



## Fast, Transient Free Capacitor Banks For Starting Large Motors



### General

NEPSI's **actiVAR™** is a cost effective and simple-to-maintain solution for starting large medium-voltage motors. It replaces complex and costly VFD drive starters and reduced-voltage-soft-starters, and their ancillary equipment requirements including E-Houses, bypass switchgear, and complex sync bypass control systems.

The actiVAR revives the age-old solution of using capacitor banks for starting large motors by leveraging ABB's DS1-M transient free switching technology, advanced digital relaying, and high-speed communication. Supplying some or all of the reactive power required during motor starting, the actiVAR® eliminates voltage sags and inrush currents associated with motor starting.

So when across-the-line motor starting is not possible, rather than turning to complex and costly solutions like VFD drives and reduce voltage soft starters, turn to NEPSI's actiVAR®. It is simple, cost effective, and easy to install and maintain.

### Product Scope

- Operating Voltage: 2.4kV through 13.8kV (50 Hz | 60 Hz)
- Impulse Withstand Voltage: 95kV BIL
- Reactive power rating: 0.5 MVAR to 100 MVAR (binary step design, 1 to 15 steps)
- Hybrid Designs that include the actiVAR and also power factor correction, motor starters, and harmonic filtering. A fully integrated solution.
- 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, and motor starters.
- Integral protection and control system



## Ratings

The **actiVAR<sup>®</sup>** 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, transient free switches, 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:	Transient Free Switch (TFS): Single Step/Multiple Step Hybrid Design: TFS & static switched capacitor banks & filter banks
Filter Types:	Notch (Band-Pass), High-Pass, C-High-Pass, Multi-Tuned
Operating Voltage (line-to-line):	2.4kV – 13.8kV
Operating Frequency:	50 Hertz   60 Hertz
Reactive power output:	0.5MVAR – 100 MVAR (500kvar – 100,000 kvar)
Tune frequency (Hz)	Untuned and Tuned between 85 Hz 2100 Hz (Untuned and Tuned between 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):	95 KV
Short-time withstand voltage (1 minute 50/60 Hertz):	36kV
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, <i>Recommended Practice for measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems</i>



## Equipment Configuration

NEPSI's actiVARs<sup>®</sup> are custom designed, configured, and rated to mitigate voltage sags related to large motor starting, harmonic distortion from plant non-linear load, and system-wide power factor for all inductive loads.

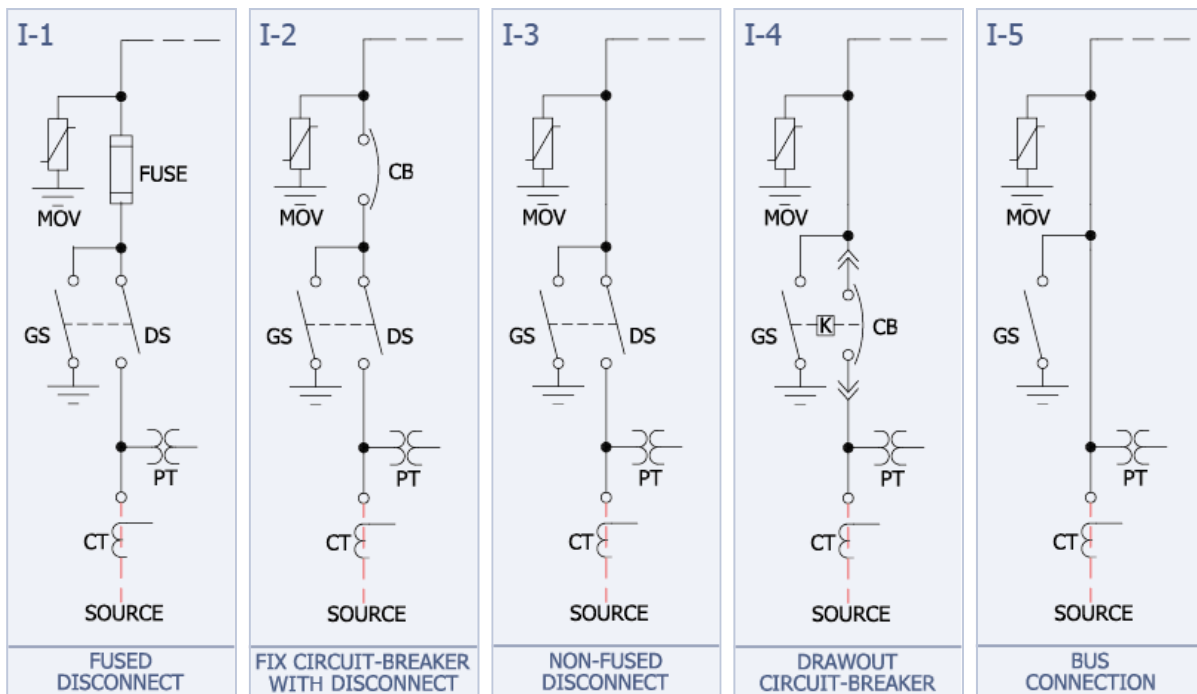
Depending upon the performance objectives, the actiVAR<sup>®</sup> may also include conventionally switched filter stages. These less costly stages use standard capacitor switches to provide "slow VARs" for power factor correction and harmonic attenuation, reserving the transient free switching stages to provide "fast VARs" for mitigating voltage sags associated with motor starting.

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	K	KEY INTERLOCK

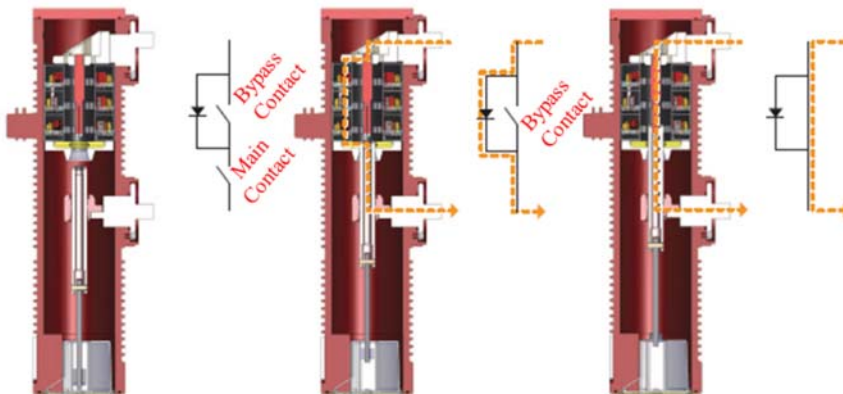


## 2 Transient Free Stage Configuration "Fast VARs"

The transient free motor start capacitor stages utilize communication, high-speed voltage sensing relays, a 3-second high-speed discharge circuit, and ABB's DS1-M transient free switching technology to provide "fast VARs" for the mitigation of voltage sags associated with large motor starting.

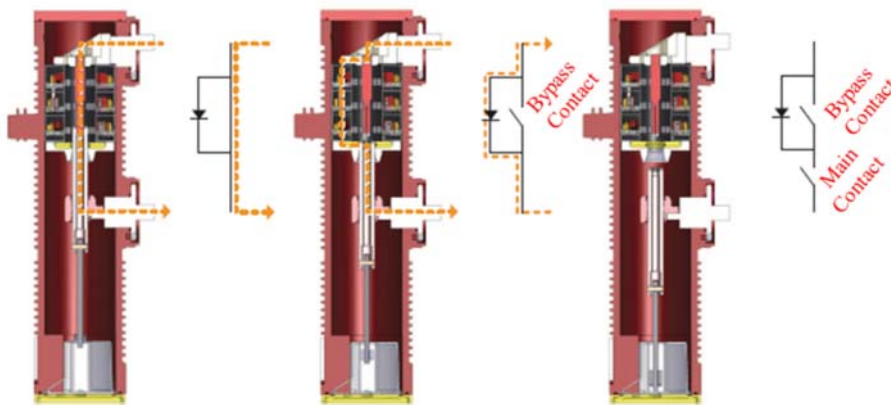
These stages tend to be large and therefore do not lend themselves to power factor correction. If additional VARs are needed for power factor correction and harmonic filtering, use of less-expensive conventionally-switched filter stages, as explained under heading three on the following page, is highly recommended.

### Transient Free Operation in Closing



ABB's DS1-M transient free capacitor Switch uses advanced diode switching technology to eliminate problems that once plagued motor start capacitor banks. By exploiting the natural commutation characteristic of a diode, it carries out closing operations without any transient current, voltage, frequency, or possibility of prestrike.

### Transient Free Operation in Opening



ABB's DS1-M transient free capacitor switch is able to carry out opening operations on capacitor banks without any overvoltage or possibility of restrike.

ABB's DS1-M transient free switch is rated 600 amps at 13.8kV and is capable of switching 10MVAR transient free. With the use of multi-stage banks, step voltages of less than 2% are typical on motor HP ratings to 10,000HP.

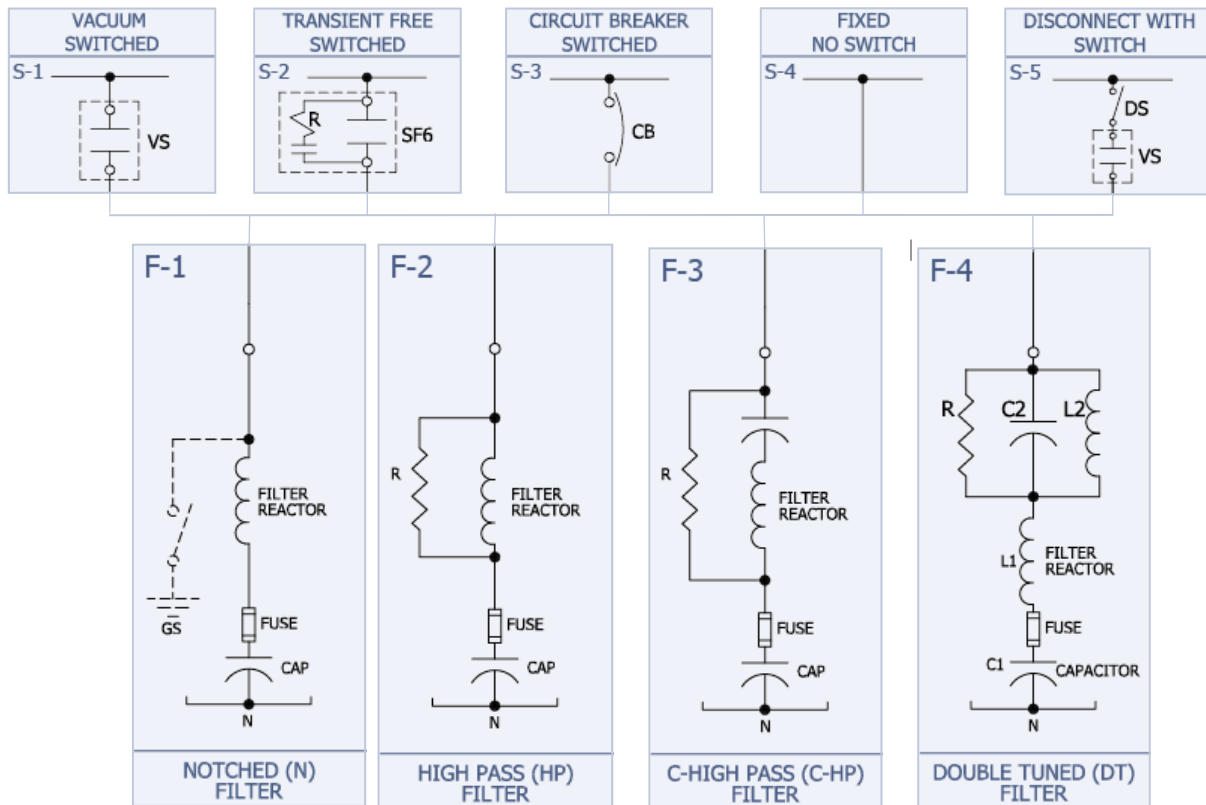




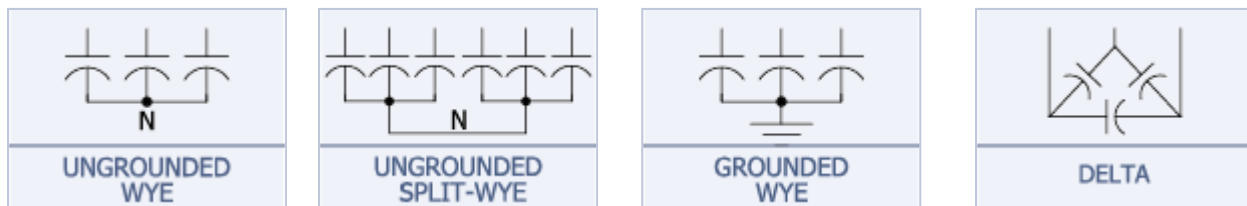
### 3 Conventionally Switched Stage Configuration Options “Slow VARs”

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

The conventionally-switched stages consist of capacitors, capacitor fuses, capacitor switching devices, harmonic filter reactors and transient inrush reactors. Transient inrush reactors replace the reactors in the diagrams below when filtering or harmonic mitigation is not required. Ungrounded wye, grounded wye, or delta configurations are available for these stages.



Harmonic filters and capacitors are 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**<sup>®</sup> is furnished with a fully integrated control and protection system that utilized well-known off-the-shelf advanced digital protection and control relays, IEC 61850 communication protocol, and fast voltage sensing to mitigate voltage sags from large motor starts.

Hybrid systems that include power factor correction utilize the plants DCS system, communication, or CT signals for automatic power factor control and regulation of plant power factor.

Typical Features	Conventionally-Switched Stage Control Options
"Fast Switching" technology for mitigation of voltage sags from motor starting.	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**<sup>®</sup> is furnished with host of protection options to keep your system up and running with minimum downtime.

All stages "fast" and "slow" vars stages 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**.

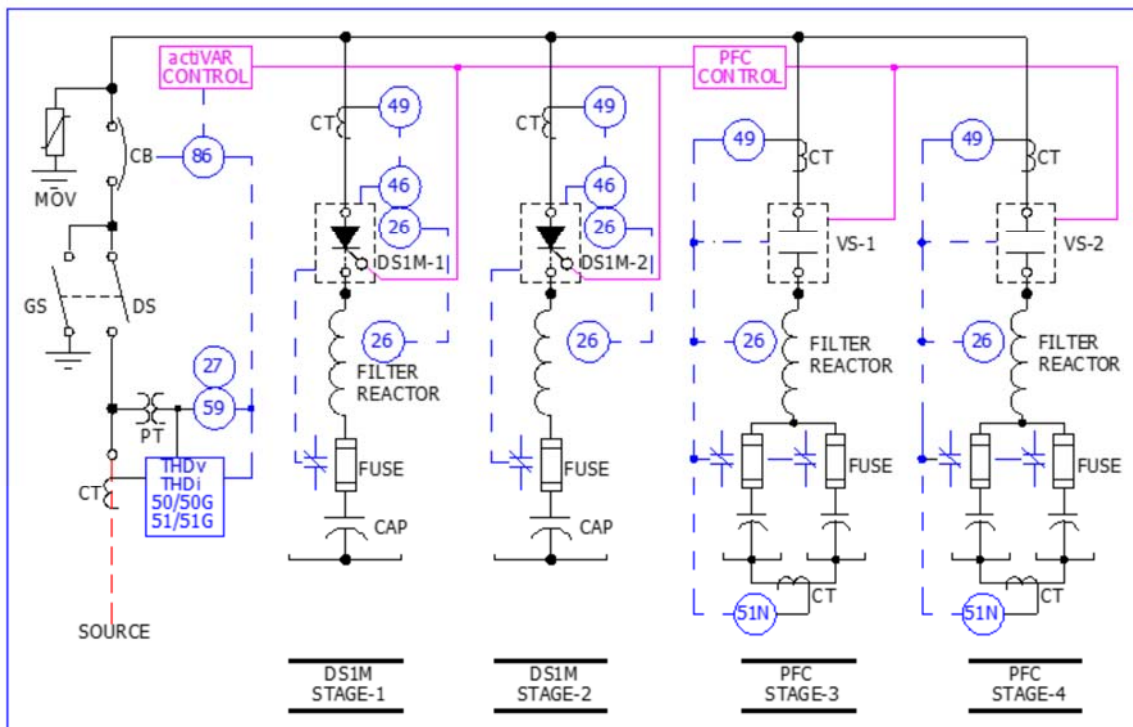




Protection Type	Designation	Description
Short Circuit and Overcurrent Protection	BF/50/51 50/51G	Provided by upstream feeder breaker, main incoming breaker (if provided), or main incoming current limiting fuses (if provided).
Arc Flash Mitigation	UFES	ABB's Ultra-Fast Earthing Switch for arc flash mitigation. This system provides protection against catastrophic failure and arc flash hazards for operating personnel.
Over-Voltage /Under-Voltage	59/27	Under and Over-voltage protection as well as backup over-voltage protection.
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	Over-temperature and fan failure protection.
Over-Load	49	Over-load protection of the high-pass resistors (if provided) and iron-core reactors (if provided). 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**<sup>™</sup>. The "actiVAR" control and "DS1-M" stages provide "fast" VARs. The "PFC" control and "PFC" stages provide "slow" VARs for power factor correction and harmonic mitigation.





## **actiVAR**<sup>®</sup> Ordering Guide

The **actiVAR**<sup>®</sup> 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](http://www.nepsi.com) and follow the product page link to fast transient free capacitor banks for starting large motors - **actiVAR**<sup>®</sup>. 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**<sup>®</sup>. 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.

