



# AVX PRODUCT GUIDE FOR MEDIUM & HIGH POWER FILM CAPACITORS

# MEDIUM & HIGH POWER CAPACITORS FOR POWER ELECTRONICS



AVX has been a world leader in high performance film capacitor technology design for over 30 years. We produce both dry-wound capacitors, from 75Vdc to 3kVdc (Medium Power Family) and oil-impregnated capacitors from 1.5kV to 100kV (High Power Family).

A key feature of AVX Medium & High Power is Controlled Self-Healing technology. This enables the capacitors to continue to function without catastrophic failure by effectively insulating any microscopic conduction sites within the dielectric.

While power film capacitors remain functional throughout their operating life, the initial capacitance value will decrease at a rate dependent upon the applied voltage and hot spot temperature. Our standard designs provide < (2-5)% capacitance loss over 100,000 hours lifetime at nominal voltage and a 70°C hot spot temperature, while application specific designs can be provided on request.

Various series of AVX Medium/High Power Capacitors are available for DC filtering, Protection, Pulse Discharge, Tuning, AC filtering and Storage applications. RoHS products are available for many medium power film series.

## APPLICATIONS

AVX Medium/High Power Capacitors are used in wide range of application sectors such as:

- Automotive
- Traction
- Industrial/Professional
- Renewable/Smart Energy
- Defense/Aero/Research

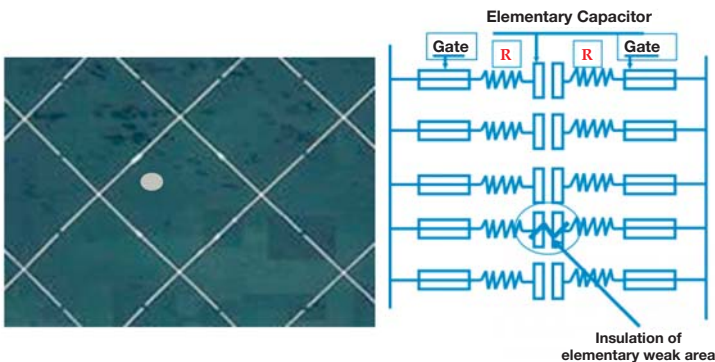
## FEATURES AND BENEFITS

For medium power (dry) technology, controlled self-healing is achieved by utilizing a segmented metallization pattern where the film surface is divided into several million elementary capacitor elements individually protected by "fuse gates". These ensure failsafe operation over design lifetime of the capacitor.

High Power (oil filled) technology uses high purity vegetable oil to enable controlled self-healing for rated voltages up to 100kV.

- Dry, oil impregnated technologies and without free oil
- Total safety, reliability and soft end of lifetime
- No derating over operating temperature range: -40°C up to +105°C ( see individual data sheets)
- High peak current and high energy options
- Polypropylene and polyester dielectric designs available
- RoHS Compliant available for most medium power products

## EQUIVALENT CIRCUIT



## CERTIFICATES




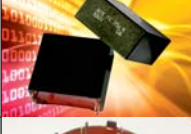

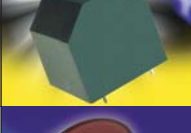








# MEDIUM & HIGH POWER CAPACITORS FOR POWER ELECTRONICS

## Product Selection Guide

### MEDIUM POWER

#### DC FILTERING





Series	Fig.	Technical Data	Features	Applications
<b>FM</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 250V <sub>DC</sub> – 2000V <sub>DC</sub> <b>Capacitance Range:</b> 0.01μF – 0.47μF <b>Ripple Current:</b> 1.0A <sub>rms</sub> – 8.7A <sub>rms</sub>	The FM products offer high reliability current stress with self-healing properties. The FM series are ideal for high frequency and high pulse-rise-time circuits. The FM products can be operated up to 105°C.	<ul style="list-style-type: none"> <li>High Voltage Power Supplies</li> <li>Snubber</li> <li>Electronic Lighting Ballasts</li> </ul>
<b>FFB</b> (RoHS compliant)		<b>Case size:</b> 1 – 6 <b>Rated DC Voltage:</b> 75V <sub>DC</sub> – 1100V <sub>DC</sub> <b>Capacitance Range:</b> 6.2μF to 110μF <b>Ripple Current:</b> 2.4A <sub>rms</sub> – 10A <sub>rms</sub> <b>Lead Style:</b> 2 or 4 Leaded or custom	The FFB capacitor is designed for DC filtering low reactive power. The FFB has been designed for printed circuit board mounting. The product is an alternative to electrolytic technology.	<ul style="list-style-type: none"> <li>Switch Mode Power Supplies (SMPS)</li> <li>PhotoVoltaic Inverters</li> </ul>
<b>FB</b> (RoHS compliant)		<b>Case size:</b> A – P <b>Rated DC Voltage:</b> 450V <sub>DC</sub> – 1200V <sub>DC</sub> <b>Capacitance Range:</b> 0.68μF – 75μF <b>Ripple Current:</b> 2.2A <sub>rms</sub> – 18 A <sub>rms</sub>	The FB has been designed primarily for high and medium power DC filtering applications. The FB series has been designed for printed circuit board mounting.	<ul style="list-style-type: none"> <li>Switch Mode Power Supplies (SMPS)</li> <li>PhotoVoltaic Inverters</li> </ul>
<b>FE</b> (RoHS compliant)		<b>Case size:</b> G – P <b>Rated DC Voltage:</b> 550V <sub>DC</sub> – 1200V <sub>DC</sub> <b>Capacitance Range:</b> 3.3μF – 100μF <b>Ripple Current:</b> 7.3A <sub>rms</sub> – 19.0A <sub>rms</sub>	These capacitors have been designed principally for high and medium power DC filtering applications. The FE has been designed for printed circuit board mounting. The FE series uses a non-impregnated metallized polypropylene dielectric.	<ul style="list-style-type: none"> <li>Switch Mode Power Supplies (SMPS)</li> <li>PhotoVoltaic Inverters</li> </ul>
<b>FRC</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 400V <sub>DC</sub> – 1500V <sub>DC</sub> <b>Capacitance Range:</b> 4.7μF – 35μF <b>Ripple Current:</b> 13A <sub>rms</sub> – 22A <sub>rms</sub>	The FRC series contains high capacity DC-Link Capacitors with wound metallized Polypropylene film, cylindrical plastic casing sealed with thermosetting resin. The dielectric strength in operating conditions can be up to 105°C	<ul style="list-style-type: none"> <li>DC filter circuits</li> <li>Solar Inverter</li> <li>Industrial Inverter</li> </ul>
<b>FFV3</b> (RoHS compliant)		<b>Dielectric:</b> Polyester or Polypropylene <b>Rated DC Voltage:</b> 75V <sub>DC</sub> – 400V <sub>DC</sub> <b>Capacitance Range:</b> 30μF – 160μF <b>Ripple Current:</b> 13A <sub>rms</sub> – 33A <sub>rms</sub>	The FFV3 capacitors are designed for DC filtering, low reactive power. The FFV has been designed for printed circuit board mounting. The series uses a non-impregnated metallized polypropylene or polyester dielectric, with the controlled self-healing.	<ul style="list-style-type: none"> <li>Switch Mode Power Supplies (SMPS)</li> <li>PhotoVoltaic Inverters</li> </ul>
<b>FFG Design</b> (FFH – RoHS compliant)		<b>Rated DC Voltage:</b> 600V <sub>DC</sub> – 1900V <sub>DC</sub> <b>Capacitance Range:</b> 5μF – 160μF <b>Ripple Current:</b> 19A <sub>rms</sub> – 76A <sub>rms</sub>	AVX FFG series capacitors exhibit high surge voltage and RMS current along with lower ESR. The polypropylene dielectric features a controlled self-healing process. DC-Link capacitors are used to couple different electrical grids to one DC voltage level.	<ul style="list-style-type: none"> <li>DC Protection</li> <li>Switchgear Products</li> <li>Sub Station Applications</li> </ul>
<b>FFVE/FFVI</b> (FFWE/FFWI – RoHS compliant)		<b>Dielectric:</b> Polyester or Polypropylene <b>Rated DC Voltage:</b> 300V <sub>DC</sub> – 1900V <sub>DC</sub> <b>Capacitance Range:</b> 12μF – 400μF <b>Ripple Current:</b> 49A <sub>rms</sub> – 100A <sub>rms</sub>	The FFV capacitor is specifically designed for DC filtering, low reactive power, DC-Link capacitors are used to couple different electrical grids to one DC voltage level.	<ul style="list-style-type: none"> <li>Hybrid Electric Vehicle (HEV)</li> <li>Power Inverters</li> <li>Solar Inverters</li> <li>Wind Power Generation</li> <li>Motor Drives</li> </ul>
<b>FFVS</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 600V <sub>DC</sub> – 1900V <sub>DC</sub> <b>Capacitance Range:</b> 22μF – 200μF <b>Ripple Current:</b> 57A <sub>rms</sub> – 87A <sub>rms</sub>	FFVS series is a specific range of DC filtering capacitors designed for use in high frequency, high ripple applications beyond the limits of standard FFVE or FFVI. Due to the internal design, stray inductance is extremely low, between 8 and 13nH.	<ul style="list-style-type: none"> <li>Induction Heating</li> <li>Resonant DC Supply for Scanner</li> <li>X-ray Machines</li> </ul>
<b>FFLI</b> (RoHS compliant)		<b>Dielectric:</b> Polypropylene <b>Rated DC Voltage:</b> 800V <sub>DC</sub> – 3000V <sub>DC</sub> <b>Capacitance Range:</b> 58μF – 3000μF <b>Ripple Current:</b> 35A <sub>rms</sub> – 110A <sub>rms</sub>	The FFLI series is specifically designed for DC filtering applications such as DC link or resonant filters. The FFLI has a dry self-healing metallized polypropylene	<ul style="list-style-type: none"> <li>Wind Power Applications</li> <li>Solar Power Applications</li> <li>Power Inverters</li> <li>UPS</li> </ul>
<b>FFLC</b>		<b>Rated DC Voltage:</b> 800V <sub>DC</sub> – 1350V <sub>DC</sub> <b>Capacitance Range:</b> 1750μF – 25500μF <b>Ripple Current:</b> 400A <sub>rms</sub>	The FFLC series is specifically designed for DC filtering applications such as DC link or resonant filters. Standard designs proposed for the FFLC cover a wide range of voltage and capacitance values which can be customized to meet specific requirements.	<ul style="list-style-type: none"> <li>Railroad Vehicles</li> <li>Industrial Applications</li> <li>Motor Drives</li> </ul>
<b>Custom Design</b> FHC		<b>Rated DC Voltage:</b> 3000V <sub>DC</sub> – 1400V <sub>DC</sub> <b>Capacitance Range:</b> 1.5μF – 1500μF <b>Ripple Current:</b> Custom A <sub>rms</sub>	Custom parts are medium power film capacitors for DC filtering, high rms current and high temperature automotive applications up to 105°C.	<ul style="list-style-type: none"> <li>Custom applications for DC filtering</li> </ul>

# MEDIUM & HIGH POWER CAPACITORS FOR POWER ELECTRONICS







## Product Selection Guide

### AC FILTERING




Series	Fig.	Technical Data	Features	Applications
<b>FV X2</b> (RoHS compliant)		<b>Rated AC Voltage:</b> 305V <sub>rms</sub> <b>Capacitance Range:</b> 0.1μF – 10μF <b>Ripple Current:</b> 1.0A <sub>rms</sub> – 22.0A <sub>rms</sub>	The FV series is an AC power film capacitor containing non-inductively wound with metallized polypropylene film as dielectric and electrode. The FV series is UL94 class v0 thermoplastic case, with an epoxy seal.	<ul style="list-style-type: none"> <li>• Across the Line Capacitors</li> <li>• EMI Filters</li> <li>• Spark-Killer Circuits</li> </ul>
<b>FLC</b> (RoHS compliant)		<b>Case size:</b> A – O <b>Rated AC Voltage:</b> 250V <sub>rms</sub> – 350V <sub>rms</sub> <b>Capacitance Range:</b> 1.0μF – 50μF <b>Ripple Current:</b> 4.0A <sub>rms</sub> – 21A <sub>rms</sub>	The FLC capacitors have been designed for printed circuit mounting for AC filtering. The FLC series has a non-impregnated metallized polypropylene dielectric specially designed to handle operating conditions up to 85°C	<ul style="list-style-type: none"> <li>• AC Filtering for Power Converters</li> <li>• UPS Systems</li> <li>• Solar Inverters</li> <li>• Motor Drives</li> </ul>
<b>FLA Single Phase</b> (RoHS compliant)		<b>Rated AC Voltage:</b> 250V <sub>rms</sub> – 690V <sub>rms</sub> <b>Capacitance Range:</b> 10μF – 600μF <b>Ripple Current:</b> 6.5A <sub>rms</sub> – 50A <sub>rms</sub>	The FLA has been designed with overpressure disconnected device for AC filtering. The FLA has a very high dielectric strength allowing operating temperatures up to 85°C. FLA series are suitable for output single phase AC filtering for power converters.	<ul style="list-style-type: none"> <li>• Overpressure disconnected</li> <li>• PFC &amp; AC Filtering application</li> <li>• UPS systems</li> <li>• Solar Inverters</li> <li>• Motor Drives</li> </ul>
<b>FLB Three Phase</b> (RoHS compliant)		<b>Rated AC Voltage:</b> 230V <sub>rms</sub> – 690V <sub>rms</sub> <b>Capacitance Range:</b> 3*20.3μF – 3*335μF <b>Ripple Current:</b> 7.3A <sub>rms</sub> – 43.3A <sub>rms</sub>	The FLB has been designed with overpressure disconnected device for AC filtering. The FLB has a very high dielectric strength allowing operating temperatures up to 85°C. FLB series are suitable for output 3 phase AC filtering for power converters.	<ul style="list-style-type: none"> <li>• Overpressure disconnected</li> <li>• PFC &amp; AC Filtering application</li> <li>• UPS systems</li> <li>• Solar Inverters</li> <li>• Motor Drives</li> </ul>

### PROTECTION




Series	Fig.	Technical Data	Features	Applications
<b>FSV</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 300V <sub>DC</sub> – 650V <sub>DC</sub> <b>Capacitance Range:</b> 0.010μF – 0.15μF <b>Ripple Current:</b> 5.0A <sub>rms</sub> – 23A <sub>rms</sub>	The FSV series is used for protection for applications with low serial inductance and high RMS current. The FSV has a polypropylene dielectric and a metal foil casing.	<ul style="list-style-type: none"> <li>• Protection of semi-conductors</li> <li>• High frequency decoupling</li> <li>• Tuning</li> </ul>
<b>FM</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 250V <sub>DC</sub> – 2000V <sub>DC</sub> <b>Capacitance Range:</b> 0.01μF – 0.47μF <b>Peak Current:</b> up to 300A <sub>rms</sub>	The FM series features a leaded, non-inductively wound polypropylene dielectric design. The product can be operated up to 105°C with self-healing properties.	<ul style="list-style-type: none"> <li>• High Voltage Power Supplies</li> <li>• Snubber</li> <li>• Electronic Lighting Ballasts</li> </ul>
<b>FSB</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 850V <sub>DC</sub> – 2000V <sub>DC</sub> <b>Capacitance Range:</b> 0.10μF – 3μF <b>Ripple Current:</b> 3A <sub>rms</sub> – 28 A <sub>rms</sub>	The FSB series features polypropylene dielectric capable of operation up to 85°C and is ideal for snubbing applications. The series has through-hole leads for pcb assembly, with an option of bolt-in terminals for the largest case size.	<ul style="list-style-type: none"> <li>• IGBT protection</li> <li>• IGBT clamping</li> <li>• Industrial Motor Protection</li> <li>• Control Circuits</li> </ul>
<b>FPX/FPY</b> (RoHS compliant)		<b>Rated DC Voltage:</b> 1000V <sub>DC</sub> – 3000V <sub>DC</sub> <b>Capacitance Range:</b> 0.5μF – 6.0μF <b>Ripple Current:</b> 15A <sub>rms</sub> – 160A <sub>rms</sub>	The FPX/FPY product is a metallized polypropylene dielectric capacitor with controlled self-healing. The reinforced metallization allows for high impulse currents. Axial connections reduce the series inductance for rigid mechanical mounting.	<ul style="list-style-type: none"> <li>• Protection of thyristors</li> <li>• Protection of gate turn-off thyristor (G.T.O.)</li> <li>• Clamping(Secondary snubber)</li> <li>• IGBT decoupling</li> <li>• EMI filtering</li> </ul>

# MEDIUM & HIGH POWER CAPACITORS FOR POWER ELECTRONICS


## Product Selection Guide

TUNING				
Series	Fig.	Technical Data	Features	Applications
FAV (RoHS compliant)		<b>Rated DC Voltage:</b> 300V <sub>DC</sub> – 2000V <sub>DC</sub> <b>Capacitance Range:</b> 80μF – 1200μF <b>Ripple Current:</b> 10A <sub>rms</sub> – 40A <sub>rms</sub>	The FAV series is a metallized polypropylene foil / film dry capacitor. The FAV applied to low frequency applications	<ul style="list-style-type: none"> <li>• High Reactive energy tuning for convertors</li> <li>• Protection of semi-conductors</li> <li>• Auto battery charger</li> </ul>
FAI 1/2/3/4 (RoHS compliant)		<b>Rated AC Voltage:</b> 300V <sub>rms</sub> – 600V <sub>rms</sub> <b>Capacitance Range:</b> 110nF – 4μF <b>Peak Current:</b> 180A <sub>rms</sub> – 600A <sub>rms</sub>	The FAI 1/2/3/4 uses metallized polypropylene dielectric specifically designed for very high reactive power. The FAI's special design gives the series a very low level of stray inductance.	<ul style="list-style-type: none"> <li>• Low &amp; High frequency applications</li> <li>• Induction heating</li> </ul>
FAI 6 (RoHS compliant)		<b>Rated AC Voltage:</b> 200V <sub>rms</sub> – 650V <sub>rms</sub> <b>Capacitance Range:</b> 1.5μF – 60μF <b>Ripple Current:</b> 490A <sub>rms</sub> – 2000A <sub>rms</sub>	The FAI 6 uses metallized polypropylene dielectric specifically designed for very high reactive power. The FAI's special design gives the series a very low level of stray inductance.	<ul style="list-style-type: none"> <li>• Medium frequency applications</li> <li>• Induction Heating</li> </ul>

## HIGH POWER

DC FILTERING				
Series	Fig.	Technical Data	Features	Applications
FFHV/FTHV		<b>Rated DC Voltage:</b> 1200V <sub>DC</sub> – 3kV <sub>DC</sub> <b>Capacitance Range:</b> 800μF – 15μF <b>Ripple Current:</b> up to 255A <sub>rms</sub>	The FFHV/FTHV series are an extension of the medium power FFLC family for high voltage DC filtering applications up to 3kV <sub>DC</sub> . This technology enables the product to be used for applications where oil free technology is preferred.	<ul style="list-style-type: none"> <li>• DC filtering of HVDC applications</li> <li>• Wind Turbines</li> <li>• DC link for Statcom</li> <li>• Motor Drives</li> </ul>
TRAFIM		<b>Rated DC Voltage:</b> 1200V <sub>DC</sub> – 6000V <sub>DC</sub> <b>Capacitance Range:</b> 130μF – 15500μF <b>Ripple Current:</b> 255A <sub>rms</sub>	The TRAFIM series is used for High Power applications. TRAFIM capacitors are impregnated with environmental friendly vegetable oil. TRAFIM includes low inductance designs and several mounting options	<ul style="list-style-type: none"> <li>• DC Link</li> <li>• Speed converter (Drives and traction)</li> <li>• Resonant filtering</li> <li>• Active correction (FACTS)</li> <li>• Windmills</li> <li>• Substation</li> </ul>
FILFIM		<b>Rated DC Voltage:</b> 56kV <sub>DC</sub> – 100kV <sub>DC</sub> <b>Capacitance Range:</b> 2.6μF – 612μF <b>Ripple Current:</b> 255A <sub>rms</sub>	The FILFIM series is used for DC filtering of high voltage applications. FILFIM Capacitors can be customized to meet applications needs.	<ul style="list-style-type: none"> <li>• DC Link</li> <li>• Active correction (FACTS)</li> <li>• HVDC</li> <li>• High Power DC Supply</li> </ul>

## ENERGY STORAGE AND DISCHARGE CAPACITORS

Series	Fig.	Technical Data	Features	Applications
DISFIM		<b>Terminals:</b> Epoxide or Ceramic <b>Energy Density:</b> 2200 J/L <b>Rated DC Voltage:</b> 2kV <sub>DC</sub> – 75kV <sub>DC</sub> <b>Maximum Energy per can:</b> 150kJ <b>Range:</b> Custom to the application <b>Capacitance:</b> Up to 40mF	DISFIM product is an impregnated capacitor ideal for pulse discharge applications. The DISFIM incorporates self-healing technology that prevents the risk of short-circuit.	<ul style="list-style-type: none"> <li>• Research Applications</li> <li>• Power Lasers</li> <li>• High Voltage Supplies</li> <li>• Welding Machines</li> <li>• Electromagnetic and ETC Gun</li> </ul>

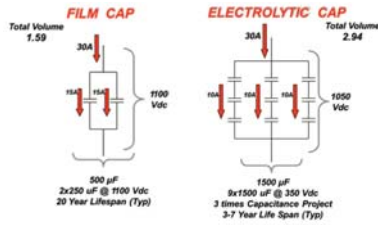
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# MEDIUM & HIGH POWER CAPACITORS FOR POWER ELECTRONICS

## ELECTROLYTIC ALTERNATIVE

	Film	Electrolytic
Surge Voltage	Up to 2 times Undc	1.2 Undc max.
Reversal Voltage	Yes	No
Rms. Current	Up to 1Arms per $\mu\text{F}$	0.025Arms per $\mu\text{F}$
MTBF	10M hours	1M hours
Life Time	>100,000 hours	1000 hours
Storage	>10 years	1 year max.
End of Life	Soft	Explosion
Environment	Friendly	Non-Friendly



### FILM VS ALUMINIUM

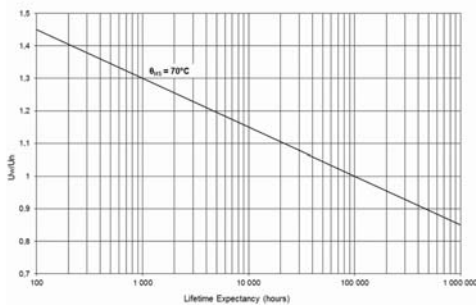
#### FILM

- Voltage capability requires no cascading
- Self-healing optimized with necked-down electrode patterns
- Self-healing maximized with polypropylene (PP)
- Generates less heat
- Smaller Footprint

#### ALUMINIUM ELECTROLYTIC

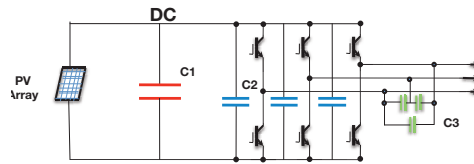
- Requires cascading for high voltage
- Low temperature greatly reduces cap
- Dry-out over time results in lower cap, Higher ESR
- Greater heat
- Larger Footprint

### LIFETIME EXPECTANCY FOR A TYPICAL POWER FILM CAP



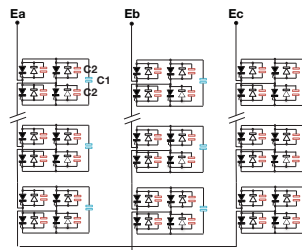
## AVX POWER FLIM – APPLICATIONS EXAMPLES

### Solar PV



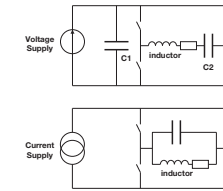
Component	AVX Series
C1	FFB/FE/FB, FFLI, FFLC
C2	FM, FSB
C3	FLA, FLB

### Static Synchronous Compensator (Statcom)



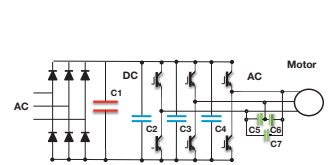
Component	AVX Series
C1	TFM, FFLC, FFHV, FTHV, IFM
C2	FPX/FPY

### Inductive Heating



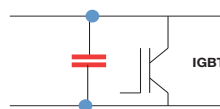
Component	AVX Series
C1	FFLC, FFLI, FFVE/FFV/FFVS
C2	FAI1/2/3/4, FAI6
C3	FAI1/2/3/4, FAI6

### Motor Drives (Traction EV, HEV, Power)



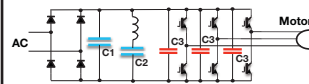
Component	AVX Series
C1	TFM/THV, FFLC/FFHV, FFLI
C2, C3, C4	FPX/FPG, FSB
C5, C6, C7	FLB, FLA

### IGBT Protection



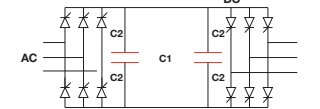
Component	AVX Series
C1	FSB, FFVE/IS, FFG, FM

### Traction



Component	AVX Series
C1	TFM, FFLC, FFHV, FTHV (DC FILTERING)
C2	TFM, FFLC, FFHV, FTHV
C3 & C4	FFVE/IS, FPG/X

### High Voltage Direct Current (HVDC)



Component	AVX Series
C1	FFLC/FFHV, FILFM, TRAFIM/FFHV
C2	FPX

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