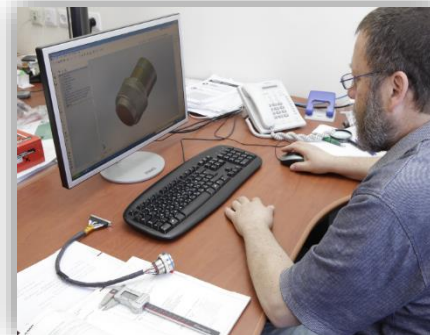
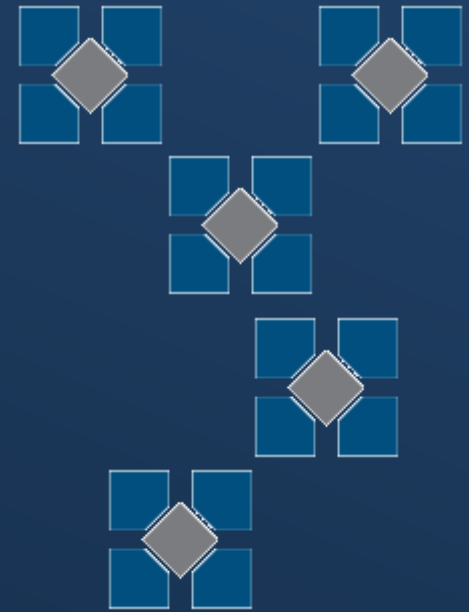


RF Immunity Ltd

The Filtered Connector Specialist



Agenda

- EMC – Electro-Magnetic Compatibility
- RF Immunity's technology
- RF Immunity's solutions for EMC field
- Tools for a Sales Engineer

Electro-Magnetic Environment



Military standard for EMI/RFI management

- MIL-STD-461 - EMC
- RTCA-DO/160D – EMC, Power Management (Civil Aviation)
- MIL-STD-1275 – Power management of Heavy Ground Vehicles
- MIL-STD-704 – Power management of Avionic Applications
- MIL-STD-1399 – Power management of Naval Applications

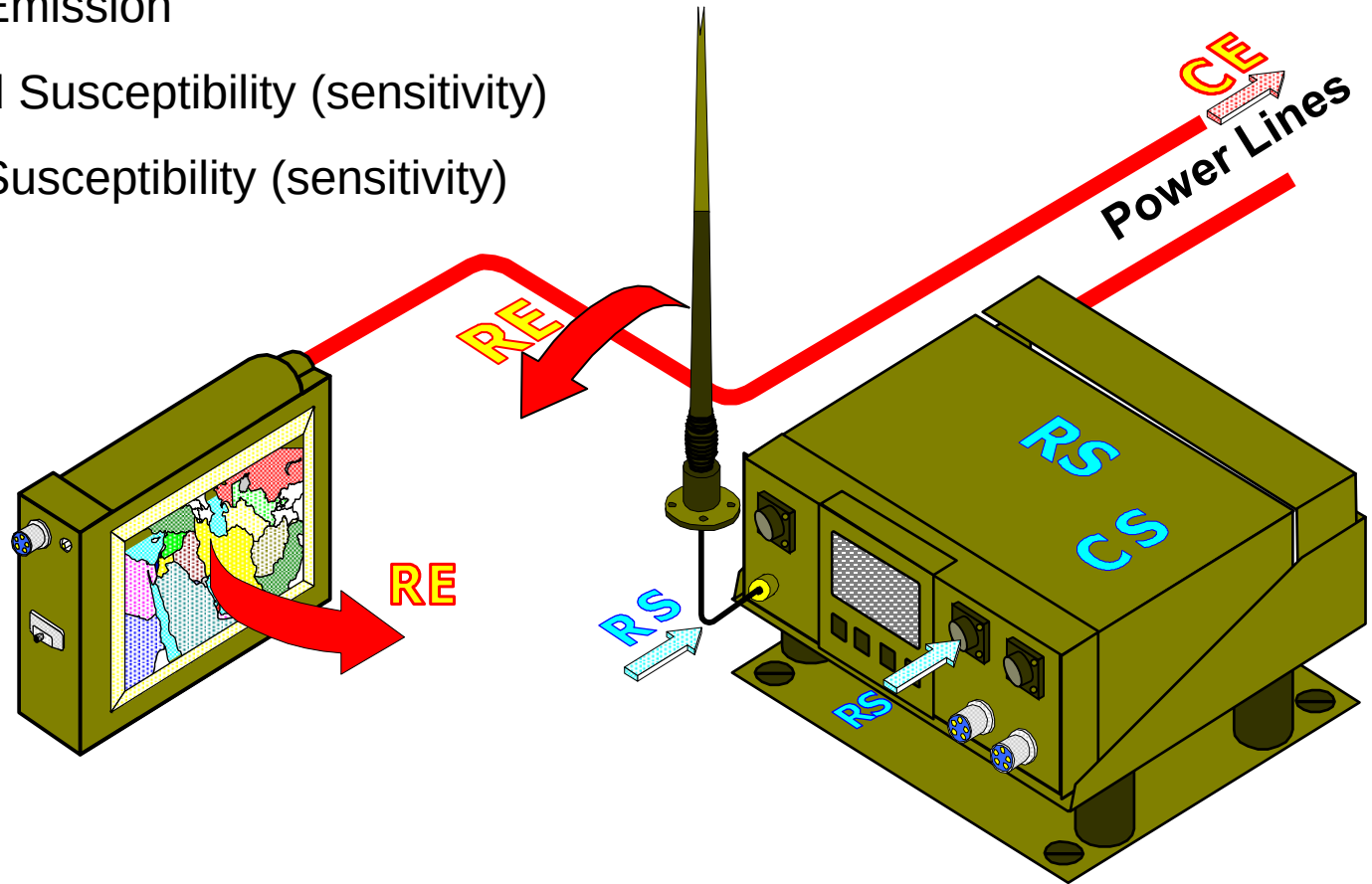
EMC designations

CE – Conducted Emission

RE – Radiated Emission

CS – Conducted Susceptibility (sensitivity)

RS – Radiated Susceptibility (sensitivity)



EMC test

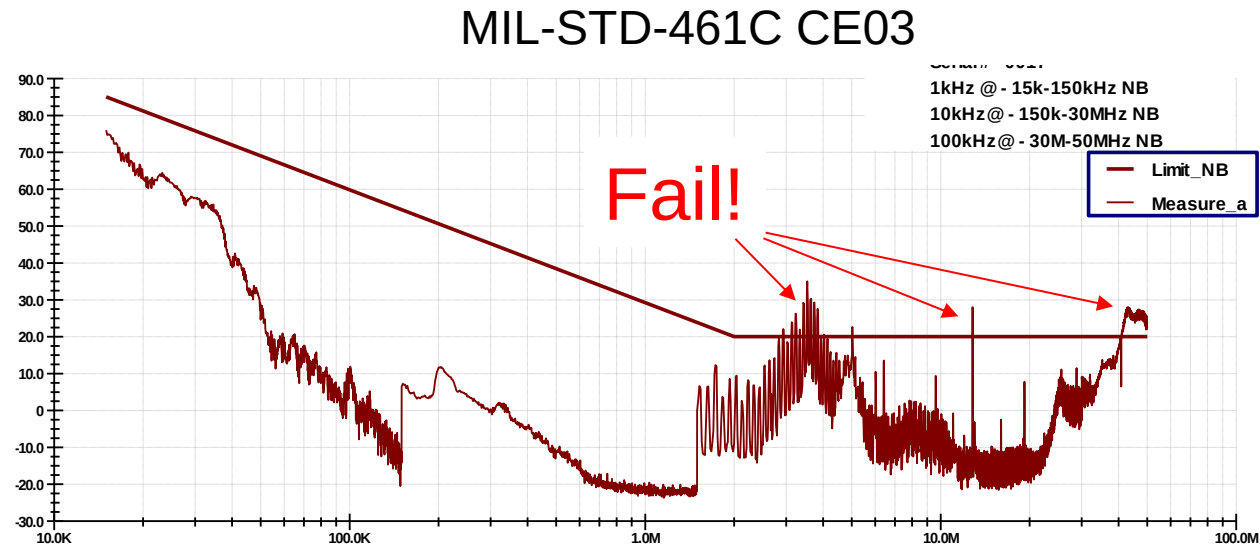
The device must pass the EMC test per MIL-STD-461C CE03:



The picture taken from <https://www.indiamart.com/>

What is filtering?

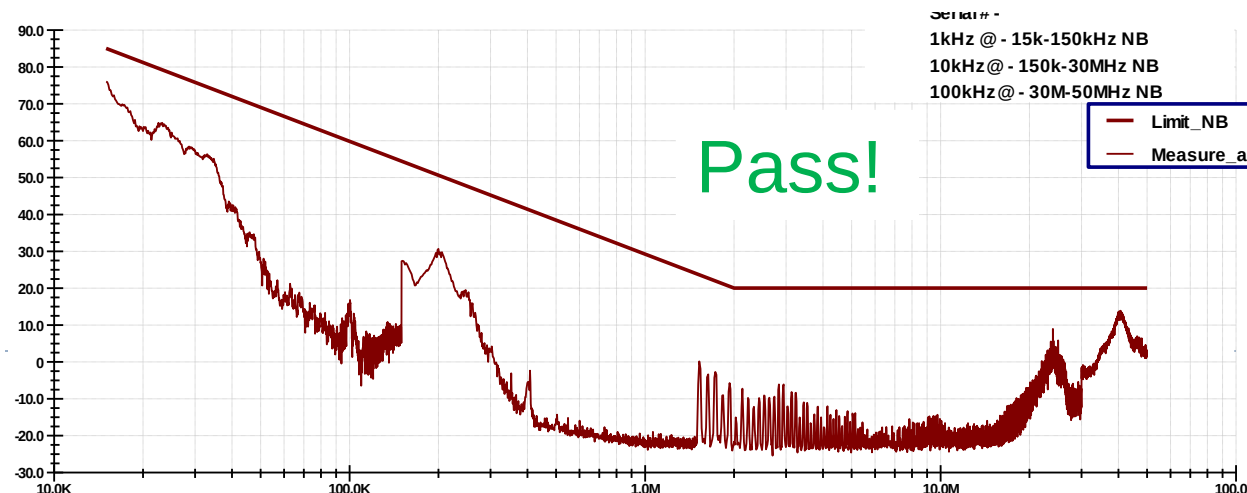
Test results before filtering:



What to do?

To filter (attenuate) – to push the noises below the limit!

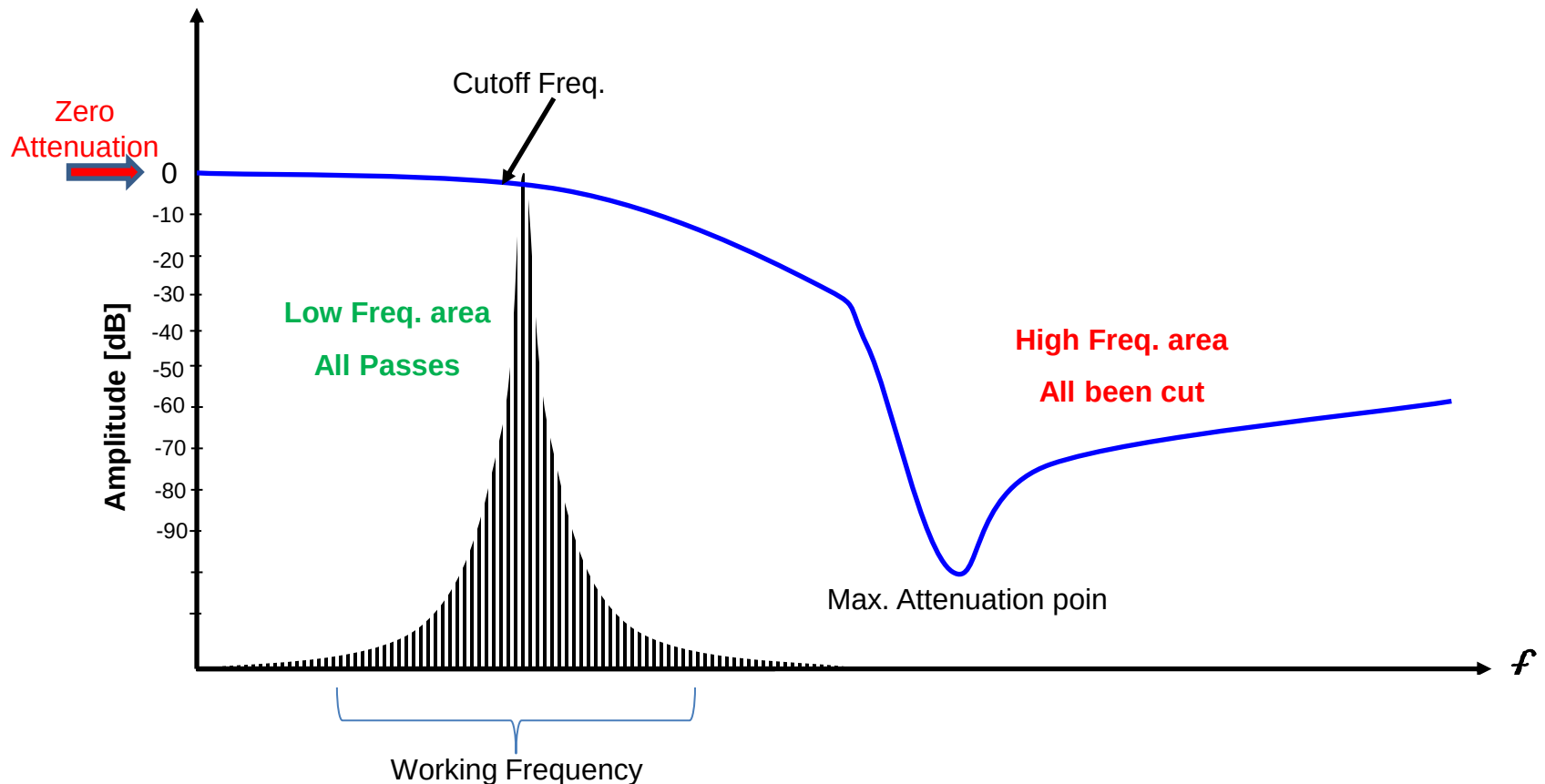
After Filtering:



Attenuation Graph

The most common technique for reducing interferences is using Low-Pass Filters which pass through the spectrum up to the cutoff frequency and attenuate higher frequencies.

RF Immunity integrates **Low-Pass** Filters into standard connectors.



Capacitance effect on Attenuation

Different Capacitance values

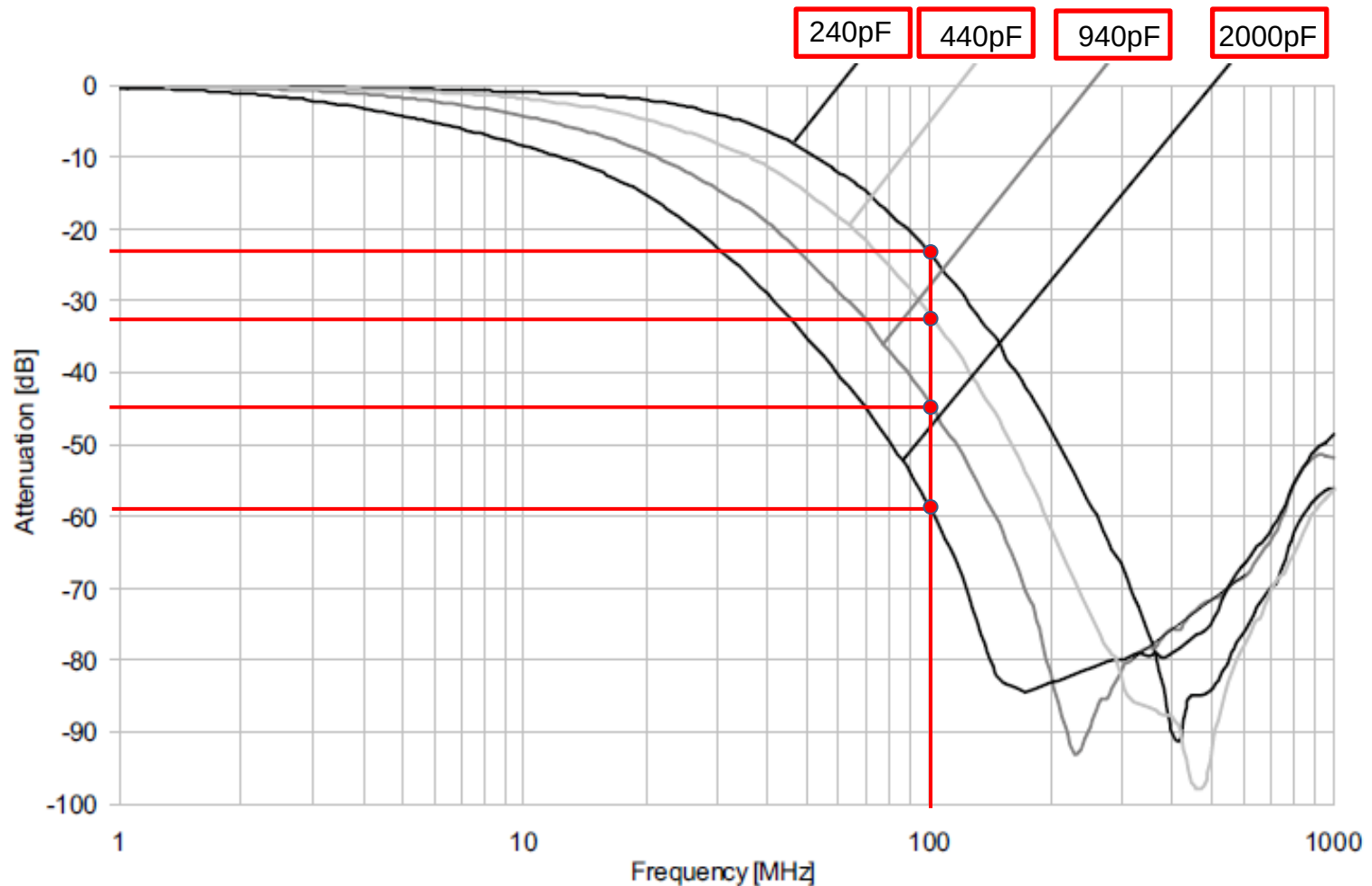
Minimum Attenuation

π Filter

Filter Code	Typical Cap. [pF] (2)	f_{co} [MHz] Typical (3)	Min. Attenuation [dB] VS. Frequency [MHz] (1)								
			1	5	10	30	50	100	300	500	1000
PP24	240	25.3	0	0	0	2	6	15	50	68	53
PP28	440	14.5	0	0	0	6	12	24	72	70	53
PP32	940	7.6	0	0	2	10	18	32	70	65	50
PP36	2000	3.8	0	2	6	20	31	52	61	58	44

Capacitance effect on Attenuation

Reviewing the attenuation of different capacitance value on freq. 100MHz

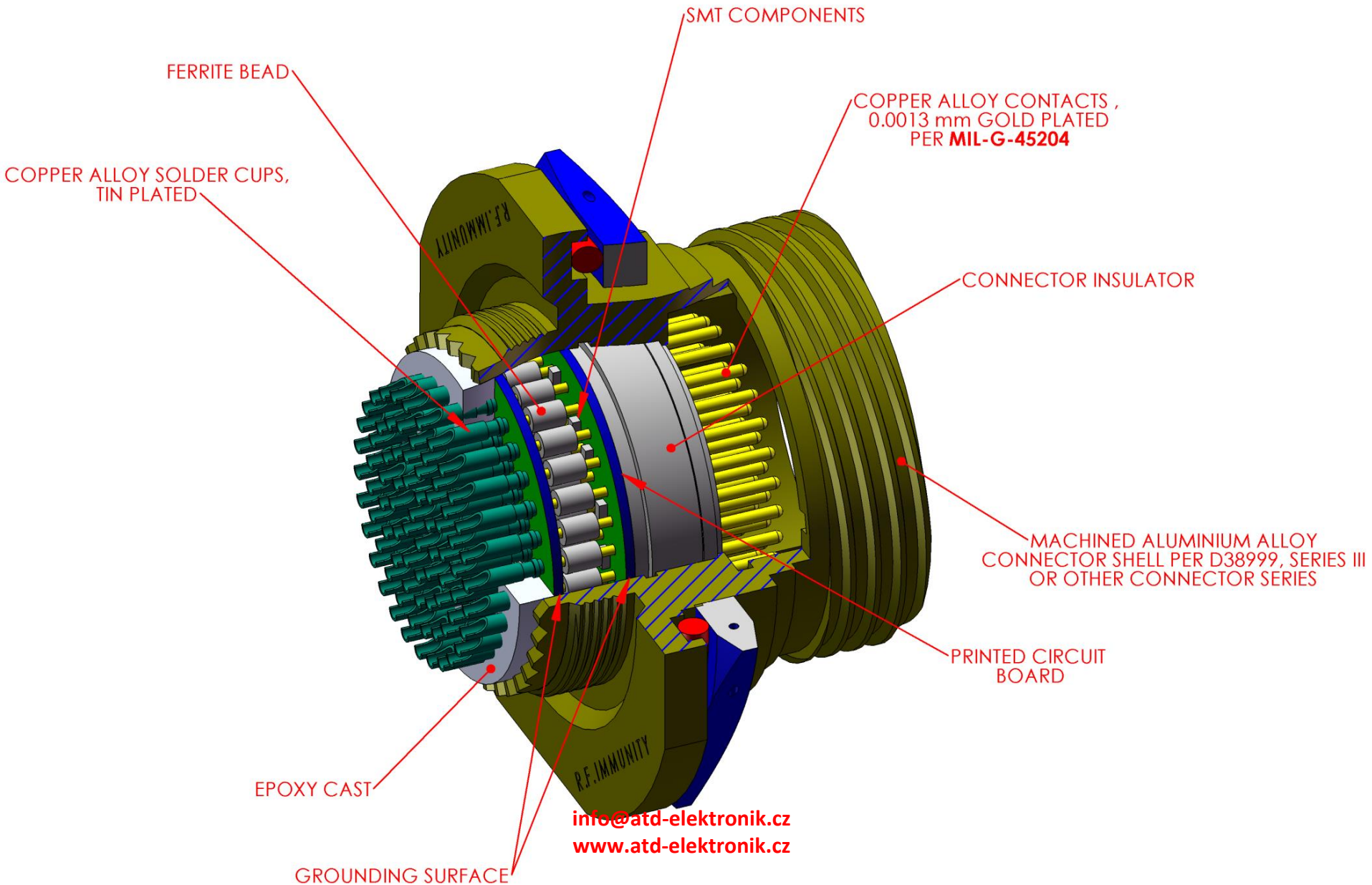




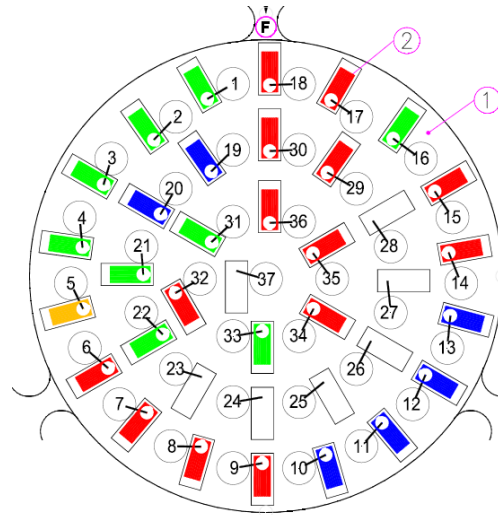
RF Immunity

FILTER CONNECTOR CONSTRUCTION

Filter Connector Construction



SMT on Board



RES. 0 Ohm	04
CAP. 22pF 200V	03
CAP. 1nF 200V	02
CAP. 10nF 200V	01
PCB	
DESCRIPTION	

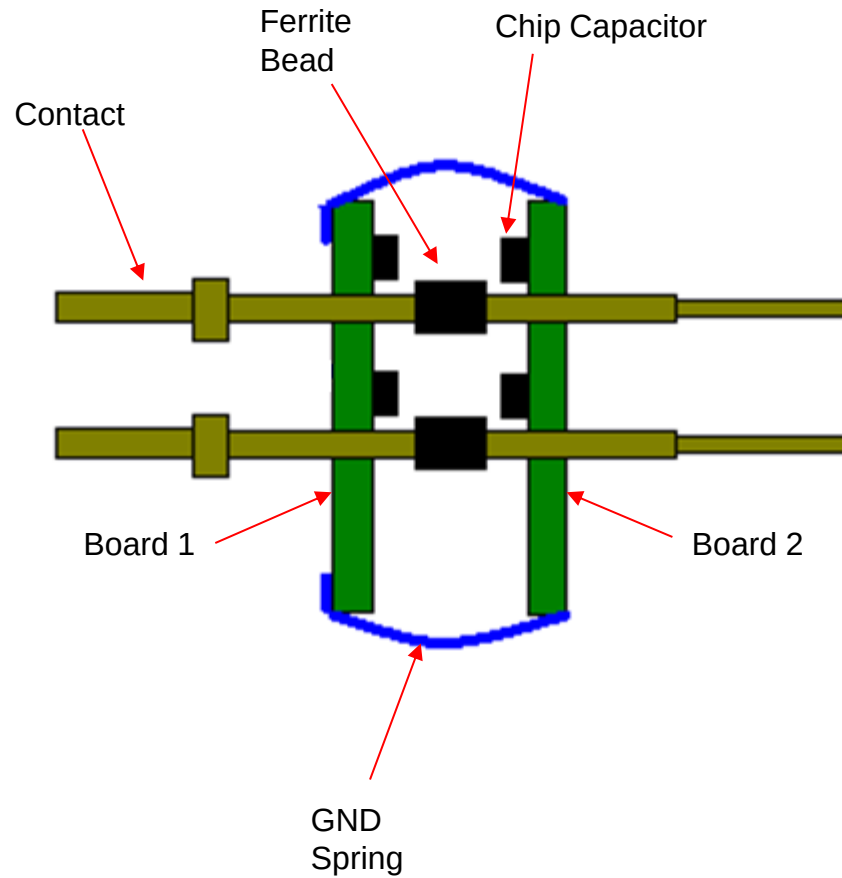
Advantages:

- Cheap and available – short time to market
- Flexibility of design (combination of any capacitance, working voltage, dielectric material)
- No MOQ required
- Not fragile

Disadvantages:

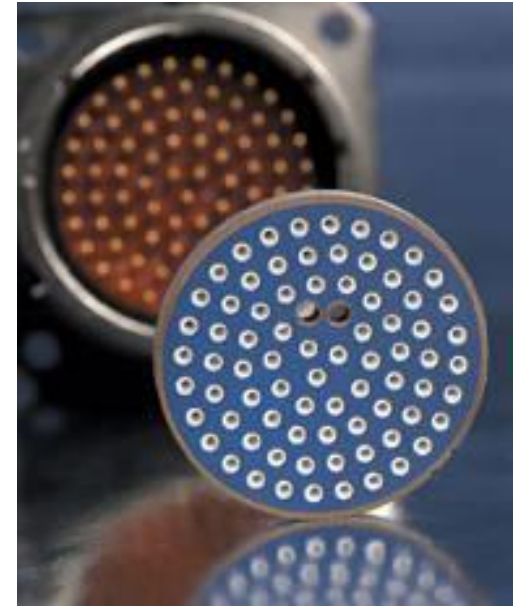
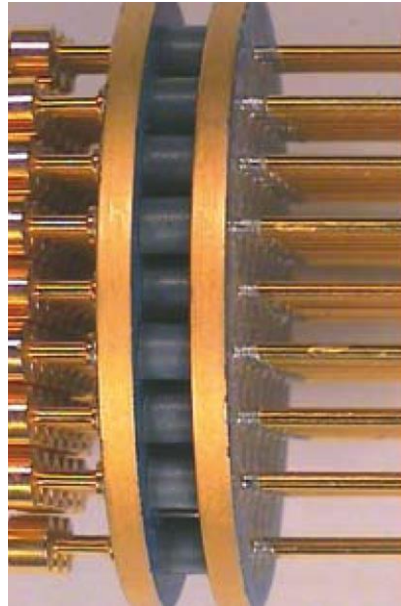
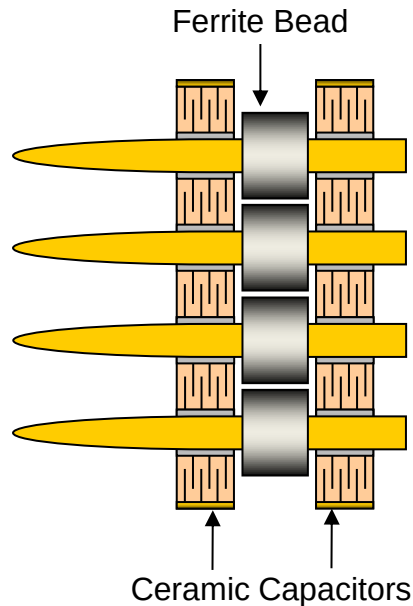
- Performance degradation after 500MHz

Filter Module



Planar Capacitor – completing technology

➤ Used only when mandatory



Advantages:

- Stronger attenuation
- Good performance also after 1GHz

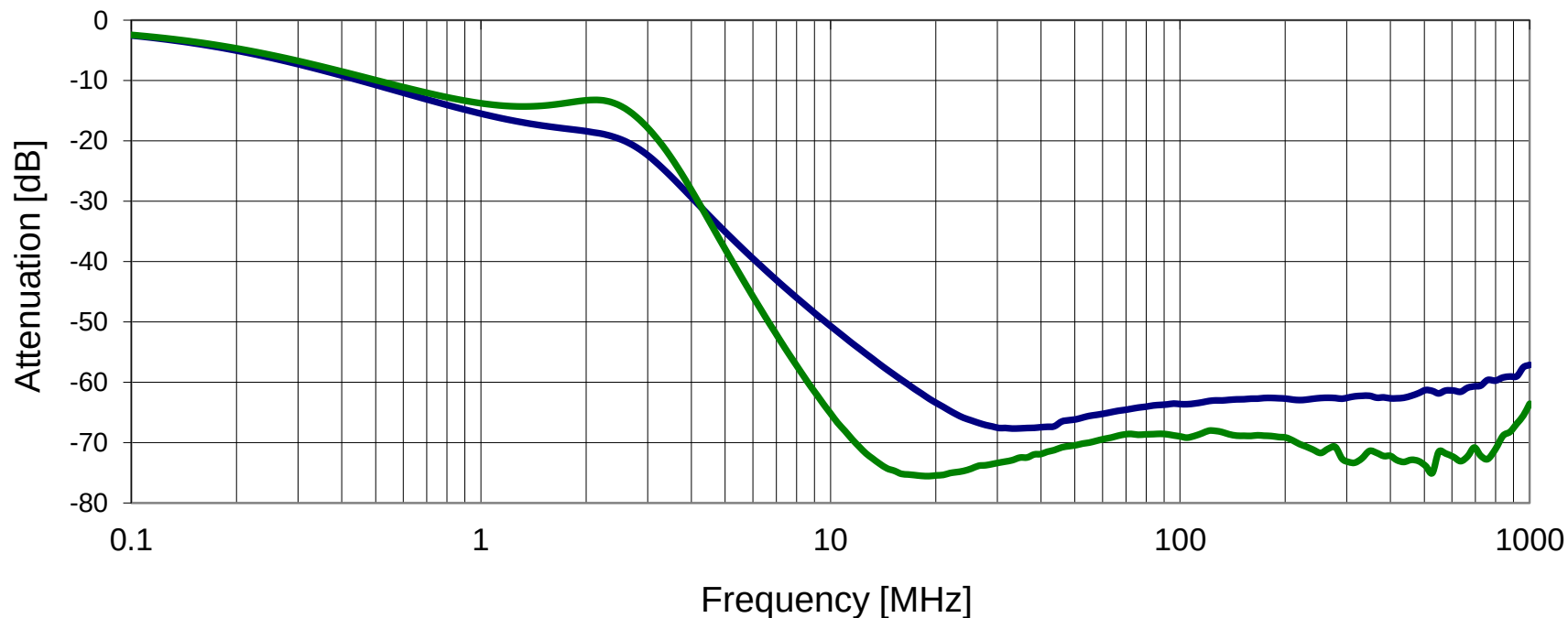
Disadvantages:

- Limited minimum to maximum capacitance ratio (up to 1:10)
- Only single dielectric material per planar array (X7R or NPO or COG)
- Up to 4 capacitance values and voltages on each planar
- Very fragile - need special soldering concerns, lower production yield, therefore, higher cost.
- MOQ for purchasing , therefore higher cost for low qty.

Planar Array vs SMT

Blue – Pi filter 44nF SMT;

Green – Pi filter 44nF Planar



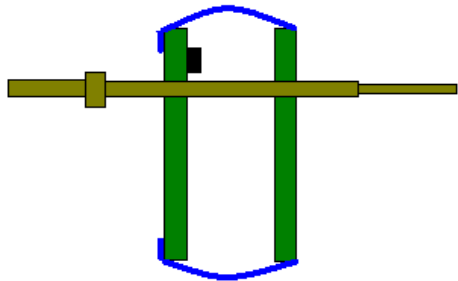
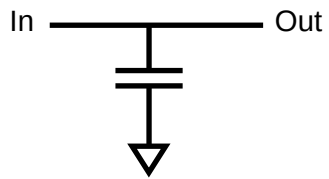


RF Immunity

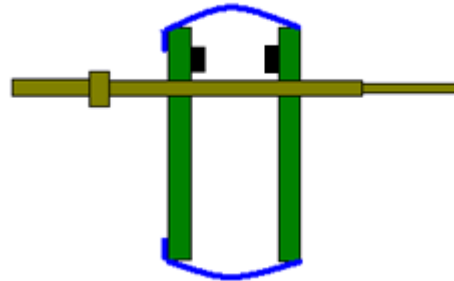
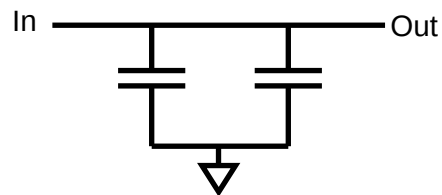
FILTER TYPES IN FILTER CONNECTOR

Filter Types

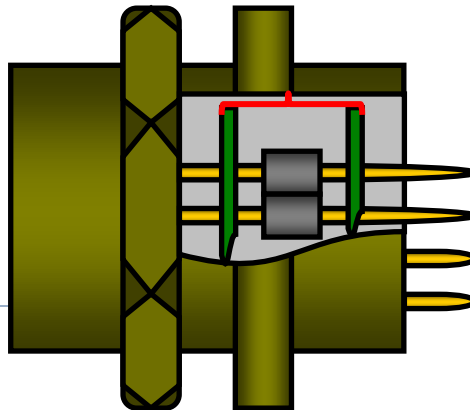
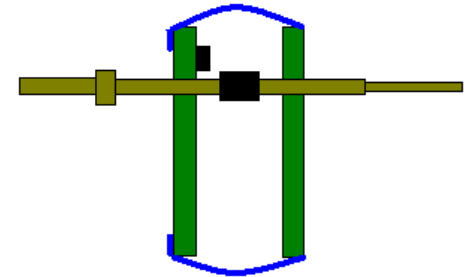
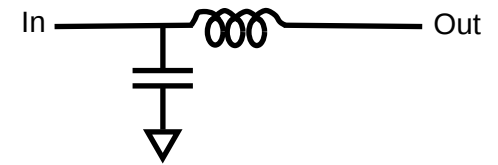
C Filter



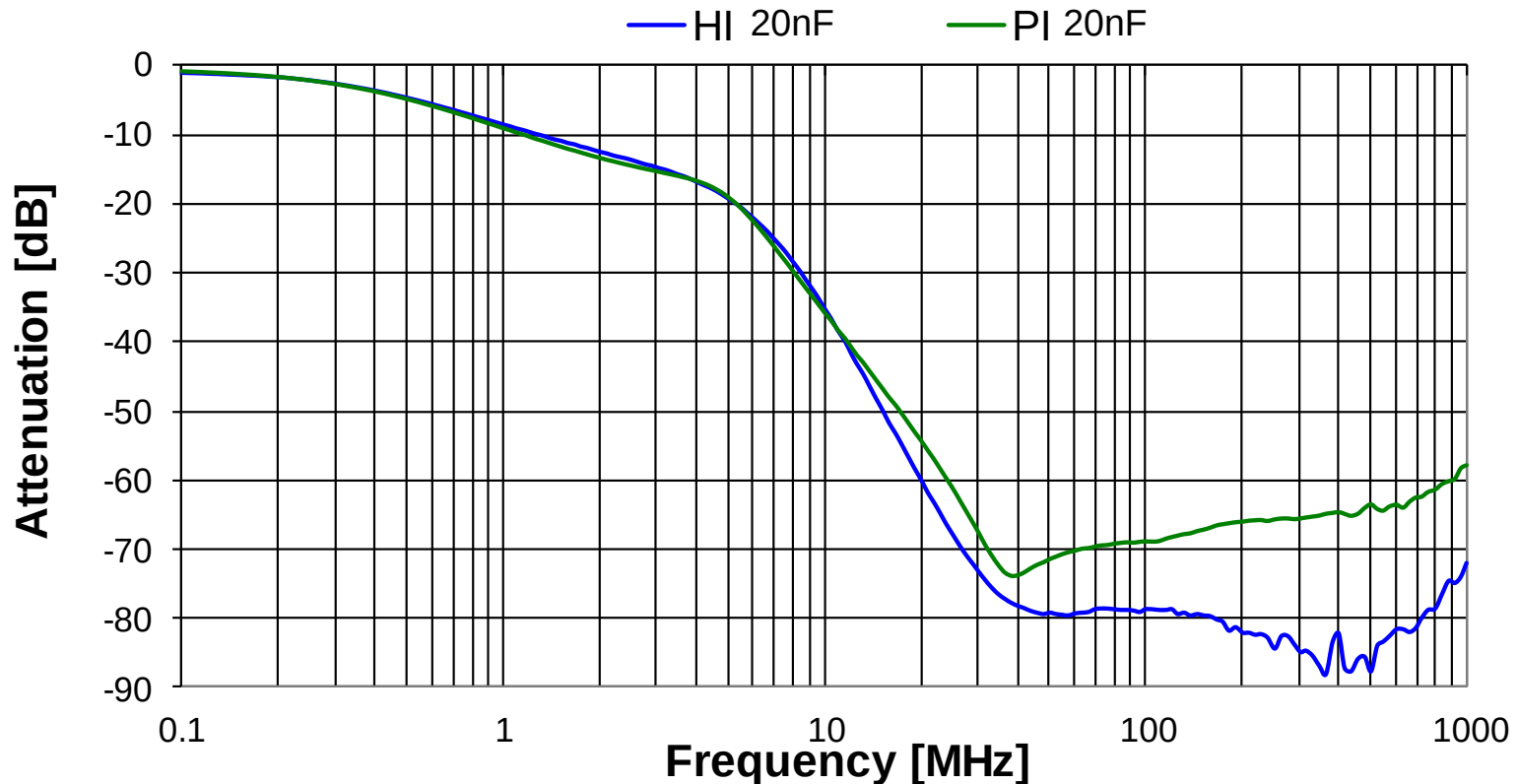
C² Filter



LC Filter



Pi vs Hi (Double Pi) Filter comparison





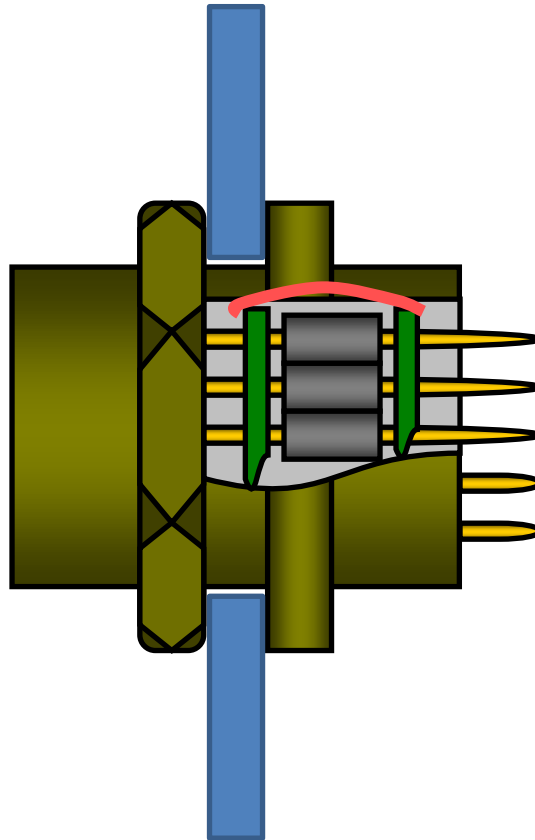
RF Immunity

WHY TO USE FILTER CONNECTORS?

Why To Use Filter Connectors

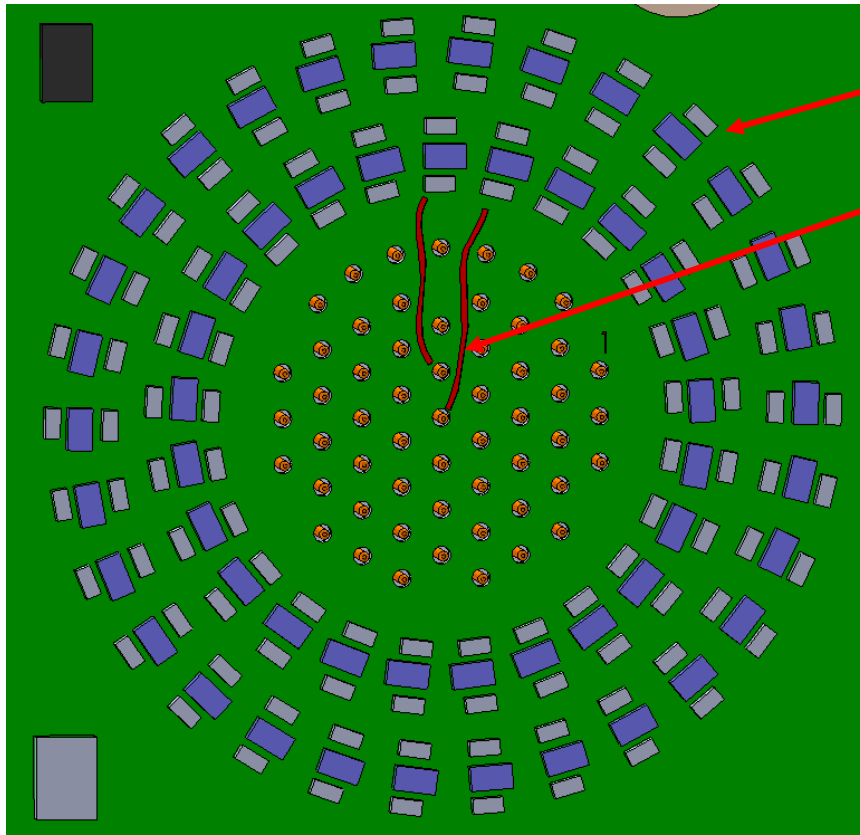
- ◆ Better Performance (Attenuation)

- ◆ Capacitors location close to the contact



Why To Use Filter Connectors – better performance

Capacitor location close to the contact:



Filtering components located in perpheria

Conductor inside the PCB
Long path = antenna!!!



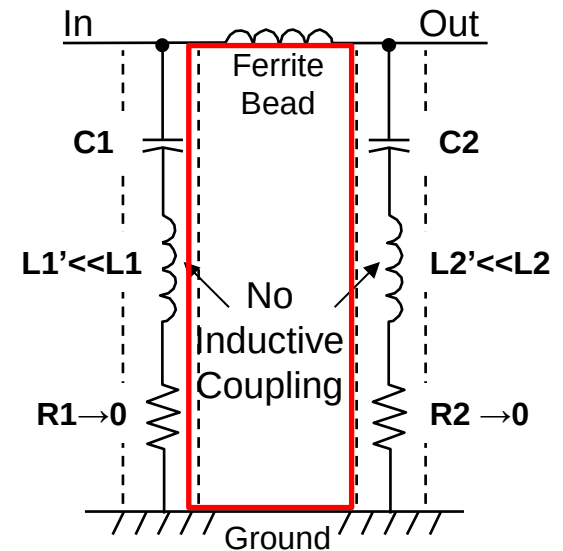
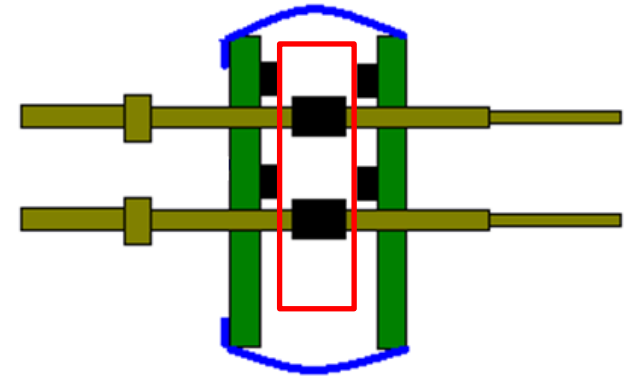
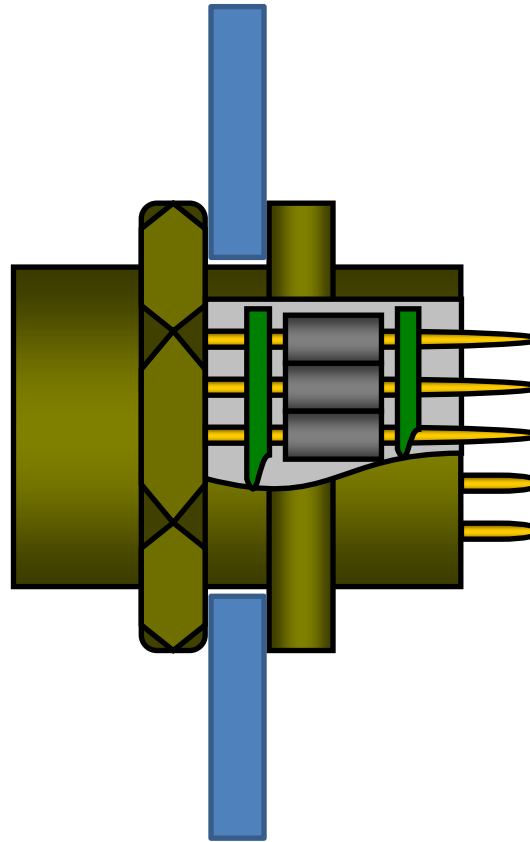
- Capacitors while filtering on mother board
- Capacitors in Filter Connector

Why To Use Filter Connectors

- ◆ Better Performance (Attenuation)

Filter Connector:

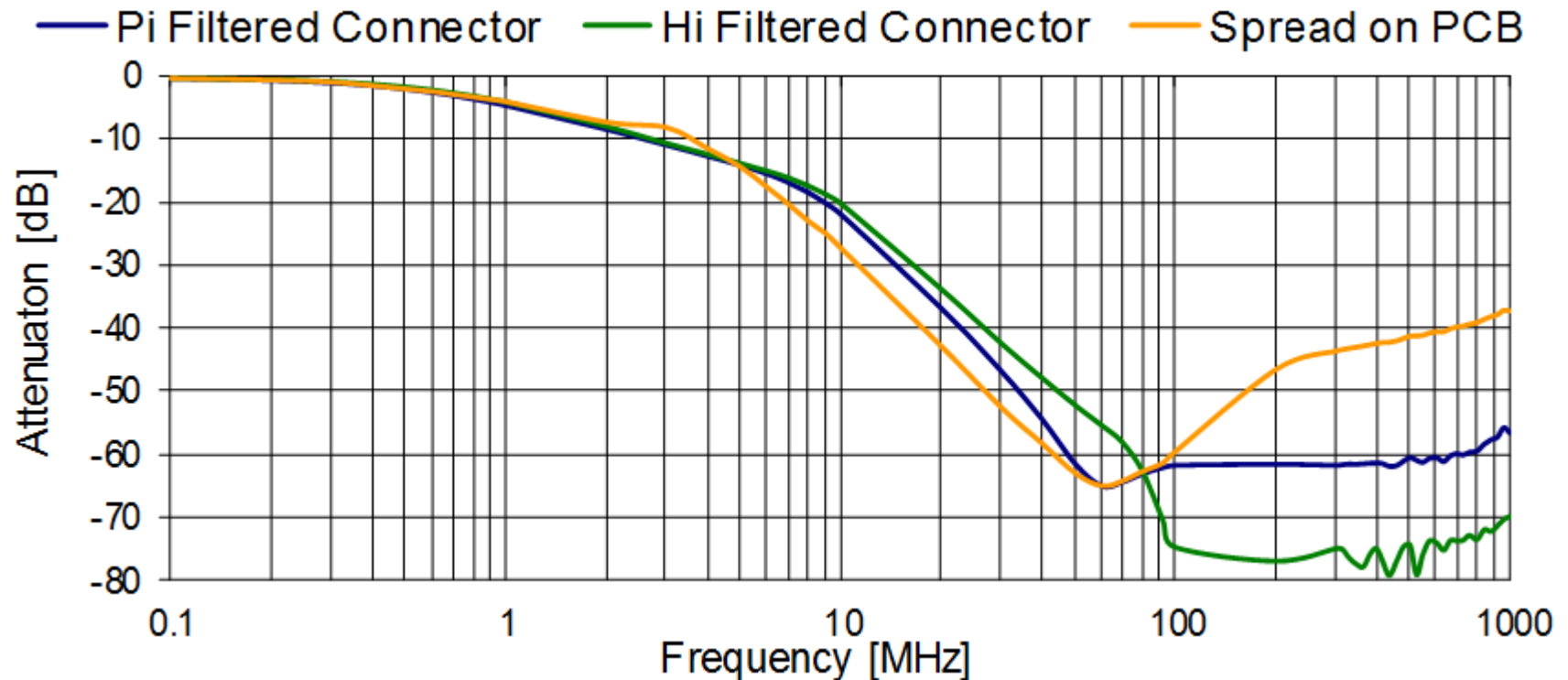
- ◆ No inductive and capacitive coupling due to initiated inductivity separating



Why To Use Filter Connectors

- ◆ Better Performance (Attenuation)

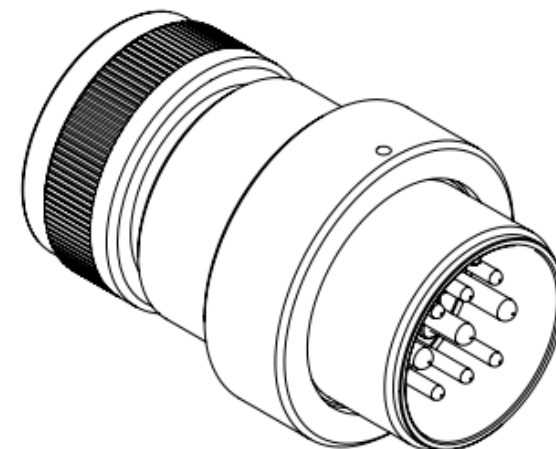
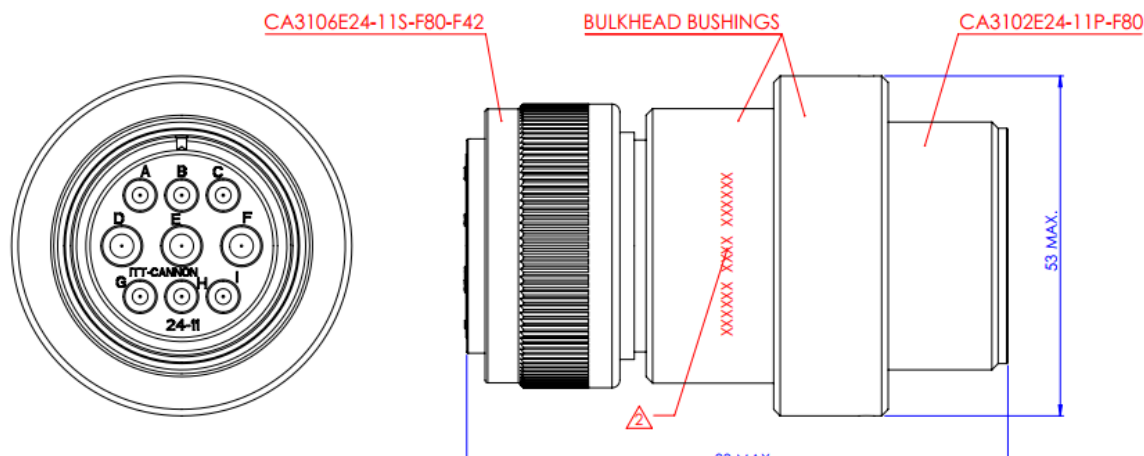
Filters Comparison:



Why To Use Filter Connectors

✦ Additional Features – Higher Current Rating

✦ Filter Adaptor 9 cont. series MIL-DTL-5015 for high current application



Filter Electrical Characteristics:

Current Rating:

#12 contacts – 18Aac

#8 contacts – 32Aac

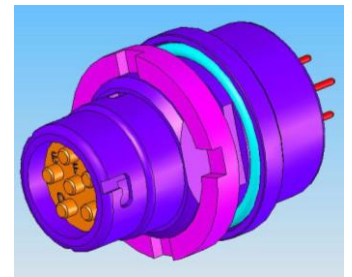
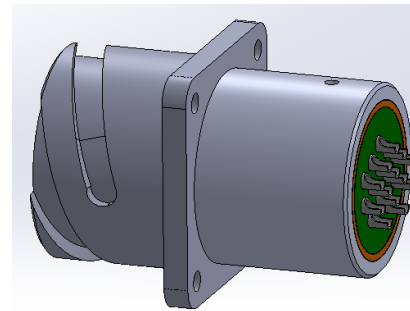
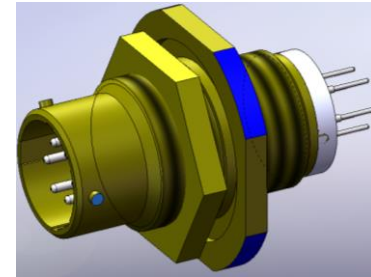
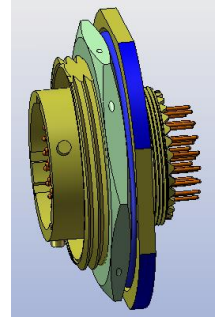
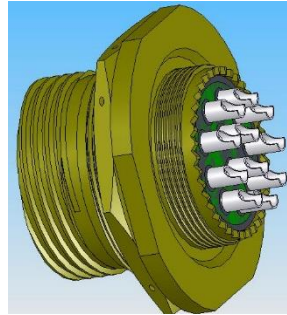
Isolation Resistance: min 1GΩ

Typical Attenuation (Measured per MIL-STD-220; 50Ω System; No Load):

Contact	Filter Type	W.V. [V _{dc}]	D.W.V. [V _{dc}]	Cap. ±20% [nF]	f_{co} [kHz]	Attenuation [dB] vs. Frequency [MHz]			
						1	10	100	1000
All contacts	Pi	1500	1875	20	300	7	35	58	49

Filter Connectors - Circular

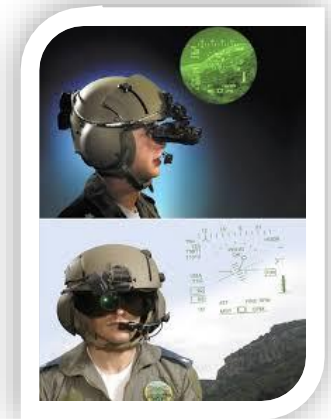
- MIL-DTL-38999 Series I, II, III
- MIL-DTL-26482 Series II
- MIL-C- 83723 Series I, II, III
- MIL-C-5015
- MIL-C-55116, VG95351 (Audio)
- VG95234
- Any metal shell connector



Military Applications

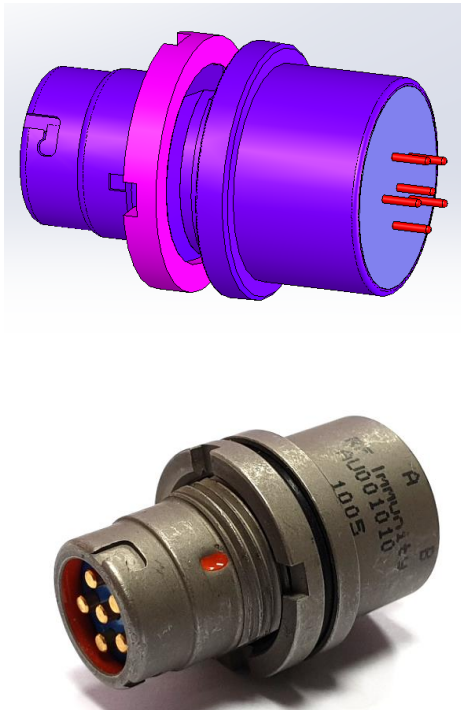
Military System & Products

Helmet Mounted Systems



Military Applications

Audio Connectors per MIL-C-55116 for Tactical Communication Radio

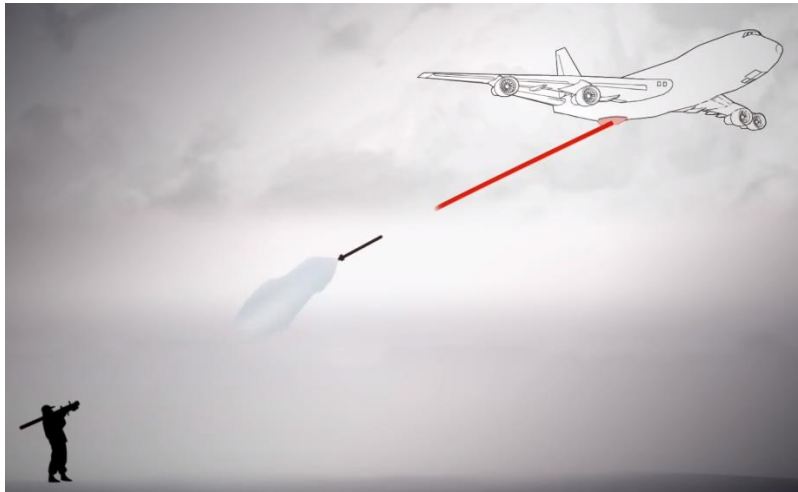


Picture taken from www.janes.com

Avionic System/ Sky Protector



- Designed for ELOP aircraft protection Laser system against portable missiles
- Combination of Filters & transient protections to meet RTCA-DO-160 sec 17,18&22.
- Special mechanical modification Zinc Cobalt connectors.



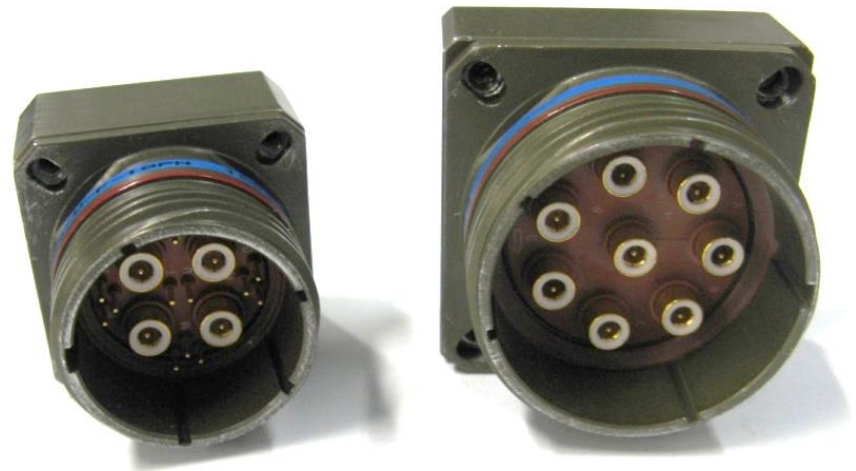
CRIMP Circular Filter Connector

- For an EADS Audio system in the Airbus A400
- Withstands the strict requirements based on the RTCA/DO160D
- CRIMP termination contacts.



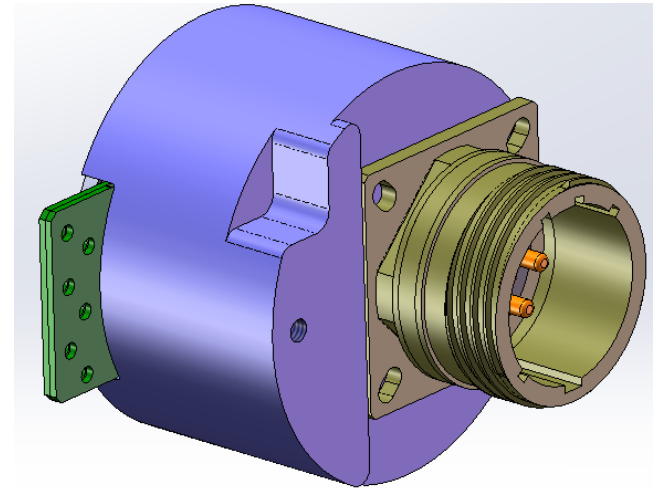
HF Contacts Filtering and Lightning protection

- Filtering Coax, Twinax, Quadrax and Triax contacts
- Used for Ethernet, Video, MaxBus 1553
- Including Transient protection RTCA/DO-160 section 22, level A2XXX.



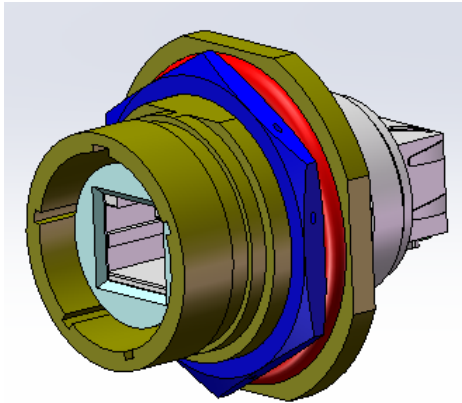
AC Filter Connector – Avionic application

- Filter connector used for power supply of 115Vac/400Hz and can withstand working voltages of 1000Vdc & DWV of 1250Vdc.
- 20db at 10Khz and 60db at 100Khz
- 4 weeks for Prototype
- Unique mechanical shape and wires termination



Ethernet Filter Connector –RJ45 interface

Ethernet 10/1000 Base-T Filter



Features:

- Electrical
 - Ethernet 10/100 and 100/1000 Base T
 - Retains Ethernet signal integrity
 - Significant attenuation at the tactical frequency range (2MHz – 100MHz).
 - Transient Protection - optionally
- Mechanical
 - Based on MIL-C-38999, Shell Size 19 (Modified)
 - Meets the mating mechanism of D38999/III



MIL-COM Connectors



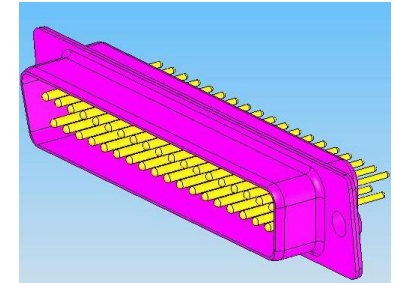
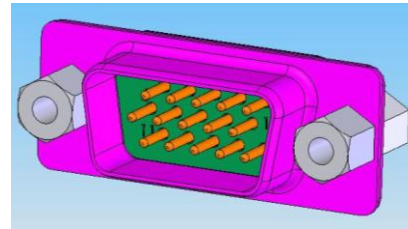
- **MIL-LAN** – Military Filter connector for a Giga Ethernet (10/100/1000 base T).



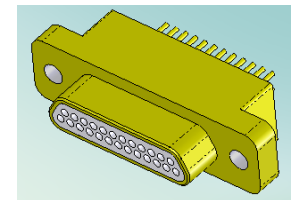
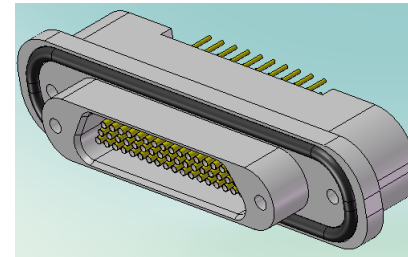
- **MIL-USB** - Filter connector for USB2.0 (480Mb/sec) protocol

Filter Connectors – D-Sub (Mil and Industrial)

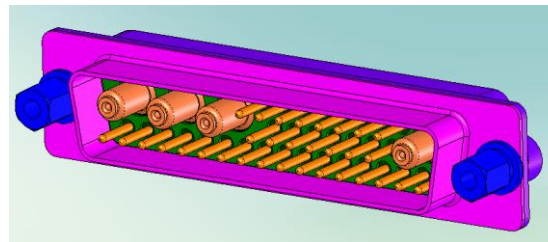
- MIL-C-24308 - D-Subminiature



- MIL-DTL-83513 – Micro D-Subminiature



- Mixed Layout (COMBO)

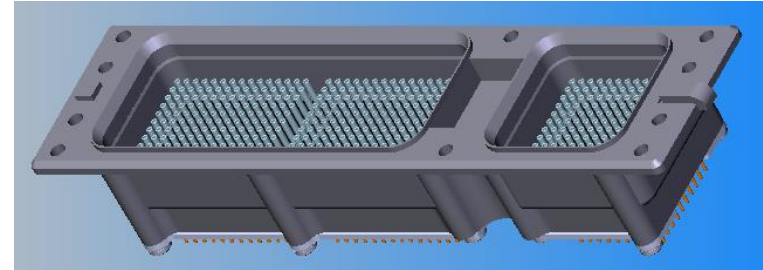


Micro D-Sub connector 31 cont. at Military UAV

[illegible]

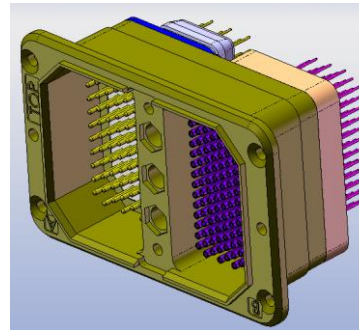
Filter Connectors – Rack&Panel

➤ ARINC 600



➤ ARINC 404 (MIL-C-81659)

(also known as DPX)



➤ MIL-C-83733 (also known as DPK)



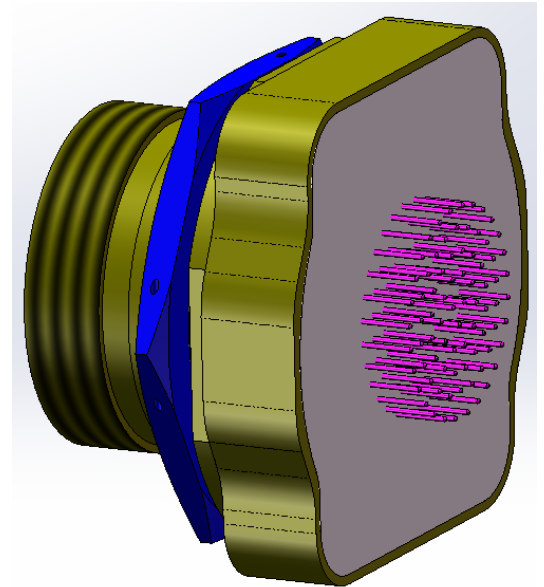
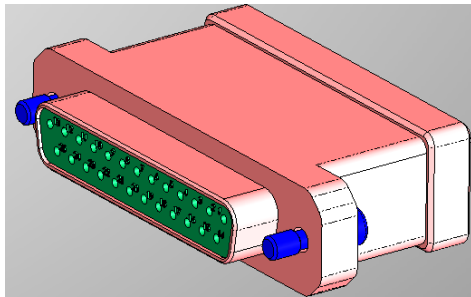
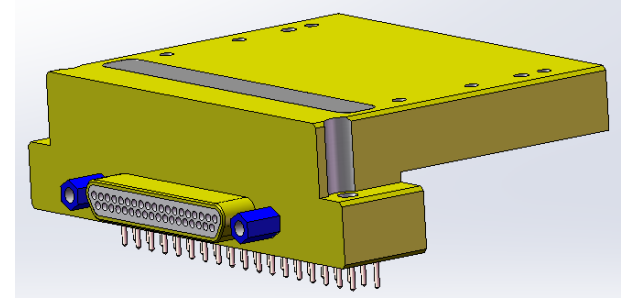
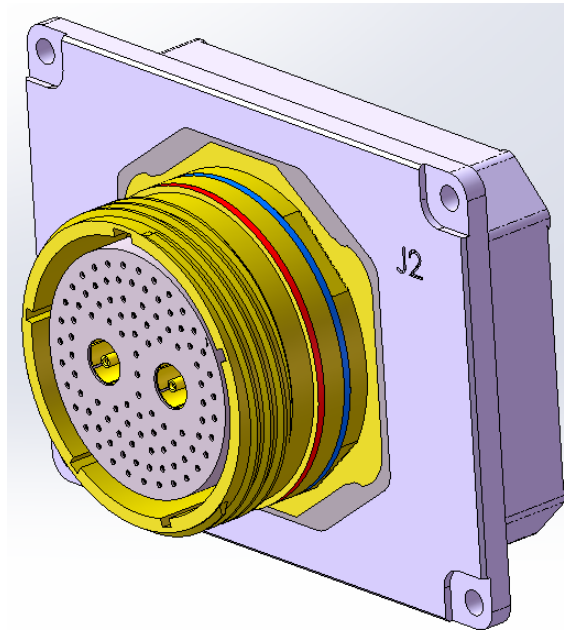
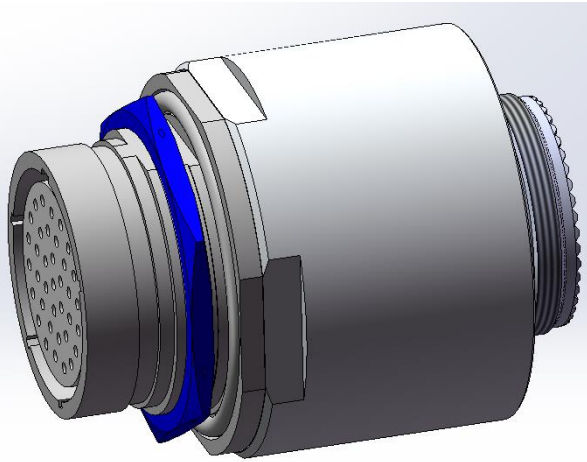
Avionic System | Filtered & Transient Protected Connector



- Head Up Display connector - F16i
- Based on MIL-C-83733 / DPK 101 contacts
- Pi & C filter typology from 470pf up to 9.4nf and Transient protection comply the RTCA-DO -160.
- Mechanical design from scratch.



Lightning and Transient Protected Connectors



Transient Protected Connectors (all series)

Transient Protection per RTCA/DO-160

Filter and Lightning Protection¹ Characteristics:

Contact	Filter Type	Filter Cap. ² ±20%	W.V [V _{bc}]	Attenuation ³ [dB] vs. Frequency [MHz]				Standoff Voltage [V]	Clamping Voltage [V]	Typ. Cap. ²
				1	10	100	1000			
1, 13, 20	CGND	-	-	-	-	-	-	-	-	-
[2+30], [7+34], [8+35], [16+41], [17+42], [18+43], [19+44], [21+45], [22+46], [23+47], [24+48]	Pi CMC	44pF	200	0	3	15	30	5	9.2	150pF
4, 31, 52, 53, 55, 63, 64, 70	Pi	940pF	200	0	2	25	45	28	80	1.5nF
3, 9, 27, 59, 60, 72-75, 78, 79	Pi	940pF	200	0	2	25	45	5	9.2	1.8nF
5, 6, 14, 15, 32, 33, 39, 40	Pi	44pF	200	0	0	0	25	30	56	100pF
10, 36, 54, 68, 69, 77	No Filter	-	-	-	-	-	-	-	-	-
11, 12, 37, 38	Pi	940pF	200	0	2	25	45	5	9.2	1nF
25, 26, 28, 29, 49-51, 66, 67	Pi	940pF	200	0	2	25	45	28	45.4	1.5nF
56-58, 71	Pi	440pF	200	0	0	20	54	5	9.2	800pF
61, 62, 76	Pi	9.4nF	200	2	15	52	50	5	9.2	15nF
65	Pi	9.4nF	200	2	15	52	50	28	45.4	15nF

⁽¹⁾ – Lightning Protection as defined in RTCA/DO-160E section 22 category A2XXX.

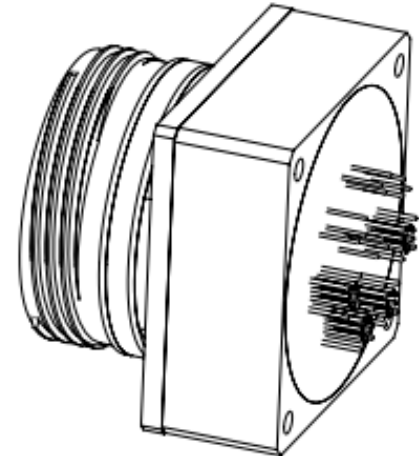
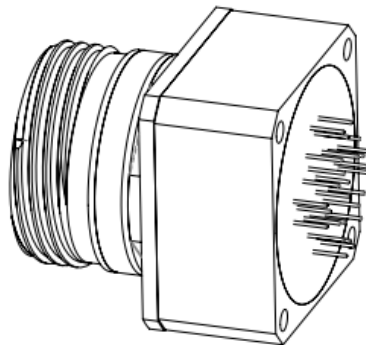
⁽²⁾ – Typical Capacitance per contact including lightning protection capacitance measured @ 1kHz / 1V.

⁽³⁾ – No-load Insertion loss measurements in 50Ω system per MIL-STD-220.

Transient Protected Connectors



- Platform – Mission Computer for LCA MK1A
- Interfaces:
 - Mil 1553B – 5 channels
 - Stroke O/P – 01 No.
 - Discrete Input / Output – 28 / 34 Nos.
 - ARINC-818 – 4 / 8 Nos.



Transient Protected Connectors

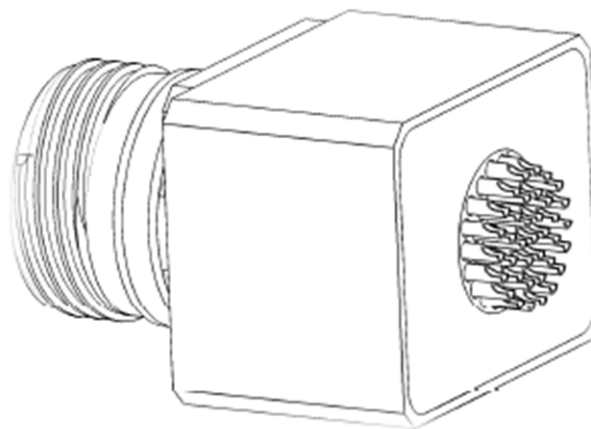
Platform – CCU Unit for LCH

1. Typical Transient Protection per RTCA-DO160E:

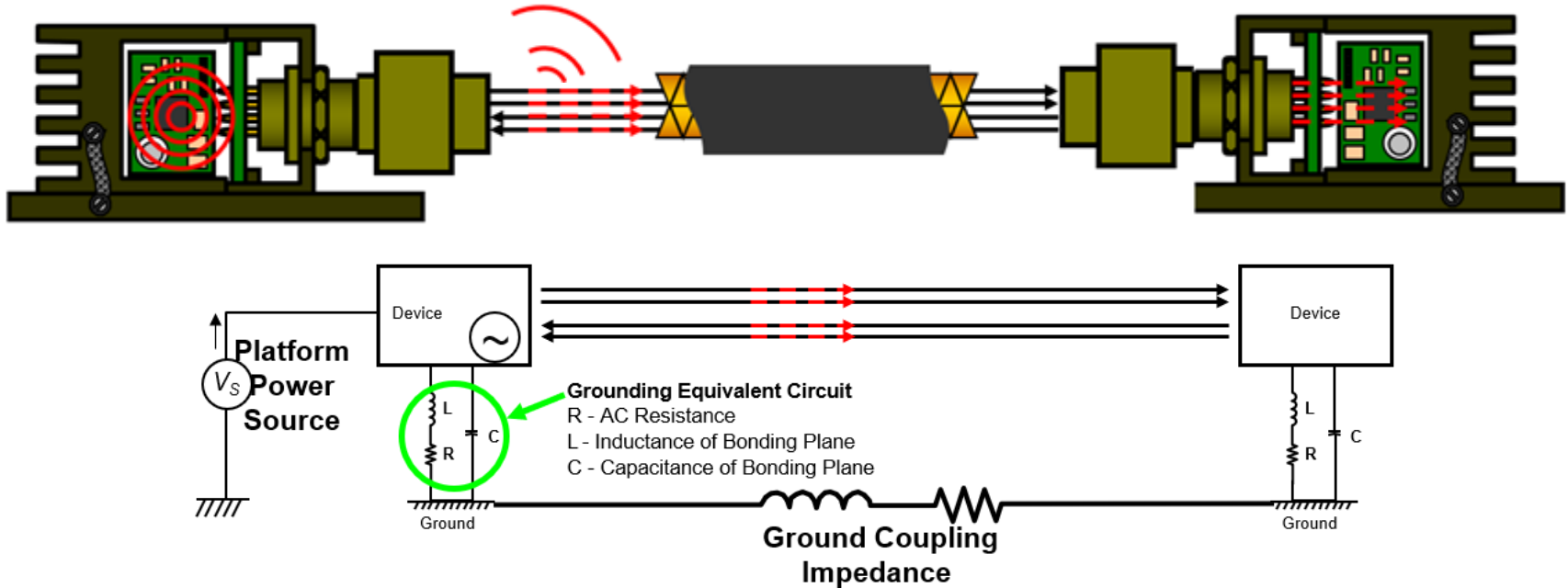
Contact	Energy Level	W.V. [V _{DC}]	V.break [V _{DC}]	V.cl [V _{DC}]
1, 2, 13, 14	4	33	36.7+40.4	53.3
25, 26	4	48	53.3+58.9	77.4
5 – 12	4	12	13.3+14.7	19.9
3, 4, 17-24, 29-32, 34, 35	3	5	6.4+7.1	9.2
15, 16, 27, 28	3	33	36.7+40.4	53.3
36, 37	No protection			
33	GND	-		-

2. Typical Attenuation (Measured per MIL-STD-220; 50Ω System; No Load):

Contact	Filter Type	Filter Cap. ±20%	Additional TVS Cap. ±25%	f _{co} [kHz]	Attenuation [dB] vs. Frequency [MHz]			
					1	10	100	1000
33	GND	-	-	-	-	-	-	-
36, 37	No filter	-	-	-	-	-	-	-
All others	Pi	4.4nF	25nF	1700	0	12	64	47



Filter Adaptors – how it works



- Poor shielding weaving or design might cause disturbances
- Disturbances caused by the power source or by other devices might be conducted through the shielded lines from one device to the other
- Reworking the systems isn't possible, replacing the connectors by Filter Connectors isn't possible
- We want to add a filtering by an outer (add-on) feature without changing anything in the hardware.
- What to do?

Filter Adaptors

➤ 40 types of Filter Adaptors



- Adaptation of existing UAV to new EMC regulation requirement
- Performed as a first stage of UAV adaptation (preliminary laboratory test)
- After passing preliminary EMC test, all connectors were replaced by Filter Connectors

Hermetically Sealed Connectors

Where used?



How been tested?



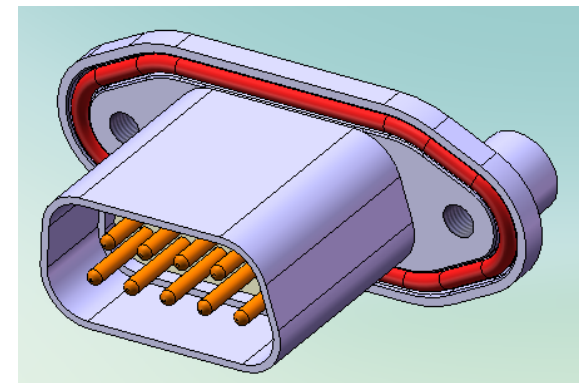
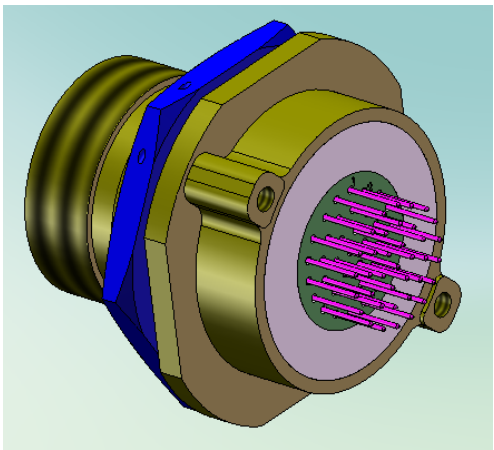
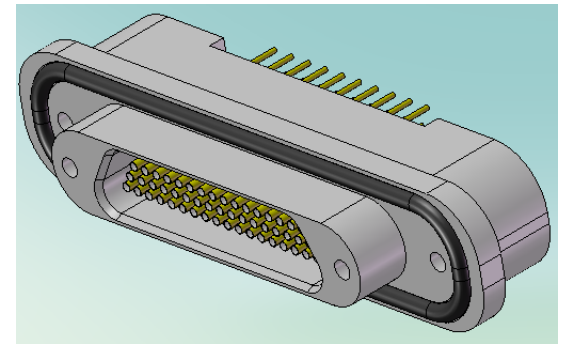
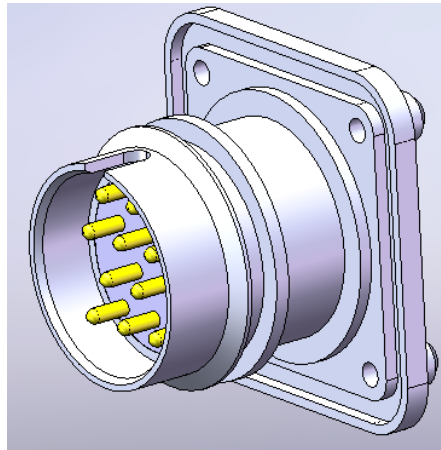
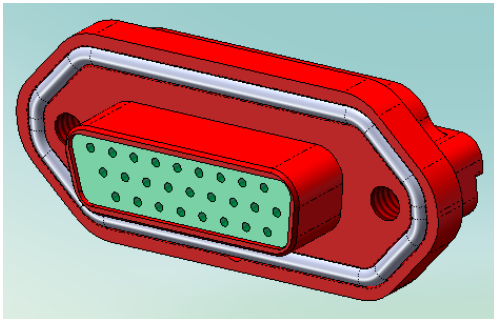
Helium Leakage Detector

Laser & Optical Systems
Nitrogen pressured to prevent
vaporizing on the lenses and
dust particulars penetration.

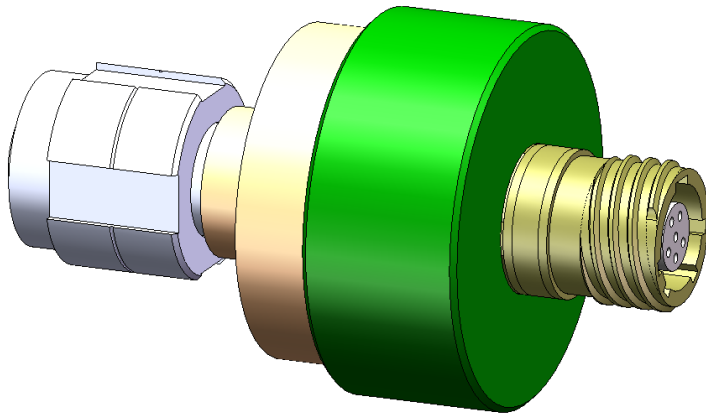
Hermetically Sealed Connectors

Hermeticity level: Leakage up to 10^{-5} cm³/sec Helium @ $\Delta P=1\text{atm}$ (by default)

* up to 10^{-7} cm³/sec Helium @ $\Delta P=1\text{atm}$ upon special request



Smart Connectors



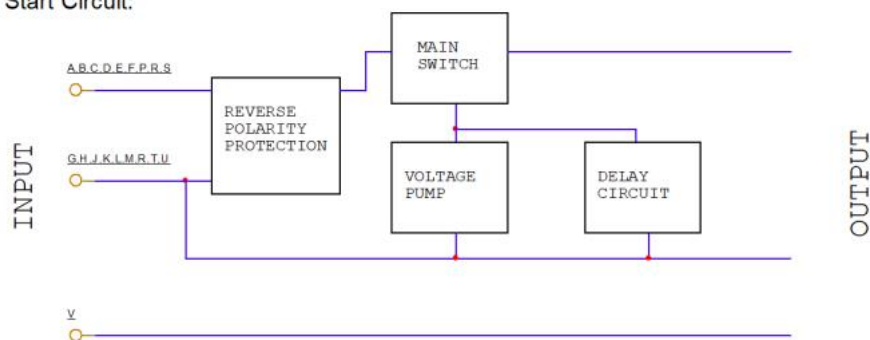
- Receptacle to Plug - Ethernet to RS232 converting Adaptor
- CPU based connector

Soft Start Power Filter Connector (inrush current limiter)

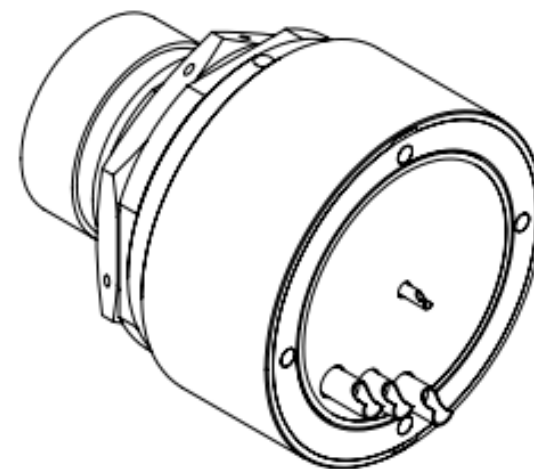
Filter Electrical Characteristics:

Current Rating: 20# each contact pin:	7.5A _{dc}
Reverse Polarity Protection:	Yes
Soft Start Circuit:	Include
Maximum Current of the Soft Start Circuit:	15A _{dc}
Response Time of the Soft Start Circuit: V _{out} (0V – 28V):	45msec ± 20%
Typical Series Resistance of the Soft Start Circuit:	8mΩ ± 20%

Soft Start Circuit:



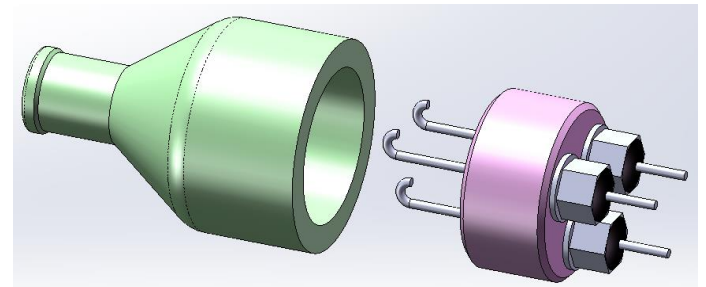
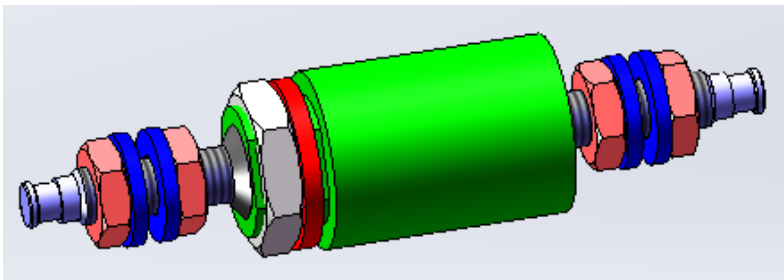
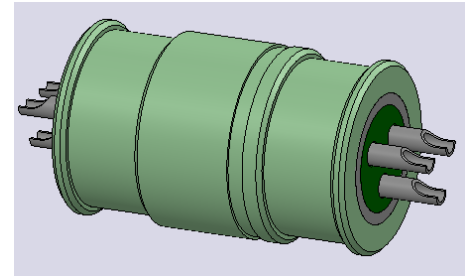
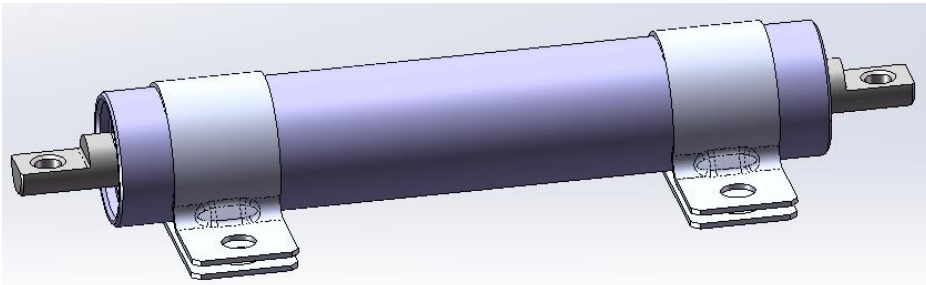
New!



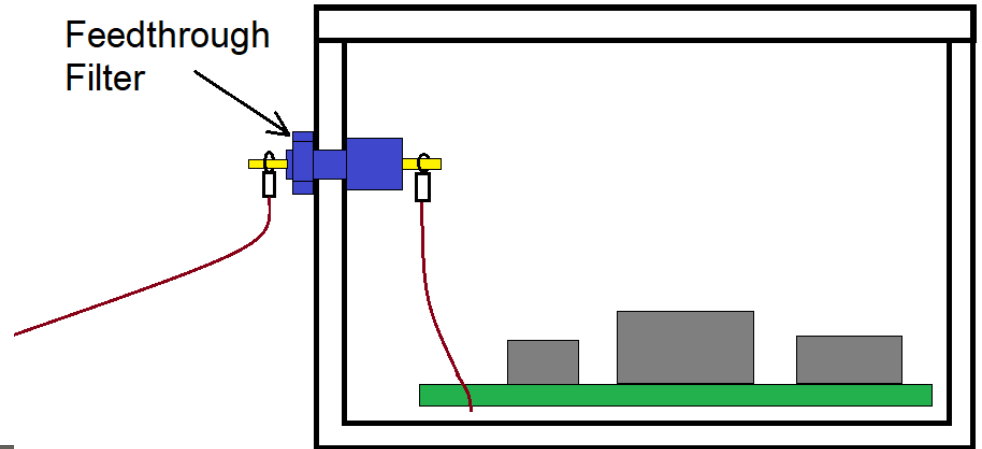
Typical Attenuation (Measured per MIL-STD-220; 50Ω System; No Load):

Contact	Filter Type	Signal	Filter		Protection Power 30kW		Pin Cap. ±20% [nF]	f_c [kHz]	Attenuation [dB] vs. Frequency [MHz]			
			W.V. [V _{dc}]	D.W.V. [V _{dc}]	V.s.o. [V _{dc}]	V.cl. [V _{dc}]			1	10	100	1000
A,B,C,D,E F,P,R,S	Pi	+	200	500	78	129	20	300	7	35	60	48
G,H,I,K,L, M,N,T,U	Pi	-	200	500	36	61.8	20	300	7	35	60	48
V	Pi	Spare	200	500	No protection		20	300	7	35	60	48

Feedthrough Line Filters



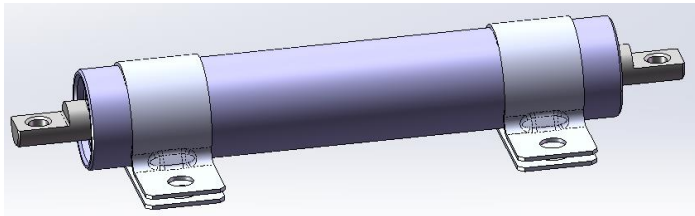
Feedthrough Line Filters



Ground System / Feed Through 120A



- Designed for the Slip-Ring system of the Leopard-2 Tank Turret

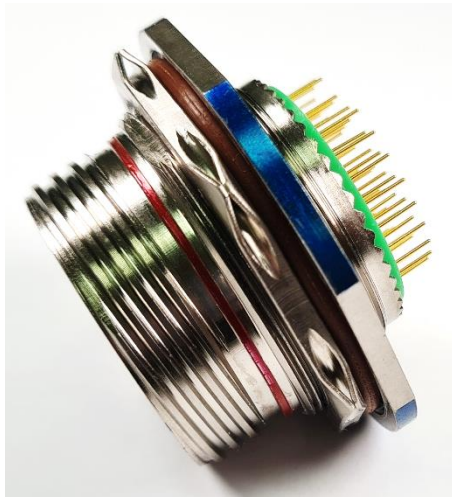


- PI filter 120A / 160V

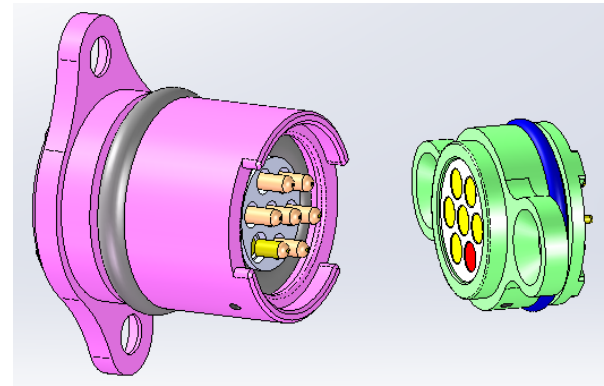
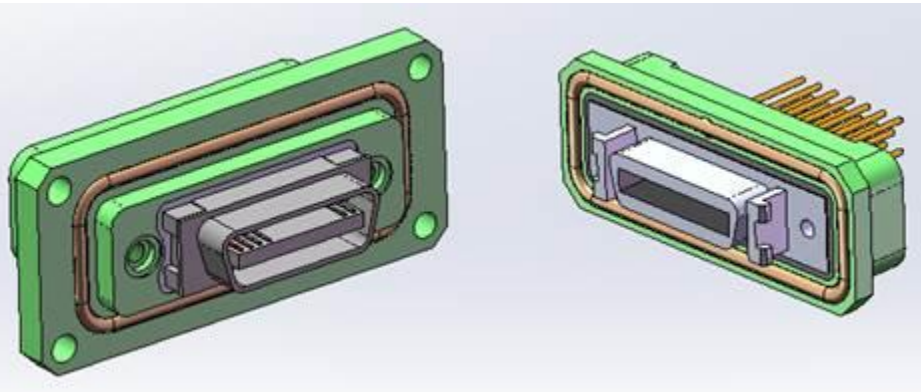
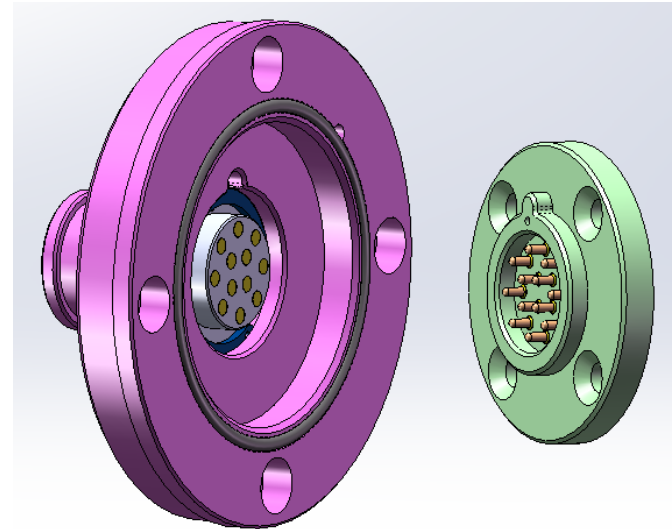
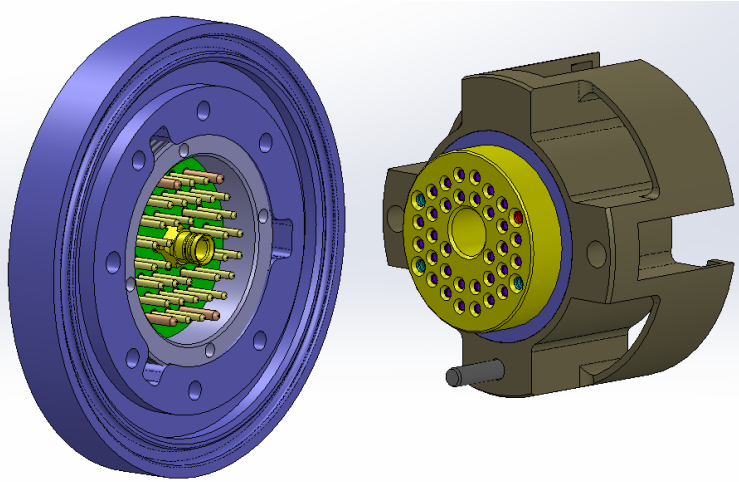


PC3 Series – D38999 connectors with PCB tails

- Standard connectors with PCB termination
- Fast delivery
- Friendly cost



Custom Design Connectors — without filter



Custom Design Connectors – Audio 55116 Splitter



Power, Converters and Filter Stand-Alone Units



Power Supply 600W / MIL-STD-461+1275

Power Line
Filter for 2 lines
- 28V/25A and
270V/8A
+ lightning
protect. per
MIL-STD-461G
- CS117

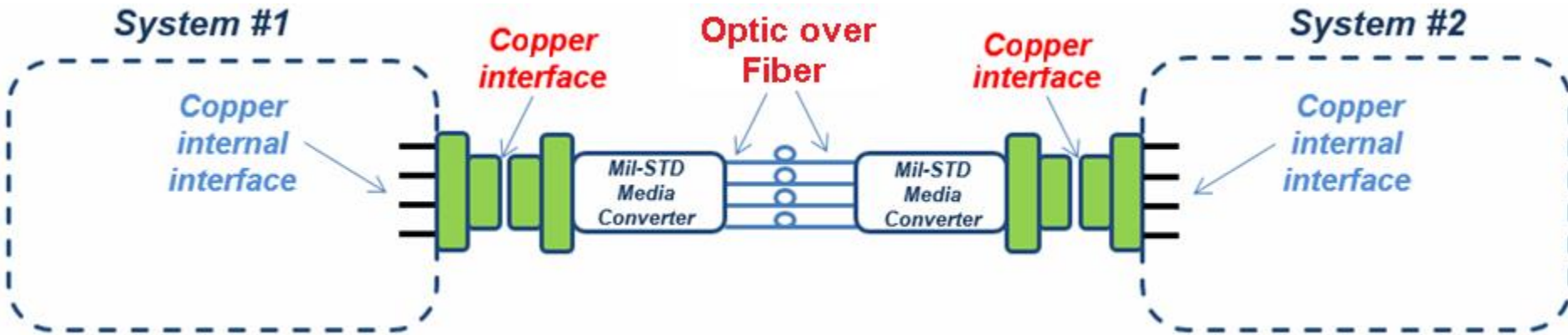


Filtered Power Distribution Unit for 3-Phase 400Hz and 28V DC



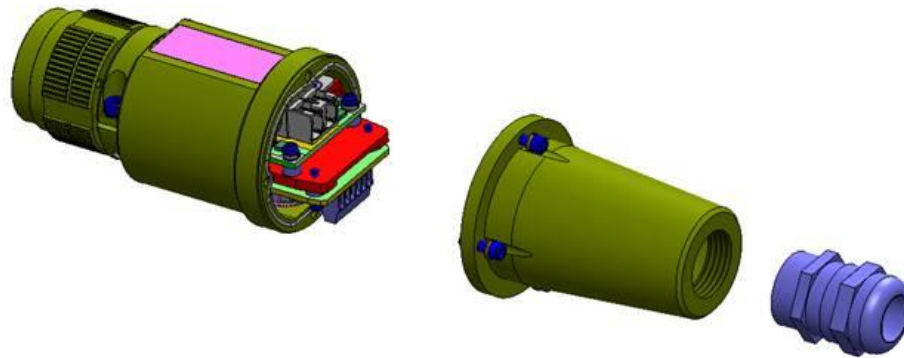
Power Supply
2x120W + Charger
2x2791 batt.+
2xEthernet
communication
channels

What is ACON ?



ACON – Benefits

- No issue of cleaning maintenance optic ferrules
- No need of optic design inside the system
- EMI Filtering before converting to Optic
- Can be adopted and designed for any existing system
- Based on D38999 Military connector, ruggedized
- Modular – the cable can be assembled/disassembled at customer site

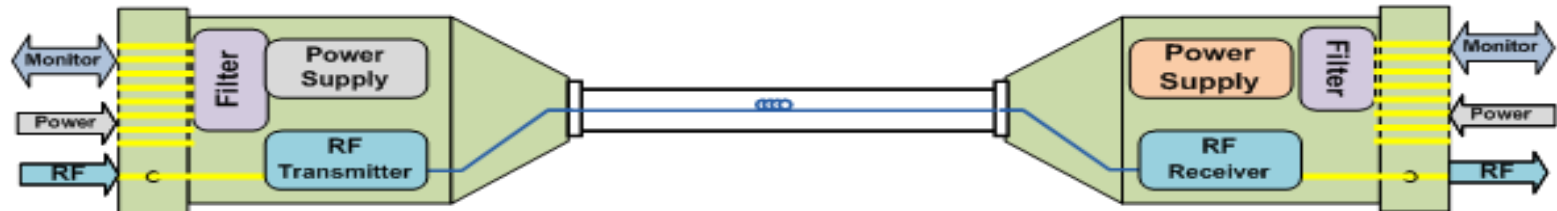


ACON – Configurations of the existing design

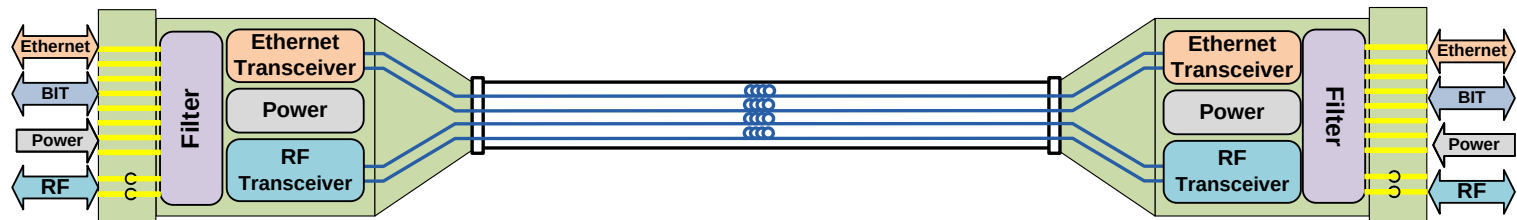
Combined 10/100/1G Ethernet and 3GHz analog link



Ethernet over Fiber



RF over Fiber (Analog channel)



Ethernet+RF over Fiber

ACON – Supported Signals

◆ Serial signals

- Ethernet 10/100/1000
- High speed serial signals up to 10Gbit/sec
- RS422/RS485
- RS232
- Indicators / Switch
- MIL-STD-1553
- ECL
- TTL

◆ Analog

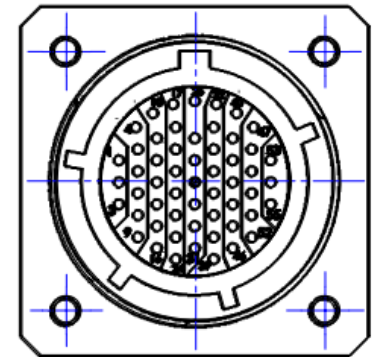
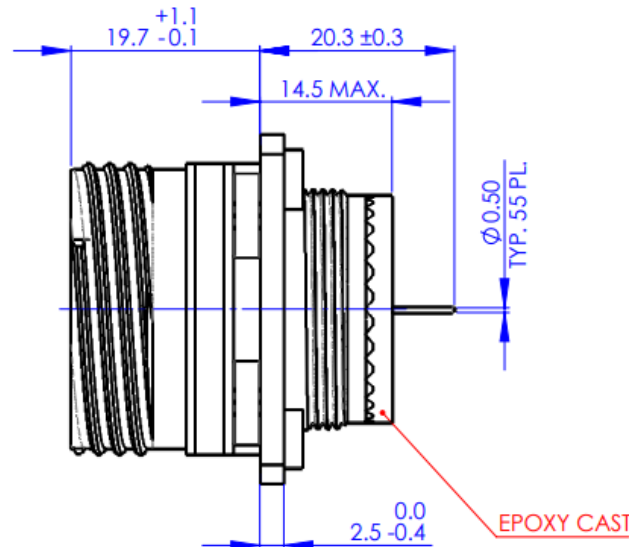
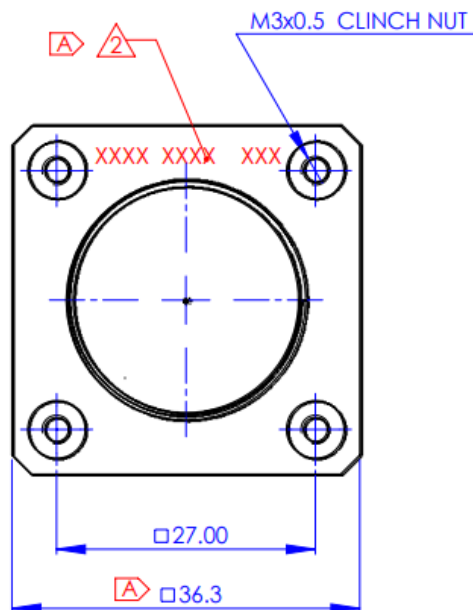
- RF up to 3GHz existing design
- RF up to 18GHz available design
- Analog sensors

◆ Video/Audio

- Composite video PAL/SECAM
- Camera Link
- HD-SDI

Drawing Example

REV.	CHANGE ORDER No.	CHANGES	DATE	APPROVAL
A	22-15	DIM. 33.3 ENLARGED TO 36.3, MARKING LOCATION CHANGED	29.07.15	YURI Z.



NAME		POSITION		DATE		THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF RF IMMUNITY LTD. AND MAY NOT BE REPRODUCED, COPIED, DISCLOSED OR UTILIZED IN ANY WAY IN WHOLE OR IN PART, WITHOUT THE PRIOR WRITTEN CONSENT OF RF IMMUNITY LTD.			
YURI ZARHIN		MECHANIC. DESIGN		22.06.15					
YURI ZARHIN		DRAWING		22.06.15					
EYAL RONEN		ELECTR. DESIGN		22.06.15					
REGINA YOFFE		PA.		22.06.15					
NIR NISSIM		APPROVAL		22.06.15		DO NOT MEASURE ON DWG. BREAK SHARP CORNERS. ALL UNDIMENSIONED RADIUS ARE R=0.2			
NEXT ASSY.		SURF. FINISH							
---						PROJECT ---			
SURFACE TREATMENTS:						MATERIAL			
----						-----			
ANGLE PROJECTION		TOLER.		TITLE: CD FOR D38999/III 55 PIN CONT. WALL MOUNT + CLINCH NUTS FILTER CONNECTOR					
		X. ±0.5							
		X.X ±0.2							
		X.XX ±0.05							
SCALE		N.A.		ANGLES ±30°		SIZE			
DIM.		Sheet1		DRAWING NO.				REV	
IN		OF 2							
MM		A3		C3C17W35P4N070384				A	

NOTES:

1. CONNECTOR BASED ON D38999/20WE35PN

△ MARKING: CFKJAT3B17-35UP2N-AIT, DATE CODE (WW.YY)



RF Immunity

The Filtered Connector Specialists

Drawing Example

Filter Electrical Characteristics

Min. Insulation Resistance – $5G\Omega$ @ $100V_{DC}$

Typical Attenuation per MIL-STD-220 (50Ω System; No Load)

Contact	Current [A]	Filter Type	W.V. [V _{DC}]	D.W.V. [V _{DC}]	Cap. $\pm 20\%$	f _{co} [MHz]	Attenuation ¹ [dB] vs. Frequency [MHz]			
							1	10	100	1000
25, 26	5	PI	200	500	440pF	14.5	0	0	24	53
All others	5	PI	200	500	7.8nF	0.9	1	15	60	52

Environmental Characteristics:

Description	Value	Paragraph per Standard			
		ISO		MIL-STD	
		2100	7137	1344	202
Sealing	Up to $10^{-3} \text{cm}^3/\text{s}$ Air @ $\Delta P=1 \text{atm}$				
Vibration (Random)	Up to 40g RMS 20 to 2,000Hz	12		2005.1	201, 204, 214
Vibration (Sine)	Up to 15g PTP 10 to 2,000Hz	12		2005.1	201, 204, 214
Shock	100g X 6ms Half Sine		7	2004.1	213
Climatic					103, 106
Temperature	-55°C to +125°C Operating and Storage				
Humidity	Up to 95% @ Storage Temp. Range	18b		1002.2	
Altitude	Up to 70,000ft	18a	4		
Salt Fog	500 hours	22		1001.1	101
Sand and Dust		23	12		
Contact Endurance	More than 500 mating cycles	16			

Materials and Finishes:

Shell	Aluminum Alloy, Olive Drab Cadmium Plating
Contacts	Copper Alloy, 1.27μ Gold plated Over Nickel
Potting	Epoxy Cast

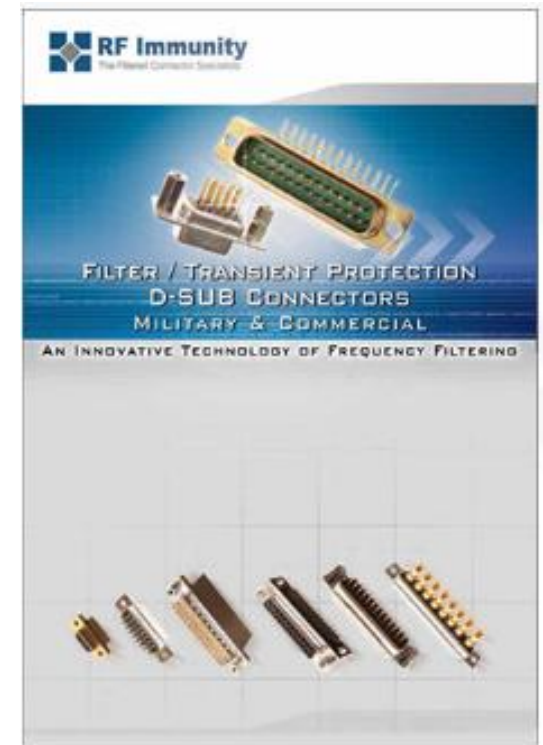
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REGINA YOFFE		PA.		22.06.15						
NIR NISSIM		APPROVAL		22.06.15		DO NOT MEASURE ON DWG. BREAK SHARP CORNERS. ALL UNDIMENSIONED RADIUS ARE R=0.2		PROJECT		
NEXT ASSY.		SURF. FINISH						---		
---		N7								
SURFACE TREATMENTS:						MATERIAL				
----						----				
ANGLE PROJECTION		TOLER.		TITLE: CD FOR D38999/III 55 PIN CONT. WALL MOUNT + CLINCH NUTS FILTER CONNECTOR						
		X. ±0.5 X.X ±0.2 X.XX ±0.05 ANGLES ±30'								
SCALE N.A.				SIZE		DRAWING NO.			REV	
DIM. IN MM		Sheet2 OF 2		A3		C3C17W35P4N070384			A	
 RF Immunity The Filtered Connector Specialists										



RF Immunity

CATALOGS



Required information to define the need

➤ **Mechanical information**

- a. Connector Type (Series, Gender, contacts arrangement or P/N)
- b. Termination Type (Solder Cups, PCB tails)
- c. Mechanical limitations (if there are)

➤ **Electrical information:**

- a. Known EMC failures
- b. EMC standards to withstand (requirements)
- c. ICD (Interconnect Drawing) – signals description (protocol, frequency, working voltage)

➤ **A special questioner is located on the last page of the catalog**

Why to work with RF Immunity?

- Problem Solvers
- Extensive practical experience
- Fast response and best customer support
- Flexible solutions
- Quick Delivery
- No MOQ
- No export regulations

Among our customers



SCHLEIFRING



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