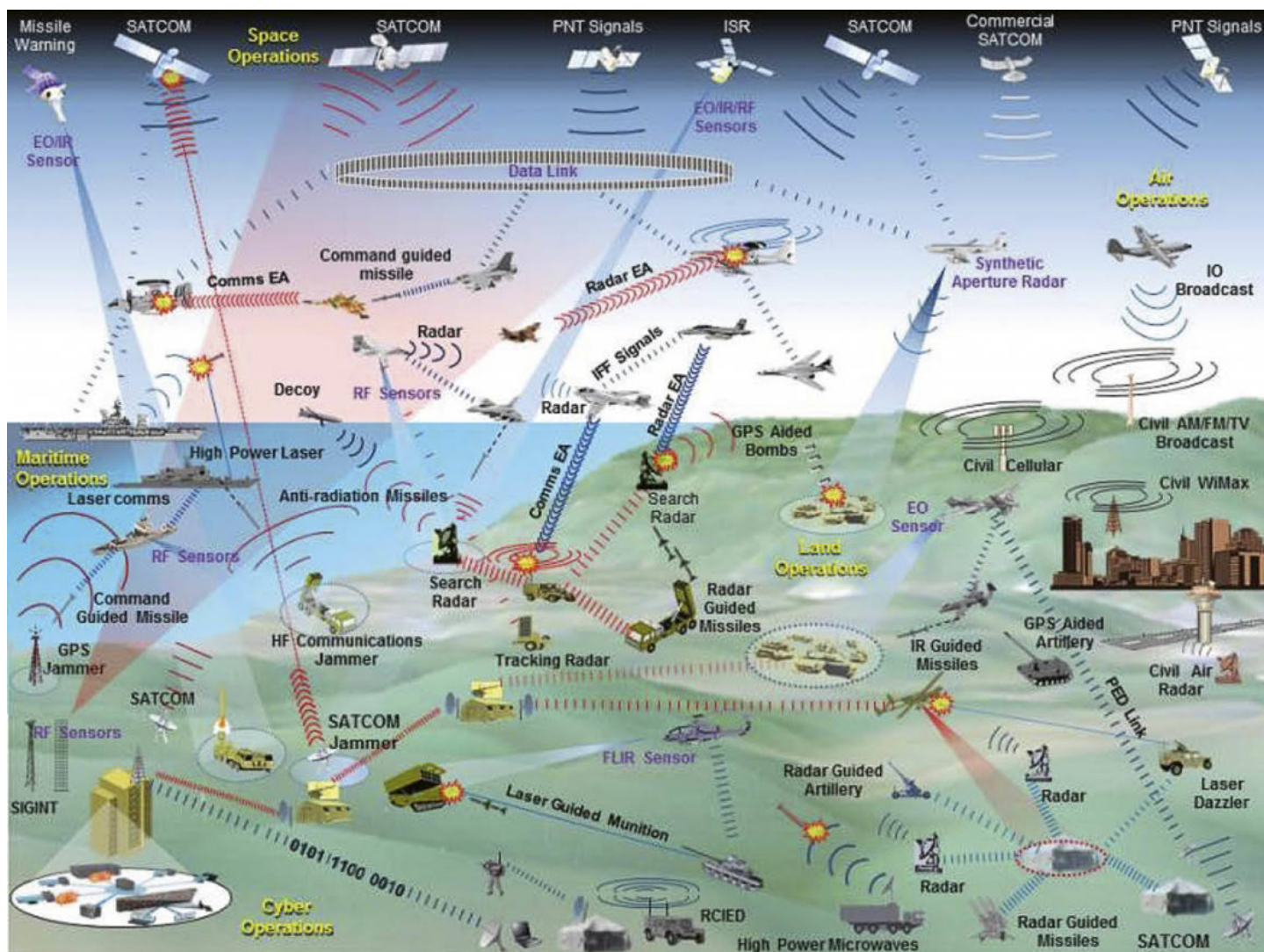
3. Industry Pain Points

- a. Performance
- b. Footprint
- c. Lead time- Connector Express!



Catalysts for Integrated Miniaturization

EMI (Electromagnetic Interference) filtering and shielding are needed to protect sensitive electronic devices from unwanted electromagnetic signals and ensure they operate correctly in an environment with other electronic equipment. The most common sources of EMI include switch mode power supplies, electric motors/generators, radio transmitters and communication equipment. EMI filtering can be integrated at the board level, but filtered panel mount connectors offer superior performance.



What is Insertion Loss?

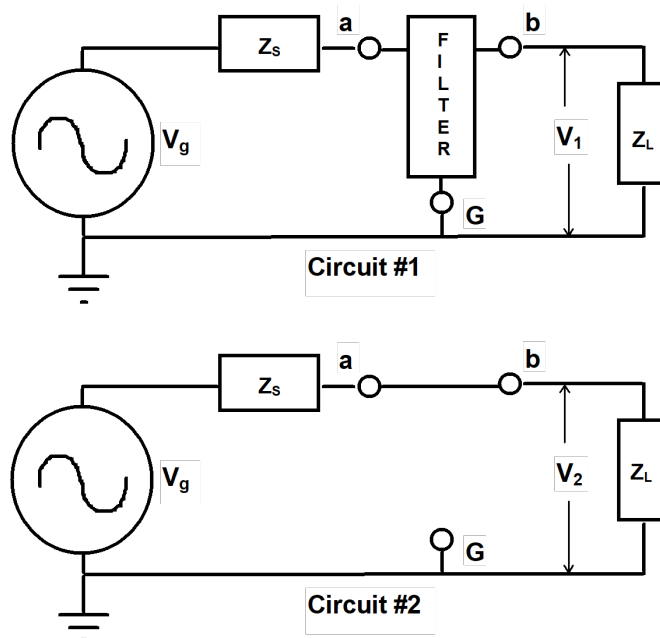
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Per MIL-STD-220

- $IL_{dB} = 20 \log (V_1/V_2)$
- Using S-Parameters:

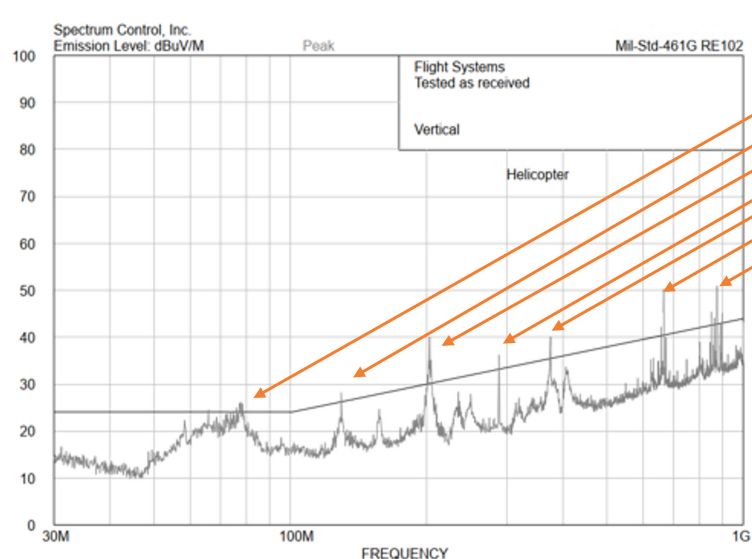
$$IL_{dB} = 20 \log \text{Mag}(S_{21})$$

(Where $Z_S = Z_L = 50 \text{ Ohms}$)

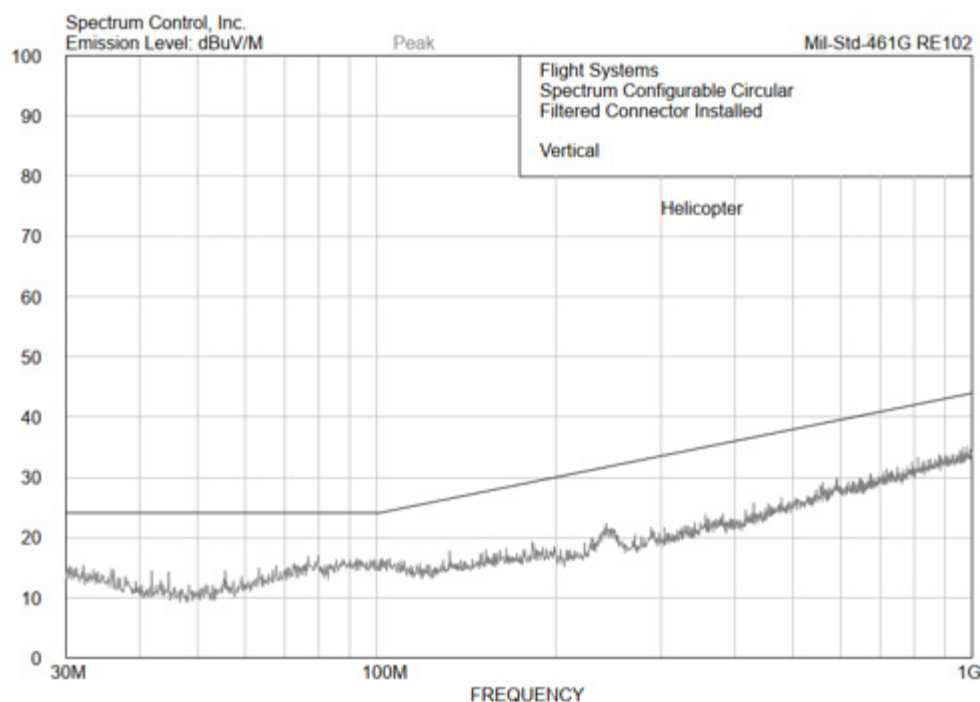


IL (dB)	Voltage Ratio
100w	1:100,000
80	1:10,000
60	1:1000
40	1:100
20	1:10
6	1:2
3	1:1.414
1	1:1

3dB is termed cut-off or half power,
or where $V_1 = [V_2]/1.414$



Outages



SCI filtered connector installed
in place of existing 38999



Radiated emissions 30-1000 MHz is often the hardest
frequency range to pass in modern electronic systems.

Designing for High Frequency Filter Performance: Parasitic Elements



Ideal capacitors do not exist!

$$ESR = \tan(\delta) * X_c$$

Equivalent Series Resistance (ESR): Sometimes referred to as parasitic resistance. The capacitor's internal construction and termination/circuit trace/path resistance are in series with the capacitor. In high-frequency applications, ESR can become a significant factor, as the capacitor's impedance increases, filtering and decoupling performance are affected.

Equivalent series Inductance (ESL): Sometimes referred to as parasitic inductance. The capacitor's internal structure and circuit trace/path length result in ESL. Increased ESL causes increased impedance to ground, resulting in voltage fluctuations, common mode noise, and potential system malfunctions.



As frequency increases, ESR and ESL become larger factors, particularly above 100 MHz. Proactive steps at the design phase can mitigate these concerns.

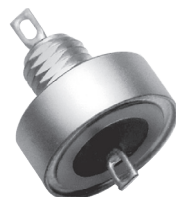
Solutions Options: Why Coaxial Ground Three Terminals are Best



Two Terminal MLCC

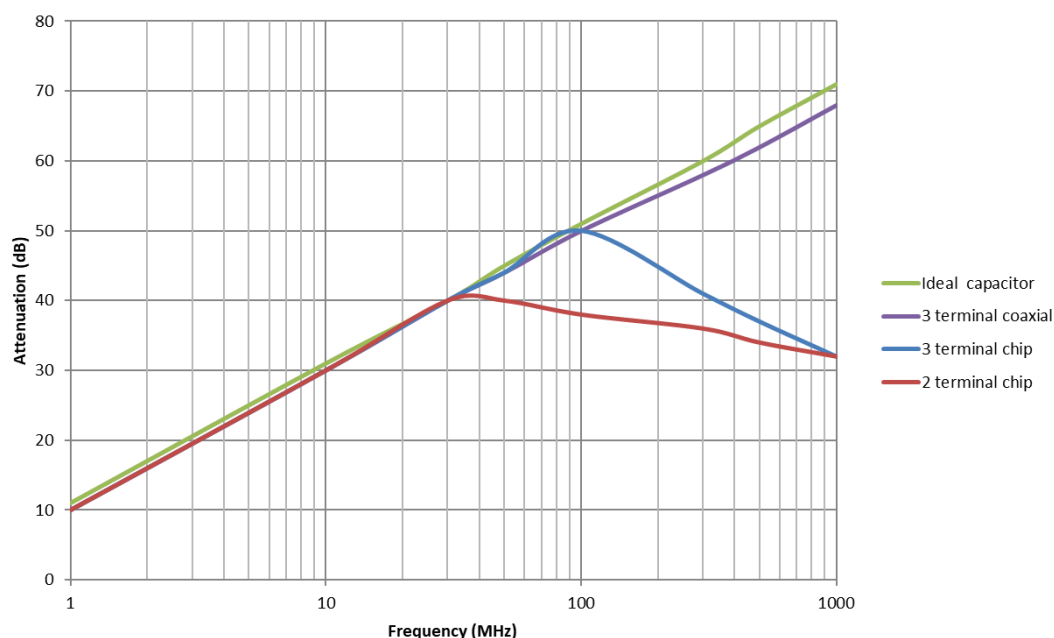


Three Terminal MLCC



Coaxially Grounded Three Terminal Filter

22nF, Typical Installed Common Mode, No Load IL



Why Connector Express; Novel Design

Design incorporates a unique hybrid approach of planar and substrate filtering that is unique in the industry.

In-house planar capacitor technology:

- Internal design control/optimization
- Internal supply chain control

Optimized substrate design & construction overcomes parasitics (ESR and ESL) typically seen with chip capacitors (minimizes high frequency effects) via:

- Optimized trace lengths/vias
- Low impedance return path via a common/continuous ground plane
- Low-loss tangent materials



- Approach ideal capacitor performance
- Selectable (configurable) substrate filtering facilitates quick turn mixed signal configurations

Combined capacitor network (planar and substrate) achieves near-ideal performance to 1 GHz and above, can be configured for mixed signal, and is available in half the traditional lead time.

Major Markets



Military

- Military
- Ground communications
- Weapon systems
- Missile systems
- Military vehicles
- Radar systems
- UAVs
- Engine controls
- Power Distribution
- Flight Controls
- Fire protection systems
- De-icing systems



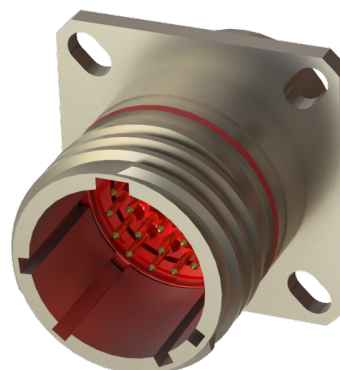
Aerospace

- Electrical systems
- Radar systems
- Communication systems
- In-flight entertainment
- Cabin systems
- Cockpit displays
- Engine controls
- Actuator controls
- Fire protection systems
- De-icing systems

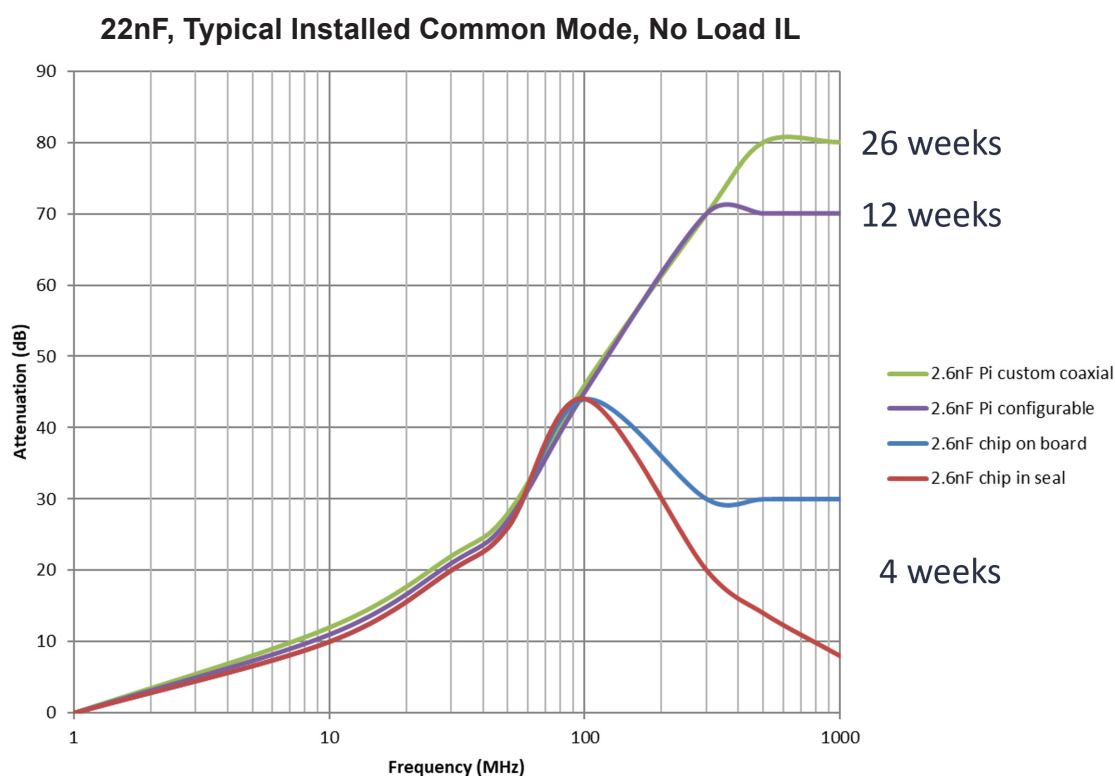
Industry Pain Points - Solutions

Physical size, footprint

- Space/weight is always at a premium
- Point of entry most effective place for a filter for high-frequency performance
- Multiple coaxially grounded three terminal filters packaged in an existing interconnect is the most efficient approach



Performance versus Lead Time



12-Week Lead Time Map

- Strategic safety stock on key raw materials
- Utilization of existing floor stock materials
- Standardized planar capacitor for each insert pattern
- Configurable tunable planar substrate filtering
- Standardized documentation for the quick release of new designs
- SOP manufacturing in a high-volume facility

Commercial / Application Notes



Selectively program RF capacitance in the filter in real time

Lead time based on available options

- Circuit values
- Size/line count
- Finish

Supports and protects the company's RF circuits and digitally enabled products

- High-frequency circuits can both generate and be affected by electromagnetic radiation

SWaP-C

- No compromise in performance
- Improved delivery
- Installs into existing footprints (no modifications)

1 Choose Finish

Variety of environmental protections to meet military and RoHS requirements

Nickel

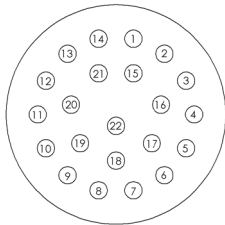
- Meets MIL-DTL-38999 finish F requirements

ODCAD (Olive Drab Cadmium)

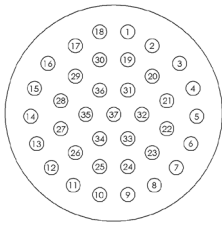
- Meets MIL-DTL-38999 finish W requirements
- Improved corrosion and anti-reflective finish

2 Choose Insert Configuration

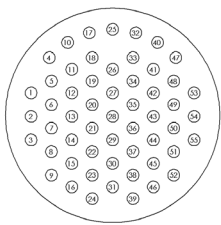
MIL-STD-1560



13-35 (22 lines)



15-35 (37 lines)



17-35 (55 lines)

3 Configurable Circuit Values

Select the filtering value for each pin from these standard options.

- 400 pF – C
- 1400 pF – Pi
- 2600 pF – Pi
- 5100 pF – Pi
- 10400 pF – Pi
- Ground Line

Standard Product Attributes

MIL-PRF-38999 Series III	Square flange (wall mount)
Aluminum shell	PC tail termination
N keying	DWV: 200 VDC working/500 VDC
Male contact gender	Current rating: 5 Amps
Size 22D contact size	

Connector Express Circuit Options

Typical Common, No Load IL

