



Medium Voltage Metal-Enclosed Thyristor-Switched Harmonic Filter Banks



General

NEPSI's **actiVAR**[®], Medium Voltage Metal-Enclosed Thyristor-Switched Harmonic Filter Banks are custom designed for power systems requiring instantaneous var support to mitigate voltage sags, voltage flicker, and high inrush currents associated with large dynamic loads and motor starting.

The **actiVAR**[®] samples your phase voltage, load, and line currents at rates exceeding 7,000 times a second, analyzes them in real-time, and instantly changes state to match your load requirements. Adjusting 60 times a second on each phase, the **actiVAR**[®] effectively stiffens your supply voltage.

Industries with large dynamic loads like pump stations, welders, shredders, rolling mills, and arc furnaces benefit from this product and have seen paybacks in less than 1 year with improved voltage stability, plant productivity, and power factor improvement.

Product Scope

- Operating Voltage: 2.4kV through 24.9kV
- Impulse Withstand Voltage: 60kV BIL - 125kV BIL
- Reactive power rating: 0.5 MVAR to 100 MVAR (binary step design, 1 to 15 steps)
- Filter Type(s): Notch (Band Pass), High-Pass, Multi-tuned
- Metal-Enclosed: NEMA 1, 3R, 4X, 12 | IEC IP10, IP14, IP56, IP52
- Comes fully assembled, tested, and ready for interconnection
- Integral air-disconnect /ground switch, fixed or draw-out circuit breaker
- Integral protection and control system



Ratings

The **actiVAR[®]** is rated and configured to meet customer requirements for voltage, basic insulation level (BIL), available short circuit current, reactive power rating, and frequency. Internal components such as disconnect and grounding switches, circuit breakers, capacitors, capacitor switches, thyristor valves, and capacitor fuses are chosen based on their ratings, costs, availability, and NEPSI's experience with the supplier's quality, service, and reliability.

Rating	Range of Available Ratings
Bank Configuration:	Thyristor Switched: Single Step/Multiple Step Hybrid Design: Thyristor & static switched filter banks
Filter Types:	Notch (Band-Pass), High-Pass, C-High-Pass, Multi-Tuned
Operating Voltage (line-to-line):	2.4kV – 24.9kV
Operating Frequency:	50 Hertz 60 Hertz
Reactive power output:	0.5MVAR – 100 MVAR (500kvar – 100,000 kvar)
Tune frequency (Hz)	85 Hz 2100 Hz (1.4th Harmonic – 35th harmonic)
High-Pass (damping) resistor rating:	1 ohm to 1000 ohms 10kW/Phase - 200kW/Phase
Short circuit (asymmetrical momentary):	16kA - 61kA
Impulse withstand voltage (Basic Insulation Level):	60kV – 125 KV
Short-time withstand voltage (1 minute 50/60 Hertz):	19kV – 60kV
Control voltages:	AC Volts: 110, 115, 120, 220, 50/60hz DC Volts: 24, 48, 110, 125, 220
Operating temperature range:	-50°C to +55°C -58°F to 131°F
Maximum altitude without de-rating:	1,000 Meters 3,300 Feet
Enclosure:	(NEMA): 1, 3R, 4X, 12 (IEC): IP10, IP14, IP56, IP52
Seismic:	As specified - Zone 4
Capacitor fusing:	Internally fused Externally fused
Performance Standards:	CBEMA (<i>Computer and Business Electronic Manufacturers Association</i>), curve referenced in ANSI/IEEE Std. 446-1987 SEMI (<i>Semiconductor Equipment and Materials International</i>), F47-0706, F49-0200, and F50-0200s IEEE 519, <i>Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems</i> ITIC (<i>Information Technology Industries Council</i>) tolerance curve IEEE 1453, Recommended Practice for measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems



Equipment Configuration

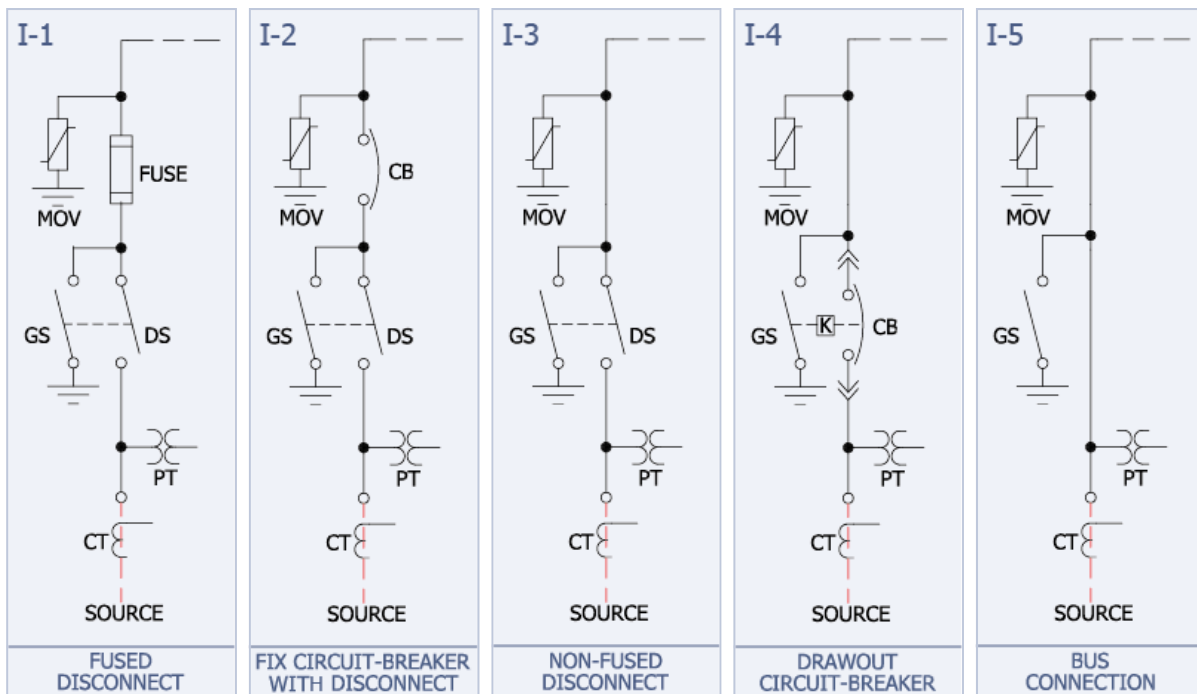
NEPSI's actiVARs® are custom designed, configured, and rated to mitigate site-specific voltage sags, flicker, harmonic distortion and system power factor. Depending upon the performance objectives, the actiVAR® may also include conventionally switched filter stages. These less costly stages use standard capacitor switches to provide "slow VARs" for power factor correction and harmonic attenuation, reserving the Thyristor-switched stages to provide "fast VARs" for mitigating voltage sags and voltage flicker.

Sections 1, 2, and 3 that follow provide details on some of the available options.

1 Incoming Compartment Configuration Options

The incoming compartment of the actiVAR is available with a range of options based on system ratings and customer preference.

Typical configurations include some of the following:



Accessories For Incoming Compartment

The following items are available for placement in the incoming compartment

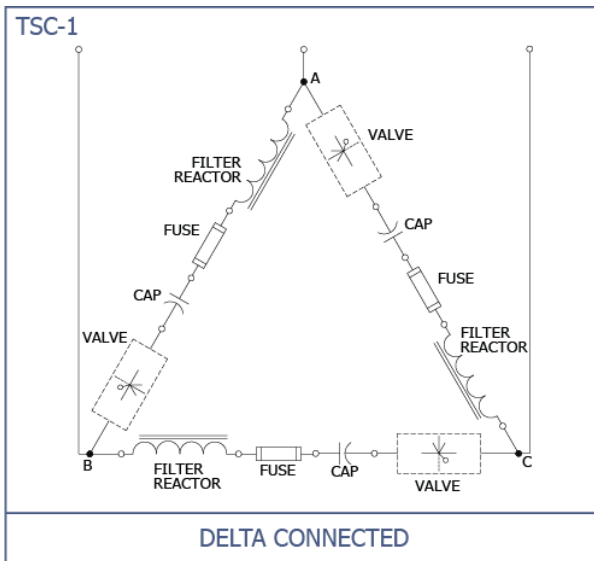
PT	POTENTIAL TRANSFORMER	MOV	SURGE ARRESTER		ROOF BUSHING OVERHEAD BUS
CT	CURRENT TRANSFORMER	CT	CURRENT TRANSFORMER		KEY INTERLOCK



2 Thyristor-Switched Stage Configuration Options "Fast VARs"

Thyristor-switched harmonic filter stages utilize thyristor valves to provide "fast VARs" for the mitigation of rapid voltage sags and flicker. If additional VARs are needed for power factor correction and harmonic filtering, use of less-expensive conventionally-switched filter stages, as explained under heading three on the following page, is highly recommended.

Delta Valve Configuration



The Delta Valve configuration utilizes thyristor valves connected in a Delta configuration. Voltage ratings of the valves, reactors, and capacitors are rated based on the system line-to-line voltage rating. Current within the Delta valve is 57% of the current outside the Delta. Details of this valve configuration are as follows:

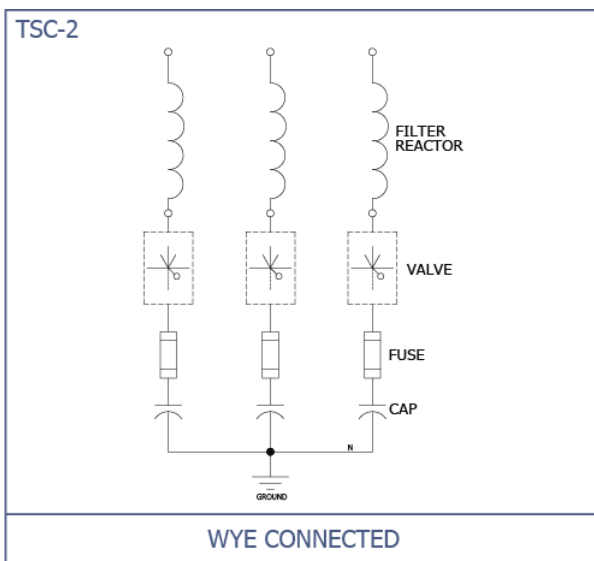
System Application Voltage: 2.4kV – 13.8kV

Valve Ratings:

Transient Current Limit: 500 amps
(with or without fins)

Continuous Current Rating: 180 amps
(with fins)

Wye-Grounded Valve Configuration



The Wye-Grounded valve configuration utilizes thyristor valves connected in grounded-wye configuration. Voltage ratings of the valves, reactors, and capacitors are rated based on the system's line-to-neutral voltage rating. Higher system application voltage ratings are possible with this configuration. Details of this valve configuration are as follows:

System Application Voltage: 2.4kV – 24.9kV

Valve Ratings:

Transient Current Limit: 500 amps
(with or without fins)

Continuous Current Rating: 180 amps
(with fins)

Restriction: Valve configuration for grounded-wye system only. Resistance-grounded, high-impedance grounded, or Delta systems must use the delta connected valve configuration.

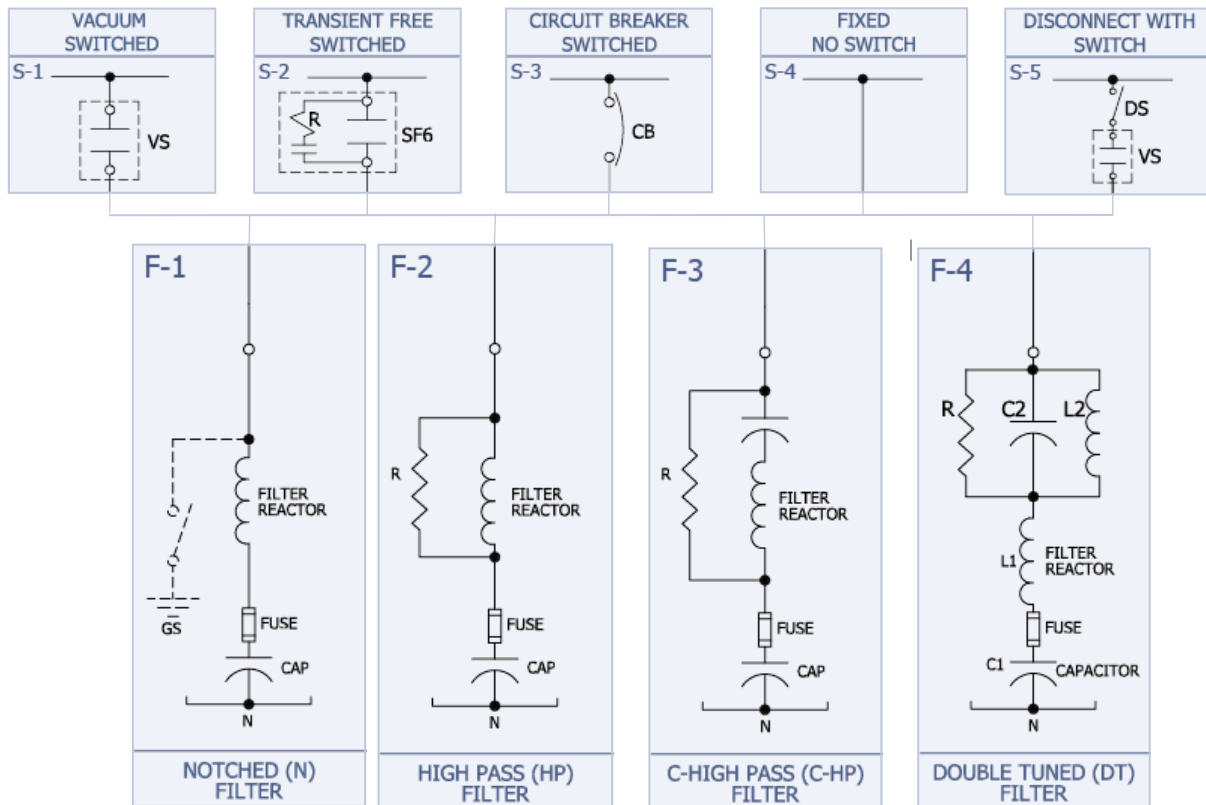


3 Conventionally Switched Stage Configuration Options “Slow VARs”

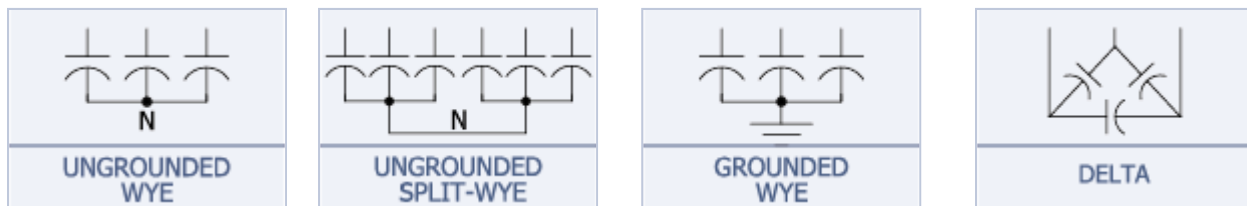
Conventionally-switched harmonic filter stages do not respond fast enough to mitigate voltage flicker and voltage sags, but are economical and effective for power factor correction and harmonic filtering.

The conventionally-switched stages consist of capacitors, capacitor fuses, capacitor switching devices, and harmonic filter reactors. Ungrounded wye, grounded wye or delta configurations can be used alongside the thyristor-switched stages.

Typical filter bank stage configuration options include some of the following:



The harmonic filter can be connected in a number of different ways depending upon bank rating and protection requirements. Typically, harmonic filters are provided with an ungrounded wye or ungrounded split-wye connection, but a grounded wye and Delta connection are also available.





Control Options

NEPSI's **actiVAR[®]** is furnished with a fully integrated control and protection system that dynamically controls system voltage by gating the **actiVAR's[®]** thyristor valves in response to measured power system parameters at a rate of 3 times per cycle.

Additionally the **actiVAR's[®]** controls conventionally switched harmonic filter stages with response times of 30 seconds to a minute to maintain average power factor and to mitigate harmonic distortion.

Standard Features	Conventionally-Switched Stage Control Options
Thyristor switched stage control for dynamic voltage control	Power Factor Control
Conventionally switched stage control for power factor control and harmonic mitigation	Var Control
Fully integrated HMI display	Voltage Control
Integrally mounted or remotely located control panel	Harmonic Voltage / Current Distortion Control
Remote access to all controller functions	Remote SCADA Control DCS Control

Protection Options

The **actiVAR[®]** is furnished with host of protection options to keep your system up and running with minimum downtime.

All stages, whether conventionally or thyristor switched, are protected against short circuit, overload, over-voltage, harmonic over-current, harmonic over-voltage, over-temperature, and unbalance operation from blown capacitor fuses. Protective relays and ancillary protective devices are chosen based on function, cost, reliability, and customer preference.

The Table on the following page summarizes the protection device numbers that are typically provided with NEPSI's **actiVAR**.

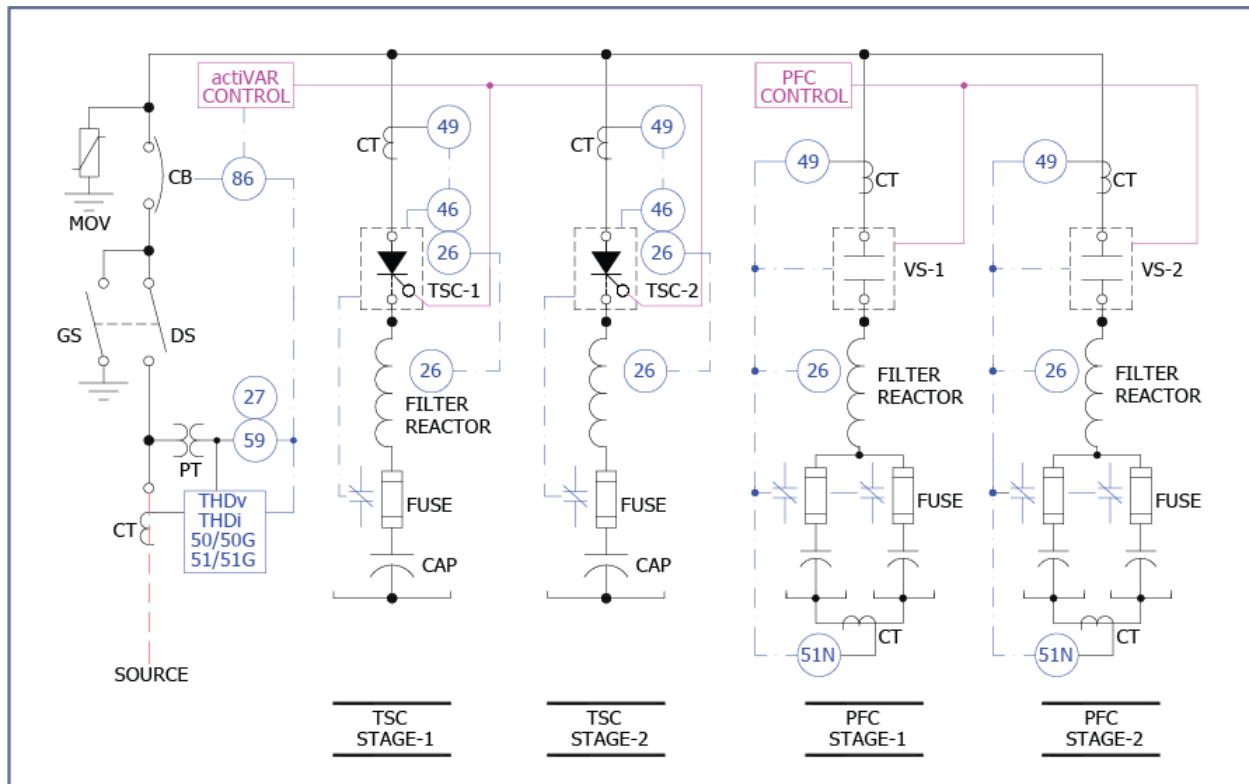




Protection Type	Designation	Description
Short Circuit and Overcurrent Protection	50/51 50/51G	Provided by upstream feeder breaker, main incoming breaker (if provided), or main incoming current limiting fuses (if provided).
Over-Voltage	59	Protect harmonic filters and power system from over-voltage. Backup to the SVC and PFC control which use voltage as a primary or secondary control input.
Under-Voltage	27	Under voltage protection system is provided to disconnect the "fast VARs" in the event of a power interruption or a "fast VARs" control malfunction.
Neutral Unbalance (Blown Fuse Detection)	59N Or 51N or 51G or Direct	Relay or direct fuse sensing to detect a capacitor fuse operation. This is critical since a blown fuse condition will change filter de-tuning, lower var output, lower performance, and possibly create system resonance.
Harmonic Voltage & Current Distortion	I_{THD} , V_{THD}	Protection against harmonic resonance, high voltage & current distortion, and harmonic overload
Over-Temperature	26	Protection for the thyristor valves, capacitors, and iron-core reactors. Also protects against fan failure.
Over-Load	49	Over-load protection of the high-pass resistors (if provided), iron-core reactors, and thyristor valves. Relay is sensitive to RMS current associated with the filter's fundamental current and harmonic current.

Typical Protection System

Typical relay protection diagram for the **actiVAR**[™]. The "actiVAR" control and "TSC" stages provide "fast" VARs. The "PFC" control and "PFC" stages provide "slow" VARs for power factor correction and harmonic mitigation.





actiVAR[®] Bank Ordering Guide

The **actiVAR**[®] is custom built to meet your requirements. Feel free to contact NEPSI for a quote or to discuss your specific application.

Additionally, visit our webpage at www.nepsi.com and follow the product page link to Thyristor-Switched Harmonic Filter Banks. There you will find additional information, including:

- Guide form specifications
- Component Cut Sheets and Instruction Manuals
- Pictures of Equipment and Components
- Technical Resources

Power System Studies

NEPSI performs power system studies to evaluate the expected performance of our **actiVARs**[®]. Required studies may include some or all of the following:

- Stability
- Motor Starting
- Load flow
- Reactive Power / Var Flow Studies
- Coordination
- Voltage Drop | Voltage Rise Analysis
- Harmonic Analysis
- Short Circuit
- Protective Coordination

Our Power System Studies are tailored to your needs and project requirements.