

VRP

PWM Automatic Voltage Regulator



| Single Phase 1.4 kVA – 17.3 kVA |

| Three Phase 6 kVA - 125 kVA |



Most modern electrical & electronic machines are built with high-performance microprocessors which require the highest quality & reliability power supply possible.

TSI Power introduced the VRP (compact & lightweight ITIC, CBEMA & IEC 61000-4-11 compliant precision PWM voltage regulator with 10 ms typical voltage correction speed) in 2001.

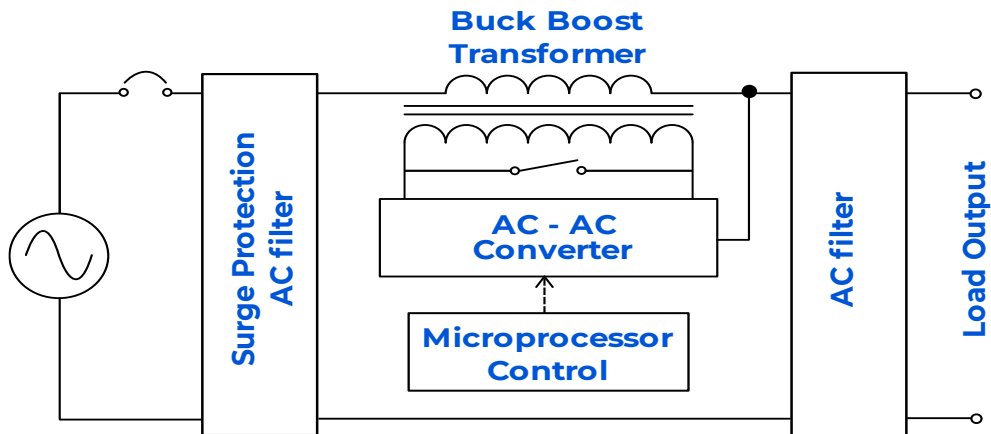
TSI Power, with more than 20 years designing and installing power protection products, specialized in PWM Voltage Regulator products. Ten of thousands of the VRP Voltage Regulators are installed and proven in many missions-critical sites globally.

VRP PWM Automatic Voltage Regulator

VRP provides interruption-free and continuously operating (cycle-by-cycle) voltage correction, ensuring compatibility with all types of sensitive loads

VRP series is designed to provide high precision power with industry leading response time of one-half line cycle (10 ms or less).

VRP Block Diagram



Features and Benefits

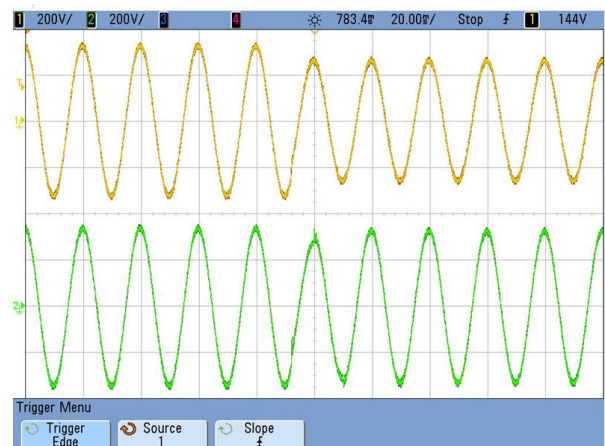
<p>Standby operation minimizes interaction with existing loads or power distribution systems, while being compatible with most loads</p>	<p>Internal surge protection and noise filtering assures trouble-free operation.</p>
<p>Wide input range ($\pm 20\%$) and precise output regulation ($\pm 3\%$) provides superior performance.</p>	<p>AC input circuit breakers and load over-current protection prevents costly equipment damage.</p>
<p>Various AC input/output connector type wiring terminals facilitate specific applications.</p>	<p>Customizable for unique and challenging applications.</p>

VRP comparison with Servo Motor and Tap Changer AVR

	VRP	Servo motor type AVR	Tap changer type AVR
Voltage correction method	High speed power electronics with microcontroller to control buck/boost transformer.	<i>Servo moto physically "move" brush along transformer winding.</i>	<i>Mechanical or solid-state relays changing tap of isolation transformer or autotransformer.</i>
<i>Response time (Transition + Correction time)</i>	<i>10 milliseconds</i>	<i>1 to 3 seconds</i>	<i>0.5 to 1 seconds</i>
<i>Load current path broken during correction</i>	No	No	Yes
Moving parts	Fan	Servo motor, fan	Mechanical relay, fan
Maintenance requirement	Low	Medium	High
Temporary output swell	No	Yes	Yes
Install in harsh environment	Yes	No	No

VRP Output Waveform

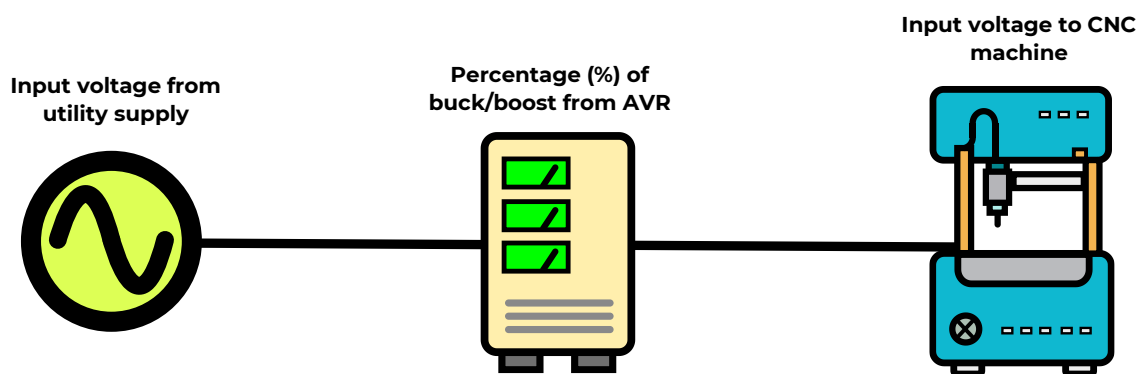
- Yellow waveform is VRP input voltage, which shows 20% undervoltage condition.
- Green waveform shows the VRP output voltage,
- VRP shows smooth transition and ultra-fast response time to correct the undervoltage condition.
- VRP provides interruption-free and ultra-fast 10 ms response (voltage detection + correction) time.



An example of servo motor type AVR operation

The following shows various voltage conditions when protecting a voltage sensitive CNC machine with servo motor type AVR. We will presume the nominal voltage is 230V, with the AVR maximum boost voltage of 20% for this example. The CNC machine is presumed to have a voltage tolerance of $\pm 10\%$ of nominal voltage, which is 207V to 253V.

This AVR's use mechanical voltage correction method where a motor must physically "move" brush to various transformer winding positions. Typical response time for adjustment to new input voltage is assumed to be about 30V per second

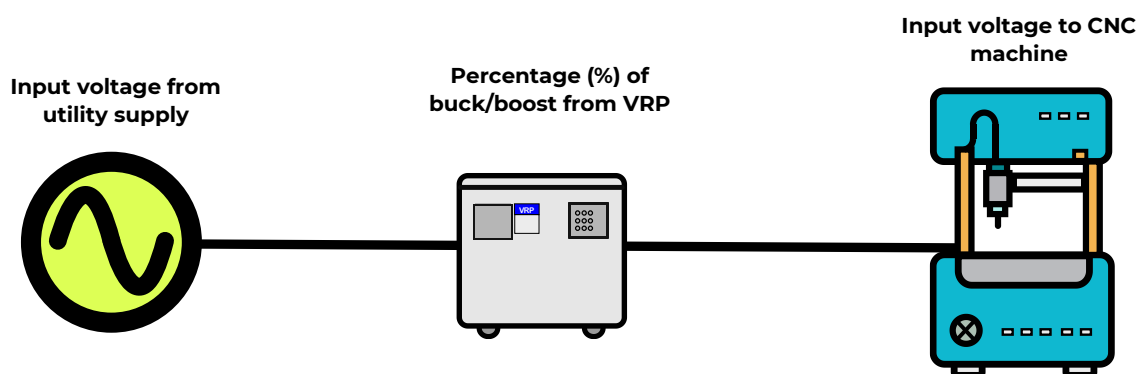


Input voltage from utility supply	Percentage (%) of buck/boost from AVR	Input voltage to CNC machine
Input: 184V (continuous) Input voltage is continuously at undervoltage condition of 184V.	AVR servo motor moves to transformer winding position that output 120% of input voltage	Output: 230V ✓ CNC machine will operate normally.
Input: 276V (continuous) Input voltage is continuously at overvoltage condition of 276V.	AVR servo motor moves to transformer winding position that output 80% of input voltage	Output: 230V ✓ CNC machine will operate normally.
Input: 184V for 100ms Input experienced a short duration voltage sag event, with 20% voltage drop (46V) for 100ms.	AVR does not respond to this event as the servo motor needs about more than 1s to correct this.	Output: 184V* CNC machine experienced voltage sag, and may shutdown or damaged.
Input: 276V for 100ms Input experienced a short duration voltage surge event, with 20% voltage surge (46V) for 100ms.	AVR does not respond to this event as the servo motor needs about more than 1s to correct this.	Output: 276V* CNC machine experienced voltage surge, and may get damaged.
Input: 184V rise to 276V During an undervoltage condition, the input has a sudden increase of voltage to 260V	AVR has 120% boost in the beginning. When voltage increase to 260V, AVR will take about 2.6s to bring the output voltage to nominal of 230V.	Output: 331V* CNC machine will receive voltage of around 331V for about 1s, before it gets normalized at 230V. It may get damaged due to the overvoltage.
Input: 264V drop to 184V During an overvoltage condition, the input has a sudden drop of voltage to 180V	AVR has 80% buck in the beginning. When voltage decrease to 184V, AVR will take about 2.6s to bring the output voltage to nominal of 230V.	Output: 147V* CNC machine will receive voltage of around 147V for about 1s, before it gets normalized at 230V. It may shutdown or get damaged due to the undervoltage condition.

An example of VRP operation

The following shows various voltage conditions when protecting a voltage sensitive CNC machine with TSI VRP voltage regulator. We will presume the nominal voltage is 230V, with the VRP maximum boost voltage of 20% for this example. The CNC machine is presumed to have a voltage tolerance of $\pm 10\%$ of nominal voltage, which is 207V to 253V.

The VRPs use ultrafast power electronics switching to mitigate undervoltage and overvoltage conditions. Typical response time for VRP to correct the input voltage is 10ms.



Input voltage from utility supply	Percentage (%) of buck/boost from VRP	Input voltage to CNC machine
Input: 180V (continuous) Input voltage is continuously at undervoltage condition of 180V.	VRP output 128% of input voltage	Output: 230V ✓ CNC machine will operate normally.
Input: 260V (continuous) Input voltage is continuously at overvoltage condition of 264V.	VRP output 88% of input voltage	Output: 230V ✓ CNC machine will operate normally.
Input: 184V for 100ms Input experienced a short duration voltage sag event, with 20% voltage drop (46V) for 100ms.	VRP will respond within 10ms to boost the voltage back to nominal.	Output: 230V ✓ CNC machine will operate normally.
Input: 276V for 100ms Input experienced a short duration voltage surge event, with 20% voltage surge (46V) for 100ms.	VRP will respond within 10ms to bring down the voltage back to nominal.	Output: 230V ✓ CNC machine will operate normally.
Input: 180V rise to 260V During an undervoltage condition, the input has a sudden increase of voltage to 260V	VRP will output 88% of input voltage within 10ms.	Output: 230V ✓ CNC machine will operate normally.
Input: 264V drop to 180V During an overvoltage condition, the input has a sudden drop of voltage to 180V	VRP will output 128% of input voltage within 10ms.	Output: 230V ✓ CNC machine will operate normally.

VRP Applications

VRP products are used widely in many applications that require stable voltage. Over 40,000 units are in operation around the world since 2001.

Telecommunications

Remote & unmanned telecom sites need stable power supply to for failsafe operation without using expensive diesel generators. VRP operates over wide input voltage range and provides precisely regulated power to mission-critical communication site & cell site base station (BTS) equipment.



CNC, Robotics, Production Automation Machines & 3D Printers

VRP provides 10 ms combined voltage detection & correction time for interruption-free operation of even the most sensitive CNC machines, robotic, production automation equipment and 3D printers

Hospitals, Analytical & Scientific Laboratories

VRP protects highly sensitive medical and laboratory equipment such as gas chromatographs, mass spectrometers, X-ray, MRI, CT and laser imaging, diagnostic & treatment equipment.



Building Systems, IT Equipment, Entertainment & Surveillance

VRP provides highest quality power to high-end electrical and electronic equipment, such as home theatres, music systems, air conditioners, computers, servers, large-format copiers / printers, special purpose LED lighting etc.

Success Stories and testimonials

VRP products are installed widely in various applications globally for more than 20 years. There are many success stories on how the users have benefited from the solution and the reliability they experienced.

“...We power our HAAS CNC VF2 Machines, Hyundai WIN (i-Cut 380TDi) machines, HAAS CNC SL20 machine with the VRP for over 1 year and are extremely satisfied with the technology and performance.

Now the equipment is stabilized and works very well, and we have not faced any problem. ...”

**Philips Machine Tools India
February 2020**

“...We were facing frequent breakdown in our Kellenberger Grinding machine due to power fluctuation, although servo (*motor type*) voltage stabilizer was installed.

TSI installed VRP unit on our Kellenberger Grinding machine ... and we found that frequent break down issue due to power (fluctuations) were completely resolved.

TSI VRP units are energizing our CNC Turning, VMC and grinding machines excellently since last 9 months and we believe these units will continue to perform well in future.

We have also not faced any maintenance related issues ...these units don't have moving parts, unlike servo (*motor type of*) technology, hence the maintenance is minimal.

**Jyoti CNC Automation
September, 2019**

“...Since 2004, Hwashin India has been using servo motor type voltage regulator to protect robot and welding application. But due to the output response time of the servo motor type voltage regulator, the robot's PCBs were still damaged by fluctuating voltage events.

We have decided to replace the servo type voltage regulator with TSI VRP products, with the hope of solving the robot's PCB failure problem. It turned up VRP was able to successfully mitigate the power problems we faced.

We have since installed more than 400 units from 2012 to 2017. We strongly recommend the VRP product as a solution to power fluctuation problem. “

**Hwashin Automotive India Private Limited
November 2017**

Success Stories and testimonials

“...We are very happy with our TSI (VRP) power conditioners.

Our table router is a very precise machine and we were having minute and

unexplainable variations in performance. The manufacturer was unable to explain or solve the problem and we were chasing it with workarounds and less efficient operation of the machine to compensate.

Once we installed the (VRP) power conditioner, those problems immediately stopped. We, of course, ordered a second (VRP) conditioner for our second machine as original equipment.

The equipment has already easily paid for itself. ...”

Carolina Closets USA
September 2018

“...I am pleased to inform you that we have 16 of your VRP units have been in service 24/7/365 since 2009 without any issues to speak of.

Equipment that they are protecting has also been very reliable and trouble free; a real success story.

I have forwarded your email to several colleagues for their consideration...”

Scientific Research Corp. USA
July 2021

Other VRP success stories

- Starting in 2007, **HP Colorspan** used over 100 VRP units to protect large format UV printers installed in locations with unstable AC mains voltage.
- **JPSA Laser** used over 50 VRP-ILC (three phase VRP units with built in delta-to-wye conversion input isolation transformer) units to protect micromachining equipment exported to China, Taiwan and Korea from 2007 to 2017.
- Since 2005, **CEM** is using several hundred VRP units to protect sensitive scientific instruments installed in USA and worldwide.
- In 2007, **Ciba Vision** used VRP units to protect highly sensitive contact lens manufacturing machines installed in their manufacturing plant in Georgia.
- **Avery Dennison** in Honduras is using several VRP-60000-0339 (60 kW, three-phase 230/400V output VRP) units since 2016 to protect several label making machines from highly unstable AC mains voltage, a common problem in Honduras.



TSI Power

TSI Corporation

POWER™

| 1103 W Pierce Avenue, Antigo, WI 54409 USA |
| Tel: + 1-715-623-0636 (US) / + 65-9842-6601(Asia) |
| sales@tsipower.com | www.tsipower.com |