

MIL-PRF-28861 QPL LIST

All are Class B available in Gold and Tin/Tin-Lead Plated Finish (Except /12)

MIL-PRF-28861/01

Style -001 thru -006, -009 thru -016
-019 thru -026, -031 thru -036

MIL-PRF-28861/04

Style -001 thru -036
(ALL)

MIL-PRF-28861/05

Style -001 thru -024
(ALL)

MIL-PRF-28861/12

Style -001 thru -036
(ALL)

Military Series DSCC DWG.#		
DSCC Specification #	Description	Capacitance Range
84083	Hermetic EMI Filter	JD Series
84084	Hermetic EMI Filter	JD Series
84080	Solder-in EMI Filter	WS Series
84081	Solder-in EMI Filter	XS Series
84082	Solder-in EMI Filter	YS Series
88010	Solder-in EMI Filter	ZS Series
86131	Bolt EMI Filter	SA Series
88051	Bolt EMI Filter	SA Series
55562	SMT Transient Suppressor	TransGuards

MIL-PRF-15733 QPL LIST

MIL-PRF-15733/23

Style -0001 thru -0006, -0013 thru -0018
-0025 thru -0030, -0037 thru -0042
-0049 thru -0054

MIL-PRF-15733/24

Style -0005 thru -0008

MIL-PRF-15733/26

Style -0001 thru -0007, -0009 thru -0011
-0013 thru -0019, -0021 thru -0023

MIL-PRF-15733/34

Style -0015
-0019
-0026

MIL-PRF-15733/38

Style -0002
-0004 thru -0006
-0008

MIL-PRF-15733/49

Style -0003, -0004, -0006, -0007

HIGH-REL EMI FILTERS

Noise is the enemy of good engineering design. Properly installed EMI filters suppress such electromagnetic interference on power and signal lines, while allowing desired signals to pass. For critical EMI filter applications, high reliability is of the utmost importance.

High reliability applications have diverse requirements, ranging from a need for a long operating life in medical or military systems to avoiding the prohibitive cost of replacing a faulty component in a satellite, undersea cable, or other inaccessible system. High-Rel filters satisfy application-critical requirements in many environments:

- Space/Satellite Systems
- Military Aircraft
- Guidance Systems
- Command, Control & Communications (C³)
- Missile Systems
- Weapon Systems
- Radar Systems
- Electro Optical Systems
- Electronic Countermeasures
- Electronic Warfare
- Pacemakers
- Medication Monitors

HIGH-REL STANDARDS

Reliability must be designed into an EMI filter. Every step in its manufacture from material selection through testing and characterization must be considered. To assure conformance to clearly define product and performance parameters, specifications have evolved for electrical performance,

mechanical configurations, test methods, screening and qualification procedures.

AVX Filters delivers high quality EMI filters which meet applicable portions of these high-reliability standards:

- MIL-F-15733
- MIL-F-28861
- MIL-I-45208A
- MIL-STD-202
- MIL-STD-220
- MIL-Q-9858
- NASA NHB 5300
- MIL-STD-790
- MIL-PRF-123
- ISO 9000
- MIL-STD-1547
- EIA-RS-469

AVX FILTERS AT THE LEADING EDGE

AVX Filters Corporation continues to provide innovative solutions to the high performance needs of its customers. It has pioneered many breakthroughs which have advanced the state-of-the-art in this demanding discipline, including:

- The first to qualify to the new High-Reliability Filter Spec, MIL-F-28861.
- Facility qualified to MIL-STD-790 during first round of audits for filter manufacturers.
- The first solder-in filter line to offer 400°C installation temperature.
- The first filter line designed to meet the new MIL-Spec requirements for heat rise/reactive current in 125 VAC and 230 VAC 400 Hz applications.
- The first to offer a filter line of hermetically sealed bolt style filters.
- The first manufacturer of medical implantable filters.

CUSTOM AND SEMI-CUSTOM

In addition to standard catalog and QPL EMI filters, AVX Filters produces two classes of these special products: Semi-custom and Custom. Semi-custom involves variations in electrical parameters, testing, and limited mechanical changes from standard product designs. Delivery is slightly longer and price is slightly higher than standard products.

Custom products require longer lead time for design and manufacturing, but give designers freedom to specify non-standard mechanical and electrical filter designs.

AVX filters dedicates a unique internal part number to every semi-custom and custom component. This insures continued configuration control for each part, allows future changes to be easily implemented, and provides assurance that the design always matches the customer requirements.

ENGINEER TO ENGINEER

Our application engineering staff will assist in defining your filter requirements, while recommending advantages, reliability, quality assurance levels, and filter performance at the lowest practical cost. They will help in filter selection and specification, including meeting DESC requirements. SCD models are available to assist you in the design process. A custom filter part number will be assigned exclusively to your SCD. To obtain prompt professional assistance, call **(818) 767-6770**.

QUALITY ASSURANCE

Quality assurance is built into every stage of manufacturing and testing. AVX Filters controls the entire process, from the capacitor's dielectric formulation through final filter test. This results in absolute traceability by lot number to a specific dielectric batch, as well as the subsequent materials, equipment and employees involved in the tightly-controlled manufacturing and testing process. In addition, critical processes are monitored using SQC, SPC techniques.

HIGH-RELIABILITY FILTER DESIGN GUIDE

To produce a high-rel filter, the manufacturing processes, the procedures, and the materials used must be kept under tight control. By monitoring and tagging these on a lot and order basis, any product failures or performance abnormalities can be traced. At AVX Filters, such information is kept on file for later traceability and analysis.

Baseline – A baseline is a system of documentation that is used to guarantee manufacturing consistency, control change, and establish reporting structure. It sets up the mechanisms to define manufacturing, materials and components selection and qualification, as well as inspections and tests. It can also define mechanisms for direct comparisons to test the difference between lots and orders.

An example of a baseline is the MIL-PRF-28861 baseline that is defined for the space level components. With this baseline in place, all the mechanisms are defined to support Class S filter production and quality assurance. AVX Filters is qualified as a Class S facility. Changes to the baseline are monitored and approved by DESC, NASA and Aerospace Corporation. Custom baselines can also be developed to fulfill specific customer requirements.

MIL-STD-790 – This standard sets up a full reliability assurance program plan with full traceability to raw materials, manufacturing processes, assembly, and tests. At AVX Filters there is full traceability down to the raw materials such as plating elements, base metals, ceramic materials, and inks, in accordance with MIL-STD-790. Other programs in this standard include failure analysis, documentation control and operator training requirements. MIL-PRF-28861 relies on this standard to define the reliability assurance program for the Class S filters.

QPL – EMI filters which fully meet MIL standards are placed on a Qualified Products List (QPL) by a specifying agency such as DESC. The MIL-qualified filters can then be ordered directly by QPL part number. This is indicated by the MIL-PRF-28861 and MIL-PRF-15733 QPL sections of the catalog.

Reliability Quality Assurance

A key factor in insuring quality components, and high reliability performance, is the implementation of appropriate tests and inspections during the manufacturing process.

There are a number of defined standards that specify the design parameters, tests and test setups, materials used, and the quality assurance provisions required. Vendor parts that are qualified to the standards are put on QPL lists for that standard.

Design and component engineers can order these standard QPL filters with their attendant specifications. Other parameters can be added to meet specific needs or define a full quality assurance program.

MIL-PRF-15733 – This is an older standard developed for specifying EMI/RFI filters. It defines specific electrical and mechanical requirements, as well as stress tests and inspections. MIL-PRF-15733 does not require full 100% testing of each component, but relies upon sample testing for each lot.

It also defines quality assurance inspections, and specifies a quality assurance reporting mechanism with yearly reports required on overall quality assurance performance. It makes use of standards such as MIL-STD-202 to define test methods.

MIL-PRF-28861 – This is a modern standard, defining stringent classes of quality. The higher level, Class S, is for critical space type applications where failure may have catastrophic results. Detailed Group A screening and Group B environmental and qualification tests are fully described.

MIL-PRF-28861 is approved for use by all departments and agencies of the Department of Defense. Like the earlier 15733, it defines filters for EMI applications. However, it goes into detailed requirements for a number of attributes such as baseline control, capacitor dielectrics, filter inductors, case and lead finishes, potting/impregnants, X-ray, DPA, SLAM and soldering methods.

Quality conformance inspection (QCI), or “Group A” testing, is performed on 100% of the filters for each production lot with limits on the number of failures allowed. For Class S filters, baseline documentation is required to track the major process steps and inspection points in manufacturing and quality assurance. This baseline also “locks” in the design through configuration control. Changes to the product design, or the process steps for defined areas, can only be done with formal government approval. Class “S” devices are qualified on a lot-by-lot basis, with Group A and B screening and testing documented on each manufacturing lot.

All AVX Filters internal design standards reflect these three standards of performance and reliability. For detailed information on these standards, see Filter Design Guide, M28861 Screening and R-Level Screening sections of catalog.

Group A, B Tests – These tests or inspections are typically defined by MIL-PRF-15733. The Group A screening test sequence will include thermal shock, voltage conditioning,

and the measurement of basic electrical parameters for the filter. It also defines visual and radiographic inspections. All filters in a lot are 100% tested, when Group A per MIL-PRF-28861 is performed. Sample inspection of a filter lot is performed when Group A per MIL-PRF-15733 is specified.

Group A per MIL-PRF-28861 stipulates that up to 10% of tested Class B filters can be defective, and are simply removed from the lot. Failure rates in excess of 10% will cause the entire lot to be rejected.

Class S filters are only allowed PDA rates ranging from 2 to 3% on individual tests. If the combined total failures exceed 10%, then the lot must be scrapped.

Group B screening defines environmental tests on samples from the production lots. Some of these tests are destructive, including Destructive Physical Analysis (DPA). These tests permit a percentage of failure for each sampling of Class B Filters. No failures are permitted for Class S filters.

DPA – Destructive Physical Analysis to RS-469 is a quality assurance technique that involves taking lot samples and cross-sectioning them for internal inspection. A filter is sectioned and then polished for microscopic examination. This is used to detect specific filter defects, such as flawed interconnects, capacitor voids, improper margins, dielectric separation (delamination), and improper dielectric grain growth. For detailed information see DPA Criteria section.

Military EMI/RFI Filters



Filter Design Guide

High Reliability/Military Qualified Products

MIL-PRF-28861 SCREENING

Class S, Class B

The Group A sequence as outlined in MIL-PRF-28861 is performed on a 100% basis whenever reliability codes for

Class S or Class B are specified by the customer. Differences between Class S and Class B screening are shown in the descriptions.

S-CLASS, B-CLASS TESTING

Test	MIL-STD-202 (method)	Description
Thermal Shock	107, cond. A	S-class: 5 cycles from -55°C to +125°C. Through hole mounting required. B-class: as above except mounting not required.
Burn-in	108	S-class: 168 hours minimum at 2.0X rated voltage, 125°C polarity reversal for the first 24-72 hours; fused B/I circuit for each filter. B-class 164 ± 4 hours at 2.0X rated voltage.
Dielectric Withstanding Voltage	301	S-class, B-class: 2.5X rated DC voltage for 5 seconds minimum, 1 minute maximum, 50 mA charging current.
Insulation Resistance	302, cond. A	S-class: test at 100 VDC or rated, V, whichever is less. Pass/fail limits are lot also based upon 125°C readings from first 50 pieces.
Capacitance and Dissipation Factor	305	B-class: same as above, except omit pass/fail as per 50 piece calculation. S-class, B-class: test at 1000 ± 100 Hz, 0.1 to 1.2 VRMS.
Insertion Loss	—	S-class, B-class: per MIL-STD-220 at load, no-load as specified.
DC Resistance	303	S-class, B-class: test is optional if DC Voltage Drop Test performed.
Voltage Drop	—	S-class, B-class: M28861 para 4.6.6.1 (AC rated), para 4.6.6.2 (DC rated)
Radiographic Inspection	209	S-class, B-class: 2 views required with 10X examination of images.
Seal Test	112	S-class: condition C B-class: condition A or D
Visual and Mechanical	—	S-class: M28861 para. 4.6.1.2 which includes element, subassembly, and pre-cap inspections. B-class: M28861 para. 4.6.1.1 for external visual only.
Solderability	208	S-class, B-class: 5 samples.

MILITARY QUALIFIED PRODUCTS

There have been many questions raised regarding the differences between MIL-PRF-15733 and MIL-PRF-28861. To

clarify these differences we have incorporated the following Analysis Chart which compares the differences between these two military specifications.

ANALYSIS MIL-PRF-15733 vs. MIL-PRF-28861

MIL-PRF-15733 Characteristics	MIL-PRF-28861 Filter/Design/Construction	Filter/Design/Construction	
		Class B	Class S
Case	Standard	Standard	Standard
Capacitor (Discoidal) • Dielectrics • K • VTL • Cap Range	Standard X7R, Z5U 2200-10K N/A Max Cap/Case Size	Special Design BR 2K max +15%, -40% Limited Cap/Case Size Conversion Design	Special Design BX 2K max +15%, -25% (when design permits) Limited Cap/Case Size & MIL-PRF-123 Req'ts Conversion Design
	Testing	Testing	
Group A • Test • PDA (parts defective allowed)	MIL-STD-105, 1.0% AQL None	100% Test 10%	100% Test Thermal Shock, Burn-in*, IR & DWV-2% each test Cap, Volt. Drop, Insertion Loss -3% max combined Total 10% max
X-Ray	None	MIL-STD-202 Method 209	MIL-STD-202 Method 209
Leak Test	Condition "A" Gross Leak	Condition "A" Gross Leak PDA 10% max	Condition "A" Gross Leak Condition "C" Fine Leak PDA 10% max
Burn-In	None generally. A few slash sheets require 1.4 x rated voltage	160 Hrs. @ 2 x rated voltage – Resistor protected	168 Hrs. (250 Hrs. max) @ 2 x rated voltage – Fuse protected *PDA .2% max last 50 hrs.
Insertion Loss	1.0% AQL	100%	100%
Solderability	None	MIL-STD-202 Method 208 5 Samples	MIL-STD-202 Method 208 5 Samples



Military EMI/RFI Filters



MIL-PRF-28861/01, /04, /05, /12

HOW TO ORDER

MIL-PRF-28861

Mil-Spec Number

/02

Slash Sheet

- 001

Dash Number

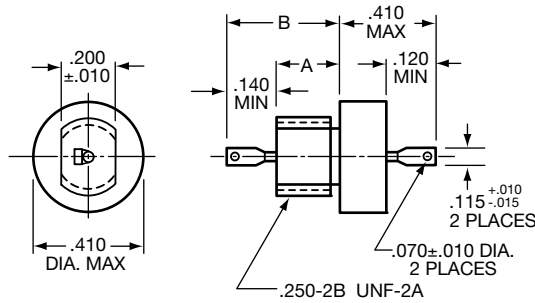
G

Finish*
G = Gold
T = Tin/Tin Lead

B

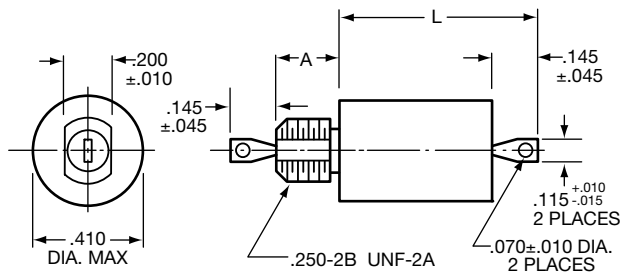
Class

MIL-PRF-28861/01



Dash number	Circuit	Rated voltage		Min. capacitance (µF)	Dash number	Circuit	Rated voltage		Min. capacitance (µF)
		DC volts	AC 1/ volts				DC volts	AC 1/ volts	
001, 011	L2	50	---	1.2	010, 020	C	200	125	0.15
002, 012	C	50	---	1.2	021, 031	L2	200	125	0.01
003, 013	L2	70	---	0.7	022, 032	C	200	125	0.01
004, 014	C	70	---	0.7	023, 033	L2	200	125	0.0027
005, 015	L2	100	---	0.45	024, 034	C	200	125	0.0027
006, 016	C	100	---	0.45	025, 035	L2	200	125	0.001
009, 019	L2	200	125	0.15	026, 036	C	200	125	0.001

MIL-PRF-28861/04



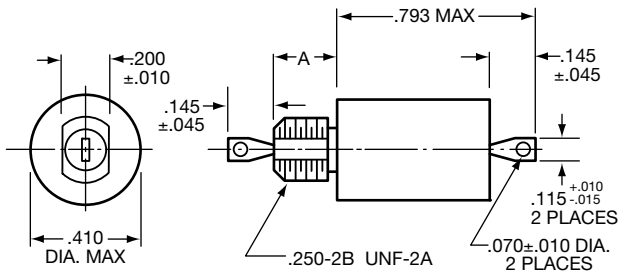
Dash number	Circuit	Max. current (amps)	Min. capacitance (µF)	Max. voltage drop (volts)	Max. DC resistance (ohms)	Dash number	Circuit	Max. current (amps)	Min. capacitance (µF)	Max. voltage drop (volts)	Max. DC resistance (ohms)
002, 020	L2	0.10	0.70	0.17	1.7	011, 029	L2	1.0	0.70	0.14	0.14
003, 021	π	0.10	1.4	0.17	1.7	012, 030	π	1.0	1.4	0.14	0.14
004, 022	L1	0.30	0.70	0.23	0.77	013, 031	L1	3.0	0.70	0.15	0.05
005, 023	L2	0.30	0.70	0.23	0.77	014, 032	L2	3.0	0.70	0.15	0.05
006, 024	π	0.30	1.4	0.23	0.77	015, 033	π	3.0	1.4	0.15	0.05
007, 025	L1	0.50	0.70	0.18	0.36	016, 034	L1	5.0	0.70	0.075	0.015
008, 026	L2	0.50	0.70	0.18	0.36	017, 035	L2	5.0	0.70	0.075	0.015
009, 027	π	0.50	1.4	0.18	0.36	018, 036	π	5.0	1.4	0.075	0.015

Military EMI/RFI Filters



MIL-PRF-28861/01, /04, /05, /12

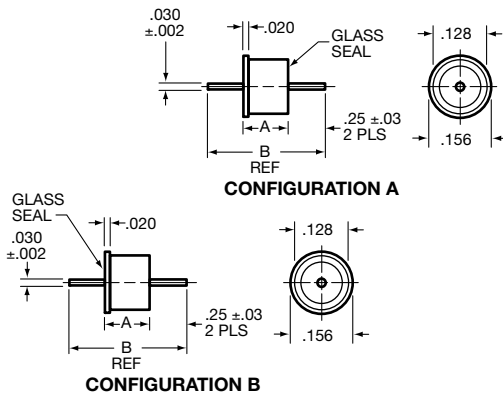
MIL-PRF-28861/05



Dash number	Circuit	Max. current (amps)	Capacitance (µF) +100% -0%	Max. voltage drop (volts)	Max. DC resistance (ohms)
001, 013	L1	0.25	0.15	0.375	1.5
002, 014	L2	0.25	0.15	0.375	1.5
003, 015	π	0.25	0.30	0.375	1.5
004, 016	L1	1.0	0.15	0.250	0.25
005, 017	L2	1.0	0.15	0.250	0.25
006, 018	π	1.0	0.30	0.250	0.25

Dash number	Circuit	Max. current (amps)	Capacitance (µF) +100% -0%	Max. voltage drop (volts)	Max. DC resistance (ohms)
007, 019	L1	3.0	0.15	0.150	0.05
008, 020	L2	3.0	0.15	0.150	0.05
009, 021	π	3.0	0.30	0.150	0.05
010, 022	L1	5.0	0.15	0.075	0.015
011, 023	L2	5.0	0.15	0.075	0.015
012, 024	π	5.0	0.30	0.075	0.015

MIL-PRF-28861/12



Dash number	Circuit	Rated voltage DC	Minimum capacitance (µF)
001, 017	L	50	15000
003, 019	L	100	2700
005, 021	L	100	5000
007, 023	L	200	10
009, 025	L	200	25
011, 027	L	200	100
013, 029	L	200	500
015, 031	L	200	1000
033, 035	L	50	10000

Dash number	Circuit	Rated voltage DC	Minimum capacitance (µF)
002, 018	C	50	15000
004, 020	C	100	2700
006, 022	C	100	5000
008, 024	C	200	10
010, 026	C	200	25
012, 028	C	200	100
014, 030	C	200	500
016, 032	C	200	1000
034, 036	C	50	10000

* Only available in gold finish

(See MIL-PRF-22861 for insertion loss and other specification details.)

