THYCON

Est.1968

Active Voltage Regulator

AVR-L | 100 - 800kVA
AVR-H | 1 - 10MVA

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Concept

The quality of power is becoming ever-more important to address the requirements of new and sophisticated technologies. The availability of high-quality power at all times ensures maximum productivity and gives producers a competitive edge. Poor voltage regulation and harmonic distortion, including voltage notching, flicker and short term sagging, are no longer acceptable reasons for production downtime.

Thycon Active Voltage Regulators (AVR) accurately and continuously regulate voltage and minimise harmonic distortion of the power supply to maintain your business productivity.

At higher power levels, AVRs can provide substantial energy saving and improved power network availability for existing power distribution infrastructure.

Applications

AVRs are suitable for any power quality application where accurate voltage regulation, harmonic voltage distortion mitigation (including voltage notching, flicker and short term sagging) or maximisation of existing power distribution infrastructure is required.
Beneficial applications of an AVR include:

- minimised disturbance notching and flicker caused by heavily switched loads
- energy savings of up to 20%

... minimise harmonic distortion of the power supply to maintain your business productivity.

- increased power distribution network availability of up to 30%
- replacement of ageing traditional mechanical transformer tap changers

Minimised disturbance notching and flicker caused by heavily switched loads

Rectifiers are notorious for supply harmonic distortion and notching effect caused by heavy switching of currents.

The waveforms shown on the following page highlight the quality of the mains supplying a 12-pulse rectifier with and without an AVR.

Energy savings

Energy savings are proportional to the extent of voltage variation experienced without the AVR versus the accurate regulation of voltage achieved by using it.

If the voltage variation is 10% higher on average than the minimum requirement of the voltage supply regulated by an AVR, a 20% saving in electrical energy can be achieved.

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2.5MVA power transformer

... associated costs such as ... maintenance and downtime are substantially reduced or eliminated ...

Increased power distribution network availability
Increase in power distribution network availability is proportional to the voltage drop experienced by poor voltage or power factor regulation on distribution lines over long distances.

If a poor power factor of 0.7 causes a voltage drop of 20% over a 200 km distribution line, an AVR can be used to improve distribution capability of the power network by 20%.
This can effectively:

- forestall the need to upgrade existing distribution power networks across the country
- reduce capital expenditure on new distribution power networks by allowing for the margin of growth as a result of using an AVR

Replacement of ageing traditional mechanical transformer tap changers
Traditional tap changers are the most expensive and least reliable component on a power transformer. Most failures are caused by contact issues, transition resistors and insulation breakdowns. Maintenance is costly as mean time to repair and down time are high.

Thycon AVRs, based on more reliable power electronic switching technology, are shunt connected to the supply and physically separated from the transformer. As a result, associated costs such as transformer size, oil requirement, maintenance and down time are substantially reduced or eliminated, as are effects such as arcing.

AVR features and benefits

- Thycon's Static Flywheel Technology
- continuous, accurate voltage regulation
- minimised harmonic distortion, notching, flicker and short-term sagging
- microprocessor-based diagnostics and controls
- energy saving
- soft-start control
- robust technology
- no moving parts
- fuseless design
- high efficiency
- high reliability
- long life
- cost effective
- low maintenance cost
- compact, modular construction
- indoor or outdoor enclosures
- Australian made

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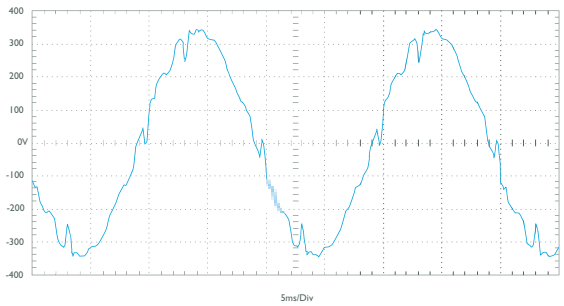
Distribution line

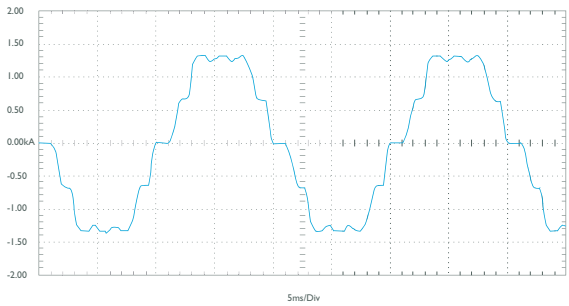
AVR on a heavily switched load

Mains supply voltage and current without the AVR, THVD: 8%, THID: 11%

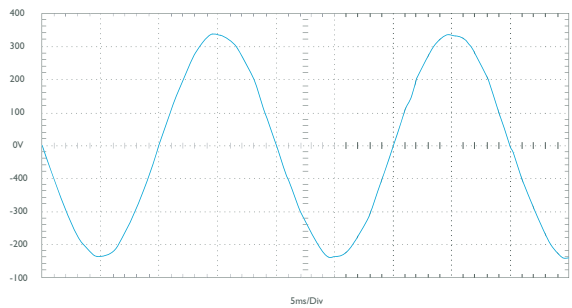
Voltage



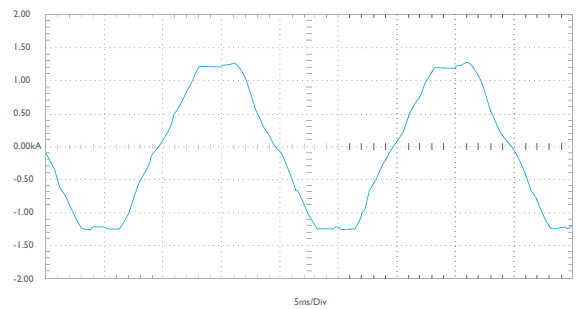
Current



Mains supply voltage and current with the AVR, THVD: 1%, THID: 6%



Voltage



Current

2.5MVA power transformer installation

Principle of operation

Thycon AVRs combine thyristor current source reactive compensator technology with fixed capacitor banks to provide a fully controllable static VAr source. Insertion of the capacitor bank and of the variable inductor gives leading reactive and lagging reactive compensation, respectively. The capacitor and inductor are varied to regulate the bus voltage at a user-defined level.

The variable inductor is achieved by regulating inductive current through a thyristor converter. Thyristor technology is mature and high-power devices are low cost, extremely reliable and multi-sourced. We believe thyristor technology offers the best basis for rugged, reliable power electronic conversion. The 12-pulse converter inherently produces low-levels of harmonic distortion without using additional filters to a level of less than 1%. Active control of the reactive compensator ensures smooth regulation of bus voltage.

An AVR has no moving parts and with the use of Thycon's Static Flywheel Technology has considerable stored energy to provide ride-through capacity for short sags. SCR conversion is used to regulate voltage and avoid the mechanical wear of traditional technology, making control of large kVAr ratings extremely effective.

If a supply failure occurs the AVR disconnects from the supply. When the supply returns the AVR waits for the supply to stabilise and then restarts. If a generator is connected then the AVR can be held off-line if required.

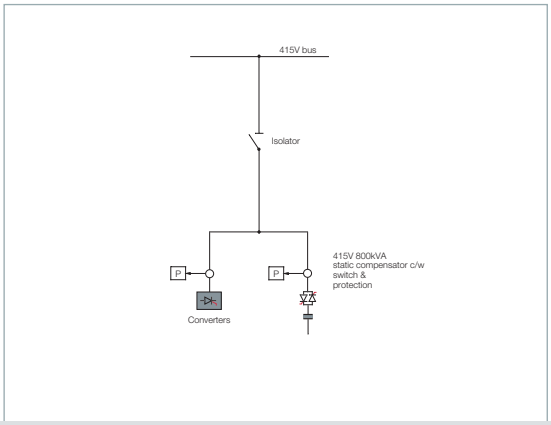
A digital signal processor (DSP) provides reactive control of the AVR. Sampled data principles are used to regulate the line voltage. The control is automatic, continuous and linear about the set-point selected by the user. This design has inherently fast transient response.

Thycon's medium voltage design simply couples low voltage 1kV reactive compensators and fixed capacitor banks to the medium voltage system through standard distribution type transformers.

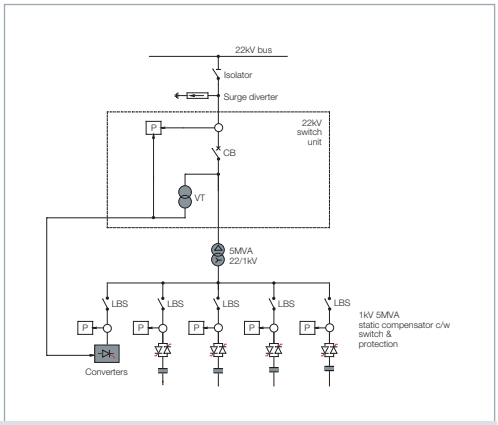
Installation and testing

The AVR offers modular design for quick and easy site installation. All that is required is the installation of power cables and control/monitoring cabling. The AVR is tested comprehensively prior to delivery and needs minimal site commissioning.

An AVR can also be provided as a complete containerised assembly that can be placed in the harshest Australian conditions and easily relocated to other sites as required .



Low voltage regulator system schematic



Medium voltage regulator system schematic

Reliability and maintenance requirements

Thycon has been supplying active voltage regulators for over 30 years and has demonstrated their high reliability and low maintenance demands in critical applications for defence, telecommunications, computer centres and manufacturing.

Transformers and power electronic converters can be force or naturally cooled, thus contributing to high reliability and low ongoing maintenance. The power components (capacitors, transformers, switchgear and instrument transformers) are all standard commercial products of proven reliability and long life expectancy.

Thycon AVR maintenance requirements are dependent on environmental and application conditions. We accommodate customer requirements from basic to full warranty maintenance. Each maintenance plan ensures the equipment operates in top condition with maximum availability of engineers and parts at minimum cost to the customer. Qualified engineers perform the maintenance with the full back up and resources of Thycon.

Qualified engineers perform the maintenance with the full back up and resources of Thycon.

Training and support

Training and support can be provided to on-site personnel to ensure that they are fully versed in the operation, maintenance and fault rectification of a Thycon AVR.

Control and monitoring

Smart digital signal processing provides control and voltage regulation of an AVR. The control is automatic, continuous and linear about the set-point selected by the user ensuring an inherently fast transient response. A soft-start mechanism at turn-on and smooth regulation throughout the operating range eliminates the typical switching effects of traditional voltage regulation methods.

AVRs can be controlled and monitored from the unit itself and remotely via serial, TCP/IP, SCADA or DNP3. The system is totally automatic and does not require manual restarting for fault-initiated supply disturbances.

Solar power

Control and status
An AVR provides a simple control and status interface.

Start and *Stop* push-buttons allow you to operate the equipment and to go on-line. *Power Available* and *Power On* LEDs indicate that the mains power is available and that the AVR is on-line. A *Cancel* button is used as an audible silence alarm acknowledge.

Monitoring
The AVR system monitor is a smart LCD panel featuring a simple and effective user interface that incorporates advanced diagnostic facilities enabling immediate access to:

- power monitoring - voltage / current / kW / kVA / power factor / harmonic distortion
- operating status and alarms
- event history
- password protected user defined settings
- service control and test options

The system monitor stores the last 200 system events in a non-volatile information buffer for fast, efficient fault diagnosis and status indication even after a re-start or a complete power outage.

Low-level interface
Operating status of the equipment to a remote monitoring system can be performed in the form of 8 standard voltage-free contacts.

High-level interface
Real-time performance monitoring of an AVR can be performed via serial, TCP/IP, SCADA or DNP3 connection. A basic hardcopy of operating events and data can be obtained by connecting a printer. An optional high-level interface via Modbus, SNMP or web html can be provided to those requiring additional display features for immediate performance monitoring and analysis. An additional feature includes the ability to notify your network server of alarm conditions and send emails to designated recipients.

AVR data, such as real time waveforms, alarms and system events, can be stored in solid state, non-volatile memory holding up to 500 MBs of information. Connecting an AVR to a PC using any of the available ports allows you to maintain a full history of the equipment over its lifetime.

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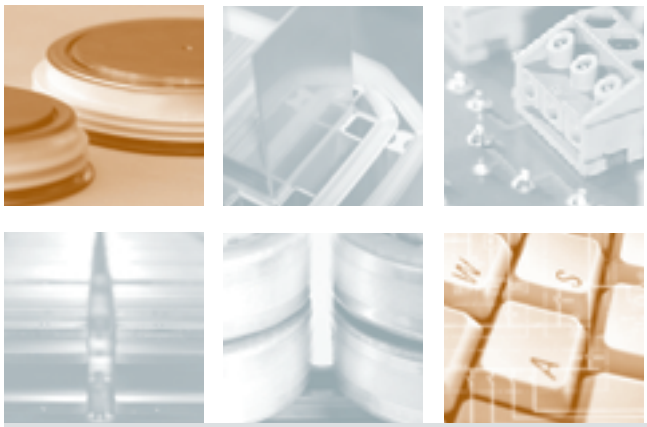

Power station

Options

Remote monitoring

Modem connection enables the AVR to dial and notify Thycon or a remote user automatically whenever an alarm condition arises. Thycon's Service Centre automatically logs data, performs analysis and diagnostics and then alerts our 24-hour service staff if further intervention is required. All AVR utilisation and incidents found or reported are logged and a full report is provided for each occurrence. The report highlights remedial actions, cautions and follow up recommendations. Alternatively, the remote user can interrogate the AVR at will.

Thycon power system monitor

The AVR monitor offers the user a web-based interactive diagnostic tool and database management system for continuous real-time monitoring of AVR system utilisations, alarms, events and variables. The database management logs data to your PC's hard disk for future analysis and display.

Future expansion and redundancy can be achieved by parallel connection of the AVR modules.

Expansion

Future expansion and redundancy can be achieved by parallel connection of AVR modules. Each module can be isolated manually or automatically from the load bus without affecting availability of supply.

Container modules

The AVR can be provided as a complete containerised assembly that can be placed in the harshest Australian conditions and relocated to other sites. Each module is self-contained enabling use in applications varying from city building rooftops to coastal oil rigs to outback mining stations.

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Thycon AVR advantages

Design advantages

Simple, reliable design	Uncomplicated design facilitates high strength, durability and reliability. The power circuit uses simple, robust static switches to form a sine wave by line commutation control technology. This design contributes to significantly higher lifetime, reliability, MTBF and lower MTTR than traditional methods.
Robust technology	Robust construction achieves reliable performance and long equipment life, as proven by over 30 years of Thycon installations.
Static switch design with no moving parts	This design eliminates the switching stresses, losses, interference and mechanical wear and tear that result from traditional designs.
Component rating	Commercially available standard mains frequency thyristors are used as single devices up to 2.4kA. No series or parallel matching of components is required to achieve high power applications.
Thyristor technology	Use of thyristors (SCRs) eliminates the need for special high-speed semiconductor fuses and “crowbar” arrangements and results in a simpler design with increased reliability. Thyristors have the highest power and fault tolerance of all semiconductor devices and can withstand faults of up to 10 times the current for 1000 times the period of transistor and IGBT switching technologies.
Fuseless design	No power fuses are required. Power components are liberally over-rated so that simple and reliable methods of circuit breaker protection can be used. This greatly reduces downtime and eliminates the need for stock control of spare fuses.
Surge protection	Built in surge protection increases the attenuation of over-voltages caused by distribution faults and lightning.
Modular construction	Construction from standardised components and modules ensures high mean time between failures (MTBF) and low mean time to repair (MTTR).
Environment	No special ventilation or air conditioning is required. The equipment is at home in computer rooms or in harsher environments without de-rating. Thycon equipment can be containerised and installed in the extremes of Australian environments.

Performance advantages

Soft start control and active regulation	Smooth transfer on-line and regulation through the operating range ensures seamless operation of the AVR.
Static transfer	Transfer to and from the load is fully automatic requiring no user checks or adjustments before it is initiated, thus removing the possibility of human error.
Thycon’s Static Flywheel Technology	The AVR uses Thycon’s proprietary Static Flywheel Technology to provide fast continuous regulation of voltage and harmonic distortion. This technology also allows the AVR to store substantial reserve power for transient conditions and high crest factor loads.
Transient response	A fast dynamic response enables correction of transient step load changes within one power cycle period.
Efficiency	System operates up to 99% efficiency resulting in low running costs and heat dissipation.
Parallel operation	Easy paralleling with similar systems during any stage of the AVR lifetime means increased flexibility and permits future growth as required.

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Technical specifications AVR-L100 - 300

	AVR-L100	*AVR-L200*	*AVR-L300*
Reactive power rating	100kVAR at 415V 50Hz	200kVAR at 415V 50Hz	300kVAR at 415V 50Hz
Rated voltage	415VAC	415VAC	415VAC
Voltage operating range	415VAC ± 20%	415VAC ± 20%	415VAC ± 20%
Supply unbalance withstand	2% continuous	2% continuous	2% continuous
Temporary power frequency overvoltage	1.8pu for 3s	1.8pu for 3s	1.8pu for 3s
Frequency - operating range	50Hz ± 5Hz	50Hz ± 5Hz	50Hz ± 5Hz
Source impedance - operating range	Not critical	Not critical	Not critical
Current RMS	139A	277A	416A
Overload current 150%	30s	30s	30s
Overload current 120%	10 min.	10 min.	10 min.
THVD*	<1%	<1%	<1%
Reactive compensation	100kVAR leading to 100kVAR lagging	200kVAR leading to 200kVAR lagging	300kVAR leading to 300kVAR lagging
Regulation time constant	Subcycle	Subcycle	Subcycle
Insertion loss	2.5kW	5kW	7.5kW
Audible noise level	<65dB(A)	<65dB(A)	<65dB(A)
Permissible ambient temp	0 to 45ºC	0 to 45ºC	0 to 45ºC
Protection type	IP20	IP20	IP20
Dimensions w x d x h (mm)	600 x 800 x 1200	600 x 1000 x 1800	600 x 1000 x 1800

Specifications are subject to change without notice
**Subject to application*

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Technical specifications AVR-L400 - 800

	AVR-L400	*AVR-L600*	*AVR-L800*
Reactive power rating	400kVAR at 415V 50Hz	600kVAR at 415V 50Hz	800kVAR at 415V 50Hz
Rated voltage	415VAC	415VAC	415VAC
Voltage operating range	415VAC ± 20%	415VAC ± 20%	415VAC ± 20%
Supply unbalance withstand	2% continuous	2% continuous	2% continuous
Temporary power frequency overvoltage	1.8pu for 3s	1.8pu for 3s	1.8pu for 3s
Frequency - operating range	50Hz ± 5Hz	50Hz ± 5Hz	50Hz ± 5Hz
Source impedance - operating range	Not critical	Not critical	Not critical
Current RMS	556A	833A	1111A
Overload current 150%	30s	30s	30s
Overload current 120%	10 min.	10 min.	10 min.
THVD*	<1%	<1%	<1%
Reactive compensation	400kVAR leading to 400kVAR lagging	600kVAR leading to 600kVAR lagging	800kVAR leading to 800kVAR lagging
Regulation time constant	Subcycle	Subcycle	Subcycle
Insertion loss	10kW	15kW	20kW
Audible noise level	<65dB(A)	<65dB(A)	<65dB(A)
Permissible ambient temp	0 to 45ºC	0 to 45ºC	0 to 45ºC
Protection type	IP20	IP20	IP20
Dimensions w x d x h (mm)	600 x 1000 x 1800	1200 x 1000 x 1800	1200 x 1000 x 1800

Specifications are subject to change without notice
**Subject to application*

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Technical specifications AVR-H

	AVR-H05M	*AVR-H07M*	*AVR-H10M*
Reactive power rating	5MVAr at 22kV, 50Hz	7MVAr at 22kV, 50Hz	10MVAr at 22kV, 50Hz
Rated voltage	22kV	22kV	22kV
Maximum continuous voltage	26.4kV	26.4kV	26.4kV
Voltage operating range	22kV ± 20%	22kV ± 20%	22kV ± 20%
Supply unbalance withstand	2% continuous	2% continuous	2% continuous
Temporary power frequency overvoltage	1.8pu for 3s	1.8pu for 3s	1.8pu for 3s
Power frequency insulation withstand voltage	50kV for 1 min.	50kV for 1 min.	50kV for 1 min.
Impulse withstand voltage	125kVp, 1/50_s (150kVp optional)	125kVp, 1/50_s (150kVp optional)	125kVp, 1/50_s (150kVp optional)
Frequency - operating range	50Hz ± 5Hz	50Hz ± 5Hz	50Hz ± 5Hz
Source impedance - operating range	Not critical	Not critical	Not critical
Current RMS	131A	183A	262A
Short-time current withstand	10kA for 3s	10kA for 3s	10kA for 3s
Overload current 150%	30s	30s	30s
Overload current 120%	10 min.	10 min.	10 min.
Auxiliary voltage supply	240/415V ac and 24 - 125V dc	240/415V ac and 24 - 125V dc	240/415V ac and 24 - 125V dc
THVD*	<1%	<1%	<1%
Reactive compensation	5MVAr leading to 5MVAr lagging	7MVAr leading to 7MVAr lagging	10MVAr leading to 10MVAr lagging
Regulation time constant	Subcycle	Subcycle	Subcycle
Insertion loss	125kW	175kW	250kW
Audible noise level	<70dB(A)	<70dB(A)	<70dB(A)
Permissible ambient temp	-5 to 45ºC	-5 to 45ºC	-5 to 45ºC
Protection type	IP54	IP54	IP54
Dimensions w x d x h (mm)	9000 x 2500 x 2500	10000 x 2500 x 2500	9000 x 5000 x 2500

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**Subject to application*

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