NEPSI
Northeast Power Systems, Inc.
66 Carey Road | Queensbury, NY | 12804
Ph: (518) 792-4776 | Fax: (518) 792-5767
www.nepsi.com | sales@nepsi.com

Medium Voltage Thyristor-Valves for Thyristor Switched Harmonic Filter Banks

NEPSI's actiVAR™ utilizes T-Star Engineering and Technical Service's single-phase oil-cooled and insulated thyristor valves (figure 1) to provide cycle-by-cycle transient free harmonic filter switching.

The valves consists of series connected diodes and thyristors (figure 2) for bi-directional control of current. The filter stages remain charged and ready for near instantaneous var support when put into operation.

Figure 1.
Thyristor Valves—By T-Star Engineering and Technical Services

Key Features

- Protection against electromagnetic interference
- Electronic components chosen for high reliability
- Very accurate protective firing function with dV/dt dependence
- Protective firing of de-energized valve in the event of both switching and lightning surges
- Supplementary protective firing functions during sensitive thyristor recovery interval
- Thyristor status monitor – including indication of protective firing
- Improved dV/dt capability
- RC damping and DC sharing resistors
- Reliable and well proven electrically triggered thyristor technology
- Valve reactors to limit di/dt stress during turn on and dv/dt during transients in the off state.
- N+1 and N+2 designs for reliable operation, high redundancy factor's and low thyristor voltage stress.
- Non-PCB oil cooled and insulated design
- Average annual failure rate of less than 0.15%
- Routine production test include electrical and thermo-mechanical checks, leak tests, and testing of firing and protective functions of the thyristor control and gating boards.

Rating Information

Absolute Maximum Valve Ratings

Characteristics	Conditions	Symbol	Value	Units
Repetitive Peak Forward and Reverse Blocking Voltage		V_{DRM} & V_{RRM}	45,500	V
Non-Repetive Peak Blocking Voltages (t< 5 msec)			45,600	V
Continuous RMS Current (with cooling fins)	Tc = 65°C	$I_{T(RMS)}$	180	A
Transient Current Limit: (with or without cooling fins)	Tc = 65°C ~20% Duty Cycle	$I_{T(RMS)}$	500	A
Peak One Cycle Surge Current, Non-Repetitive, T_J=25C, V_r=0	60 Hz 50 HZ	I_{TSM} I_{TSM}	4,500 4,200	A A
I^2t for Fusing	60Hz 50Hz	I^2t I^2t	$8.44x\ 10^4$ $9.00x\ 10^4$	A^2 sec A^2 sec
Maximum Rate-of-Rise of On-State Current (Repetitive)		di/dt	100	A/µsec
Maximum Rate-of-Rise of On-State Current (Non-Repetitive)		di/dt	200	A/µsec
Peak On-State Voltage	T_J=125C, T_{TM}=1000	V_{TM}	30.8	V
Turn-On Delay Time	V_D=0.5*V_{DRM}	t_d	2.0 (typical) 2.5 (max)	µsec µsec
$dv/dt_{(crit)}$	T_J=125°C Exp. Wave-form V_d=67% Rated	dv/dt	>10,000	V/µsec

Note: Above values are typical and are based upon manufacturers testing and projected capabilities. This information is subject to change without notice. The manufacturer makes no claim as to suitability for use, reliability, capability, or future availability of this product. Contact T-Star for additional information.

Application Note:

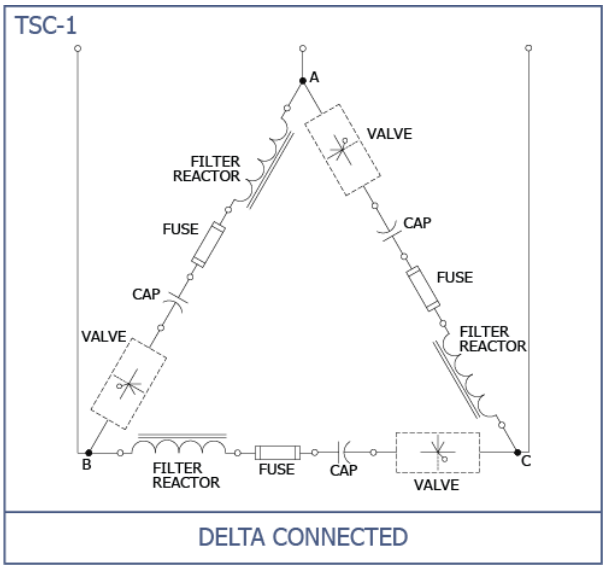
Thyristors valves have a limited thermal capacity. Thus the maximum design temperature of the thyristor valve is chosen sufficiently low to allow a capacitor failure without loss of thyristor life. This design temperature should not be exceeded under any normal operating conditions.

Based on specific application parameters, NEPSI may recommend deviations from the above specifications and/or may provide valves with higher ratings.

Thyristor Valve Configuration Options

Thyristor-switched harmonic filter stages utilize thyristor valves to provide "fast vars" for the mitigation of rapid voltage sags and flicker .

Delta Valve Configuration



DELTA CONNECTED

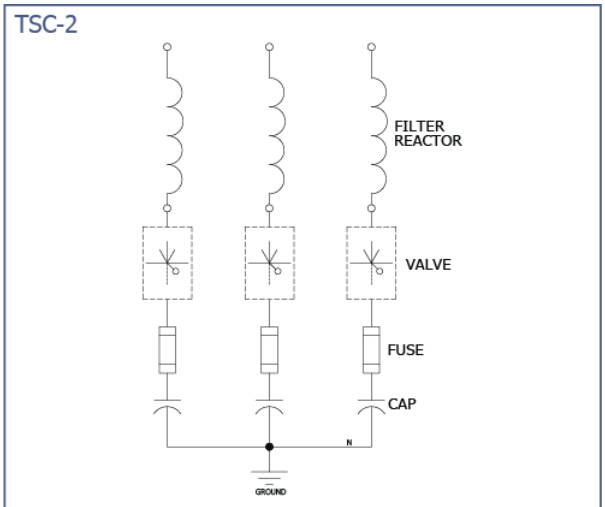
The Delta Valve configuration utilizes thyristor valves connected in a Delta configuration. Voltage ratings of the valves, reactors, and capacitors are rated based on the system line-to-line voltage rating. Current within the Delta valve is 57% of the current outside the Delta. Details of this valve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



WYE CONNECTED

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.

Construction Details and Dimensional Data

Thyristor Valves are provided with and without fins based on duty cycle and anticipated reactive current of the application.

Designs with fins have continuous ratings and are typically used on high duty cycle loads. This design utilizes transformer cooling fans beneath the fins. The number of fins will vary depending upon the application and the anticipated current and duty cycle rating.

Designs without fins have a transient ratings (no continuous current rating) and have duty cycle ratings on the order of 20% or less and are typically used for motor starting and low duty-cycle applications.

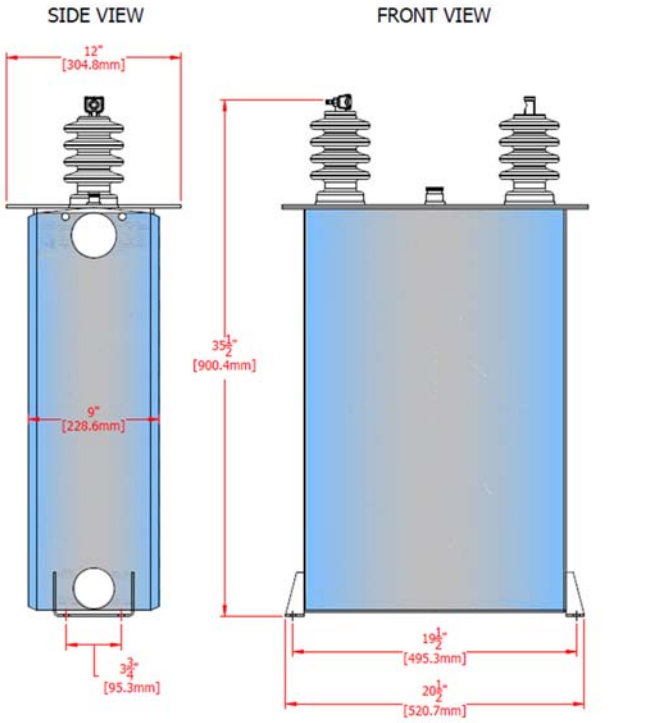
Drawings are typical and can change without notice.

Valves are to be lifted from the top using eye bolts. Threaded bolt holes for eye bolts are provided on the lid assembly (eye bolts not provided).

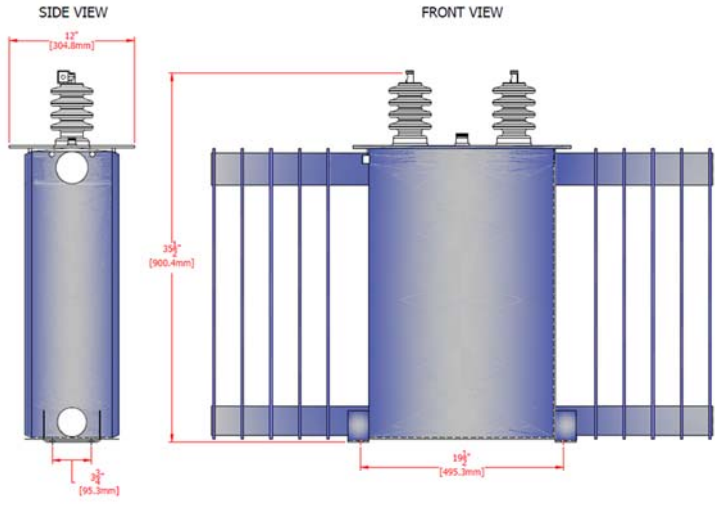
Valves utilize non-PCB Mineral Oil or natural ester fluid for insulation and cooling. A pressure relief valve is provided as a means to relieve pressure in excess of pressure resulting from normal operation.

The valve tank consist of 16 guage stainless steel. The tank cover consist of 0.25” stainless steel with threaded bolt holes.

Valves are equipped with two high-voltage porcelain bushings with properly chosen BIL and creepage distance for the system voltage and elevation.



THYRISTOR VALVE
WITHOUT COOLING FINS



THYRISTOR VALVE
WITH COOLING FINS

Construction Details and Dimensional Data

T-Star valve consists of multiple diodes and thyristors connected in series to obtain the desired voltage rating. The diodes face the reactors as shown and therefore hold the capacitors at a negative charge when gated off.

RC snubbers and sharing resistors protect the diodes and the thyristors from transient current and transient voltages during operation.

The air-core reactors provide di/dt and dv/dt protection for the valve's internal components during valve gating as well as transients from external lightning and switching transients.

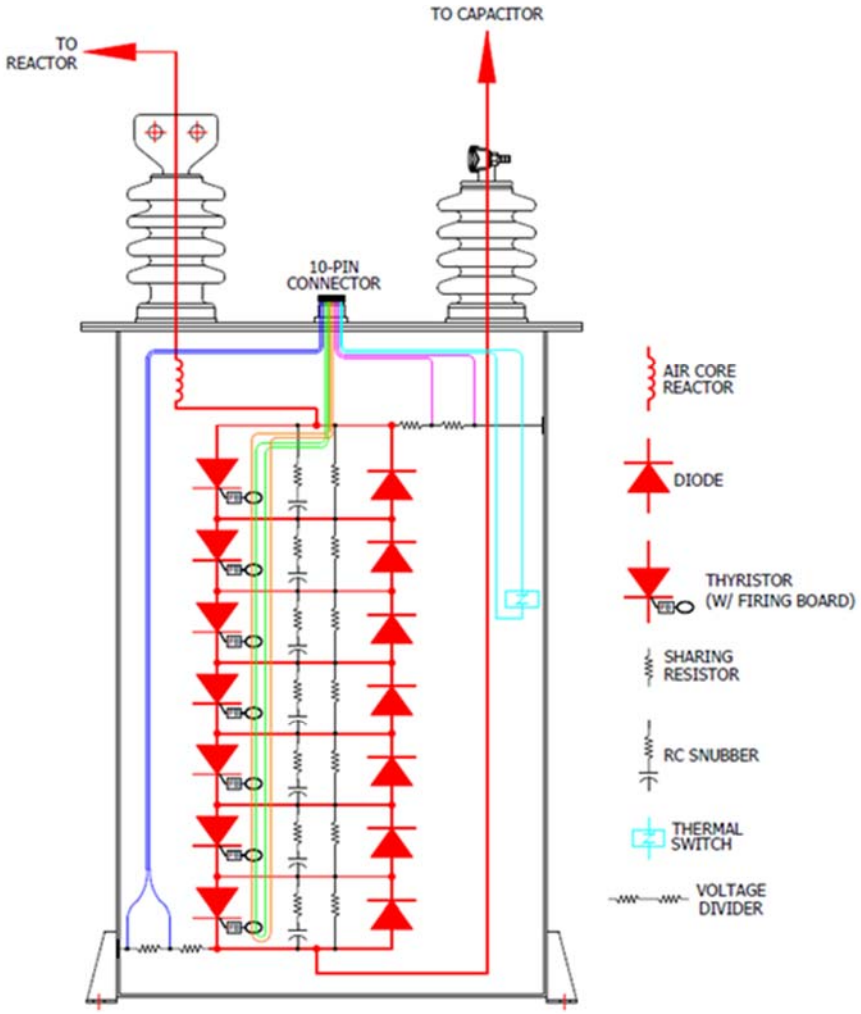
A thermal switch is provided and wired to the actiVAR™ controller to thermally protect the thyristor valve.

Both input and output voltage dividers are provided for sensing valve health and zero-voltage sensing for transient free gating of thyristor valve.

Two gate loops are provided for redundancy.

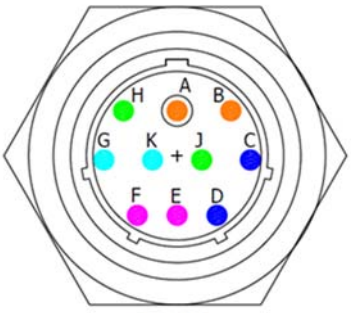
Valve controls are accessed from a military connector located at the top of the valve. Various checks can be performed to confirm the condition of the valve.

Note: Actual stack, connector, and pin outs may differ from those shown.



THYRISTOR VALVE INTERNAL SCHEMATIC

STATIC VALVE CONTROL		
MEASUREMENT FROM/TO	RESISTANCE Ω	DESCRIPTION
A/B	< 1	LOOP A
C/D	10k	OUTPUT VOLTAGE (2)
E/F	10k	INPUT VOLTAGE (2)
H/J	< 1	LOOP B
G/K	< 1	THERMAL
C TO OUTPUT BUSHING	~20.5M - 22.1M	OUTPUT VOLTAGE (1)
E TO OUTPUT BUSHING	~20.5M - 22.1M	INPUT VOLTAGE (1)



10-PIN CONNECTOR

actiVAR ™ 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.

Thyristor Switches and Control Systems

At the heart of NEPSI's **actiVAR®** is T-Star Engineering and Technical Services thyristor valves and valve controllers. Based outside Pittsburgh, Pennsylvania, T-Star specializes in the manufacture of medium-voltage thyristor valves and high-speed thyristor controls.

T-Star principals have designed, and installed over a hundred open air thyristor-switched capacitor systems. Many of these systems are maintained by T-Star under annual contracts. T-Star personnel have over 50 years of combined experience in thyristor valve engineering, application, and design.

T-Star thyristor valves and control systems undergo constant review ensuring that years of applications experience are translated into improved performance and reliability while maintaining simple customer-side requirements.