EM - ENERGY SOLUTIONS

ELECTROMAGNETIC ENERGY SOLUTIONS

2020

Revolutionary design!

Low, Medium and High Voltage

AVE

Automatic Voltage Stabilizer

For a truly clean and stable power supply

A **Cost Savings**
Reduced energy consumption, costs and carbon footprint

B **Increased Safety**
Protect lives and assets by reducing arc-flash danger and ground fault hazard in both grounded and ungrounded systems

C **Reduced Downtime**
Protect lives, extend equipment lifetime and increase production output

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OPTIMIZING FUTURE POWER SYSTEMS

Eager to learn more?
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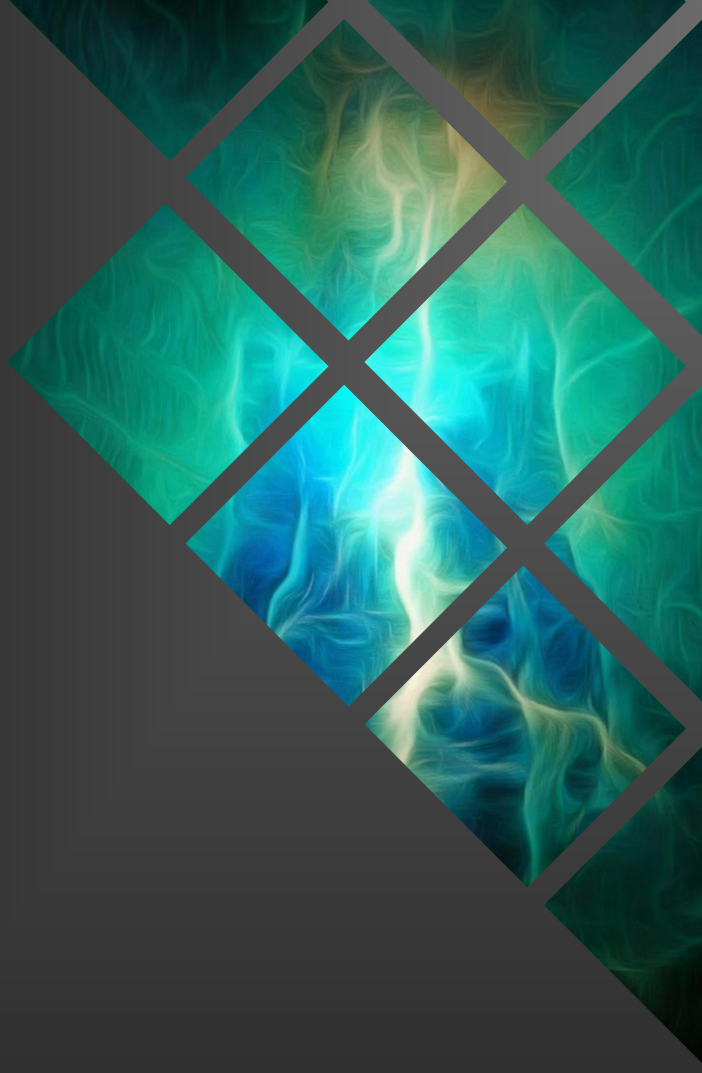

Industry Challenge

Today's use of electronics and power electronics are setting higher demands for power quality. The industry is experiencing considerable costs in terms of increased power bills, reduced operational lifetime, and damage to electrical equipment.
Many of these problems are related to voltage imbalance, the harmonic distortion created by increased use of power electronics, transient voltage surges, and voltage sags & swells. These are large and expensive problems in the industry. Electric motors will operate at higher temperatures and lower efficiency, which results in significantly reduced life expectancy and increased power consumption. For electrical equipment, a rule of thumb is that an average temperature increase of 10 degrees Celsius equals a 50 percent reduction in life expectancy. Equipment failure and system lockup result in unreliable operation with downtime and production stop. Many industries run delicate processes that require a fully functional production line. Production stop related to faulty equipment can significantly impact production output and, subsequently, a company's earnings.
Another high potential industry hazard is Arc-Flash. Arc-Flash is one of the most dangerous electricity-related incidents for both personnel and equipment. It is an electrical explosion/discharge that results from a low-impedance connection through the air to ground or another high voltage phase in the electrical system. It can be initiated through accidental contact, underrated equipment compared to available short circuit current, contaminated insulated surfaces, as well as other causes.

An arc-Flash event can dissipate large amounts of deadly energy in the form of a shock wave and superheated metal plasma. Temperatures can reach as high as 19 000 degrees Celsius, even hotter than the surface of the sun.
This kind of energy can set fire to clothing and severely burn human skin in fractions of a second. According to Industrial Safety and Hygiene News report, there is, on average 30 000 Arc-Flash incidents every year with an estimated 7000 burn injuries, 2000 hospitalizations, and 400 fatalities.

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TECHNOLOGY

How it works

EM Energy Solutions' revolutionary patented technology for voltage stabilizing, ensures an optimal phase voltage balance on both grounded and ungrounded distribution systems.
AVE is an EHRGS (Electromagnetic High Resistance Grounding System) that reacts to any voltage imbalance and equalizes the voltage between all phases with the speed of the current.
By constantly logging the supply transformers phase to ground voltages and using this to control single-phase variable or multitap transformers, one can achieve optimal phase voltage balance. A state-of-the-art controller controls the variable transformers. The system has an operator panel for control functions and display of operational status together with a comprehensive alarm system that will notify operators about various events like ground faults, transients, and high harmonic distortions.

The unit also has an integrated power quality analyzer that gathers all relevant information about power quality and presents this on the local HMI panel or to any remote interface users. To summarize, AVE serves as a surge suppressor, voltage regulator, and harmonic filter. It is easy to install and is connected as close as possible to the transformer secondary side. It will protect all downstream equipment, thus making other power quality technology, such as MOV based devices unnecessary and obsolete. By having the AVE installed, the result will be substantial cost savings and increased electrical safety.

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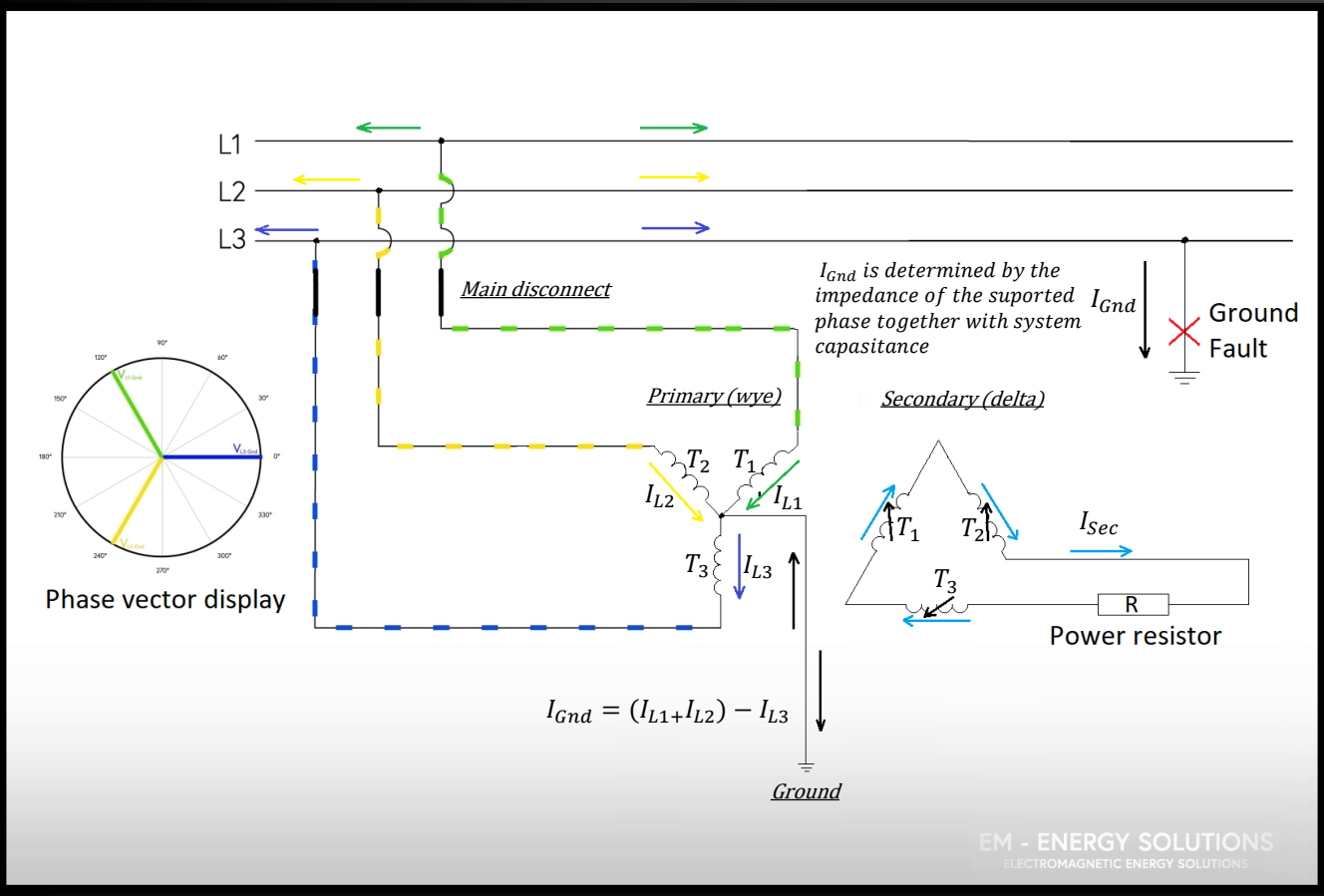
TECHNOLOGY

AVE current flow

Here you can see a simplified schematic of AVE's main circuit. The variable transformers are connected in wye configuration on the primary side with neutral connected to ground, while the secondary sides of the variable transformers are connected in delta-series with a stainless-steel grid resistor. The schematic visualizes the current flow in the AVE during a ground fault. The working principle will be the same for any other voltage imbalance related problem.

If we look at the phase vector display, we see that the voltages are ideally 120 degrees offset during the fault. The two healthy phases (L1 and L2) support the low voltage/faulted phase (L3). Energy is redirected from the healthy phases to the low voltage phase through the transformer circuits secondary side and will cause an increase in voltage on the low voltage phase. During the fault, all phase currents will be in phase, making us able to use simple mathematics to calculate the ground current (See equation for I_{Gnd} in the schematic).



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System Benefits

Balanced voltage
AVE will keep the voltage balanced and phase vectors perfectly 120 degrees offset using state-of-the-art variable transformers. Voltage imbalance will be held within 1 percent, ensuring optimal performance.

Arc-Flash mitigation
Most Arc-Flashes starts as a ground fault. AVE will prevent the first arcing ground by discharging energy from the distribution system, subsequently avoiding phase to phase faults. This will reduce Arc-Flash potential with more than 85 percent.

Reduced zero-sequence harmonics
Prevents control system lockups by Keeping the ground reference, free from noise.

Reduced energy consumption
Stop wasting capacitive energy to ground. Power will now instead be redirected back into the system to optimize phase voltage balance. With optimized phase voltage balance, electrical equipment will consume less energy, ensuring substantial cost savings.

Extended life expectancy on motors
Only a 3% voltage imbalance can cause a significant temperature increase and a reduction in life expectancy. Keep your voltage balanced and keep your electric motors cool.

Reduced I^2R losses
I^2R losses will be drastically reduced with optimal phase voltage balance.

EMP Protection
Due to the fundamental design based on mutual induction and the fact that it reacts with speed of the current, it can mitigate distortion in the GHz range.

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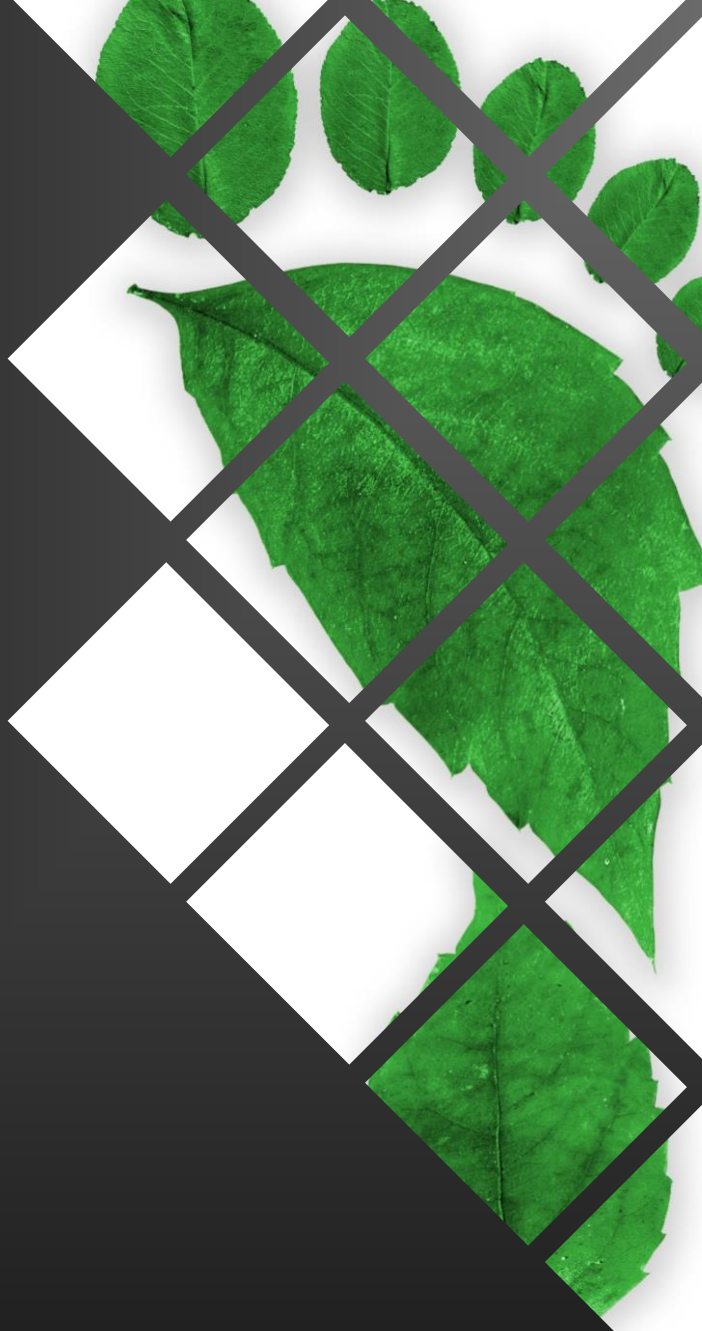
Check-out our website For more information and contact details



System Benefits

Mitigate transient events
The larger the transient, the more AVE will counteract it. Protect your equipment from damaging transients. Conventional semiconductor-based surge protection devices are to slow and often allow as much as five times nominal voltage into the system. With AVE installed, that is history; nothing reacts faster than the electromagnetic field!

Increased personnel safety
With the comprehensive ground fault detection system. The operator can address the issues in a timely and safe manner. The system also protects against Arc-flash and transient overvoltage, increasing workers' safety.

Reduced Downtime
Less equipment changeout and maintenance, together with increased personnel safety.

Save Costs
Energy savings will often give payback in a year or less. Prevention of one Arc-Flash or transient event can easily save more than the cost of an AVE.

Reduced CO_2 emissions
Reduced energy consumption and equipment changeout contribute to decreased emissions.

Increased production output
Based on all the advantages above, raise both your production output and earnings.

Business advantage
Give your business a leading-edge technology advantage. There is nothing like EM Energy Solutions' revolutionary technology on the market today!

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PROVEN TECHNOLOGY

Locations

The technology has gone through thorough testing, both in-house, laboratory, and in the field.

Last year we completed detailed testing and presentation at PNDC (Power Network Demonstration Center) in Cumbernauld Scotland, where a full test report is now available on our website.
Units have also been installed and proved their unique capabilities in several countries, including Norway, South Korea, and the UK.
Just recently, we demonstrated the technology at one of the world's largest shipbuilding manufacturers in the world, Samsung Heavy Industries, with astonishing results.

Two of our units installed in a welding factory at Samsung Heavy Industries.

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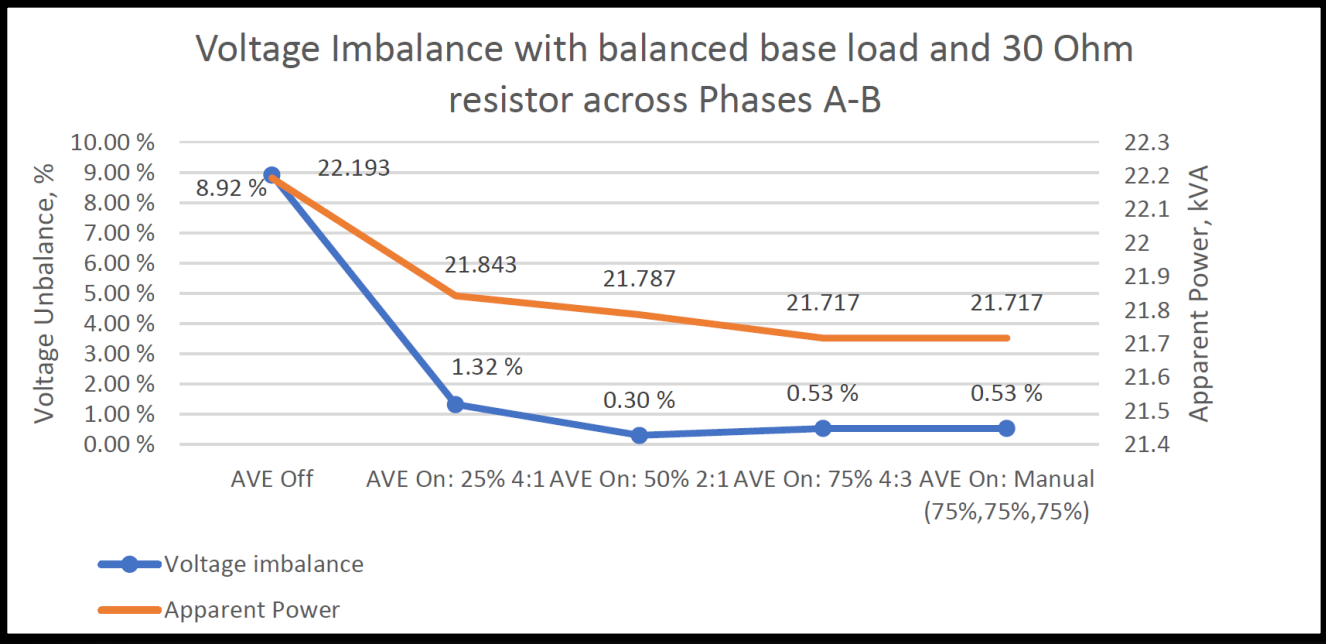
Check-out our website For more information and contact details

PROVEN TECHNOLOGY

PNDC Test

Here you can see the result of one of the tests performed at Power Network Demonstration Center. As a baseload during the trial, we had three power-resistors each at 10 Ohm connect in delta-configuration, consuming around 22,2 kVA. Furthermore, It was connected one 30 Ohm power-resistor between phases A and B to induce a voltage imbalance close to 9 percent. When the unit was activated, one can see from the graph how the voltage imbalance dropped to 1.32 percent, and consumption reduced with 350 VA. Voltage unbalance and consumption was reduced even more by adjusting the ratios on the variable transformers.

The energy reduction was close to 500VA. If we calculate this into kW hours over a year, it would add up close to 4400 kWh. Depending on local electricity costs, one could imagine the savings possible on a larger scale system.
Much more detailed information can be found at our website.



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AVE PRODUCT LINE

The next pages will take you through our AVE product line

AVE with variable custom-made transformers.

Eager to learn more?
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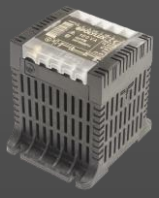
AVE MAIN COMPONENTS

Industrial 4G router for remote WEB access.

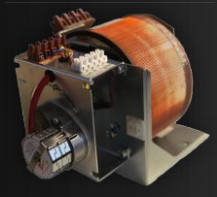
High quality non-inductive steel grid resistor.

Failsafe impulse contactor ensuring protection even if the unlikely event of control system power loss should occur.

Power Quality Analyzer with trigger point functionality and cloud solutions.



Variable tapping isolation transformer for AVE FIXED and MINI series.



Custom made motor controlled variable isolation transformers.

Main disconnect switch with high short circuit capacity. Optional cabinet door interlock.

State-of-the-art Controller with Advanced algorithm for optimum phase voltage control.

Optional floor mounting base.

Local HMI panel for display of system information and unit control.

Eager to learn more?
Check-out our website For more information and contact details

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AVE

AUTOMATIC VOLTAGE EQUALIZER

AVE is designed for optimal phase to ground voltage control. With the use of motor controlled variable isolation transformers, accurate control of individual phase voltage is possible. The unit can balance voltage imbalances close to 100% (fault condition) to nearly zero percent imbalance. The AVE has a state-of-the-art power quality meter, which will give operator detailed status of the network quality and trigger events. Operational status and network information can be obtained locally from the HMI panel and from a remote web interface. A cloud solution is also possible so you can access and monitor your system in real-time from anywhere in the world.

Voltage class [Vac]	250/480
kVA rating [kVA]	3000/6000
Current rating I_{sec} [A]	7000/14000
Power Quality meter	✓
Web interface	✓
Cloud solution	Optional
Floor Mounting	Optional
Weight [lbs/kg]	308/140
Size [Inch/mm] w x h x d	31,5×47,2×15,8/800x1200x400
Distribution System	3ph Grounded/Ungrounded
Display size [Inch/mm]	10/254

No compromise!

For transformer sizes up to 6000kVA

AVE comes with NEMA 12K style enclosure.

Eager to learn more?

Check-out our website For more information and contact details

PREMIUM QUALITY 3 YEARS WARRANTY

AVE FIXED

AUTOMATIC VOLTAGE EQUALIZER

AVE Fixed is a more cost friendly solution but can still pack a punch. It uses fixed high-quality isolation transformers with variable tapping regulated by a controller. It will make an instantaneous correction to any phase voltage imbalance. Any steady-state voltage imbalances will be corrected with the variable tapping functionality, making it capable of correcting 100% voltage imbalances (fault condition). Due to its roughed design transformers, the unit requires very little maintenance. It comes with an integrated power quality meter with access through a remote web server and cloud solution. Control and status information from the unit can also be obtained from the local HMI panel.

Voltage class [Vac]	250/480/690
kVA rating [kVA]	1200/3000/6000
Current rating I_{sec} [A]	1000-13800
Power quality meter	✓
Web interface	✓
Clud solution	Optional
Floor mounting	Optional
Weight [lbs/kg]	364/165
Size [Inch/mm] w x **h** x **d**	31,5×47,2×15,8/800x1200x400
Distribution system	3ph Grounded/Ungrounded
Display size [Inch/mm]	10/254

Cost effective!

For transformer sizes up to 6000kVA

AVE FIXED comes with NEMA 12K-style enclosure.

Eager to learn more?

Check-out our website For more information and contact details

PREMIUM 3 YEARS WARRANTY QUALITY

AVE MINI

AUTOMATIC VOLTAGE EQUALIZER

AVE-mini is a more cost and space-effective solution for lower range transformers between 400 to 1200 kVA. The same electromagnetic principles as used on the standard AVE is applied. The compact design reduces the challenge in terms of available space. It is fitted with high-quality single-phase transformers utilizing controller regulated variable tapping to achieve voltage balancing to a high degree of accuracy. The unit have the integrated power quality meter as optional. The operator can obtain necessary system information from the HMI panel located in the front door.
AVE-mini also comes in single phase solutions, making it suitable for smaller housing areas.

Voltage class [Vac]	250/480
kVA rating [kVA]	400/800/1200
Current rating I_{sec} [A]	480-1400
Power quality meter	Optional
Web interface	Optional
Clud solution	Optional
Floor mounting	Optional
Weight [lbs/kg]	198/90
Size [Inch/mm] w x h x d	23,6×39,37×15,8/600x1000x400
Distribution system	1ph/3ph Grounded/Ungrounded
Display size [Inch/mm]	4,3/109

Cost and space effective

For a wide range of smaller size transformer

AVE MINI comes with NEMA 12K-style enclosure.

Eager to learn more?

Check-out our website For more information and contact details

PREMIUM 3 YEARS WARRANTY QUALITY

AVE HIGH VOLTAGE

AUTOMATIC VOLTAGE EQUALIZER

AVE High Voltage is designed for voltages up to 15000 volts. The unit is fitted with single-phase isolation transformers with controller regulated variable tapping. The AVE High Voltage will be custom sized for each installation, ensuring optimal sizing for the specific transformer energy rating and voltage class.
Due it's roughed design, the unit requires very little maintenance. When installed in front of a smaller sized transformer, it will protect downstream transformers from external events like lightning strikes, short circuits, and phase voltage imbalances.

Voltage class [Vac]	1500/5000/7500/15000
kVA rating [kVA]	-
Current rating I_{sec} [A]	-
Power quality meter	✓
Web interface	✓
Cloud solution	✓
Floor mounting	Optional
Weight [lbs/kg]	-
Size [Inch/mm] w x **h** x **d**	-
Distribution system	3ph Grounded/Ungrounded
Display size [Inch/mm]	10/254

High voltage Solution
(IEC 60038)

For reference, style and size dependent-on voltage class and capacity.

Eager to learn more?
Check-out our website For more information and contact details

PREMIUM 3 YEARS WARRANTY QUALITY

AMO

AUTOMATIC MOTOR OPTIMIZER

The Automatic Motor Optimizer is designed for protection of frequency-controlled motors. Harmonics and voltage spikes from frequency drives create a wide range of problems like reduced motor efficiency and drastically shortened motor life expectancy. These problems also limit the allowed cable length between motor and VFD. With the AMO installed, a significantly increased cable length is allowed between VFD and motor. The AMO extends motor life by balancing phase to ground voltages, allowing the drives and control system to operate reliably. The AMO is also suitable for use on smaller-scale distribution transformers up to 400kVA. In situations where available space for installation is a challenge, and the transformer sizes are small, the AMO is the perfect match.

Voltage class [Vac]	250/480/690
kVA rating [kVA]	100//200/400
Current rating I_{sec} [A]	100-920
Power quality meter	×
Web interface	×
Cloud solution	×
Floor mounting	Optional
Weight [lbs/kg]	-
Size [Inch/mm] w x h x d	-
Distribution system	3ph Grounded/Ungrounded/VFD
Display size [Inch/mm]	-

Extend motor life expectancy

For reference, style and size dependent on voltage class and capacity.

Eager to learn more?

Check-out our website For more information and contact details

PREMIUM QUALITY 3 YEARS WARRANTY

PQA

POWER QUALITY ANALYZER

EM Energy Solutions products is fitted with an advanced power quality analyzer (PQA), either integrated or as a standalone solution. The PQA includes a comprehensive energy management and power monitoring program. The system has trigger point waveform recording, which enables the operator to go back and lock at any trigger point to fully understand the sequence of events in the power system. Waveform capture function allows users to record and view ten cycles before and after a trigger point. Also, it has a local digital display, web interface, and cloud solution.

Simple hookup, connect 3-phase voltage supply, and flexible Rogowski coils to the meter from the distribution transformer secondary side.

Rogowski coils come in various current ratings and sizes.

Voltage class [Vac]	250/480/690
Current rating [A]	5-50000
Web interface	✓
Cloud solution	✓
Wall or floor Mounting	Wall
Weight [lbs]	8
Dimensions [Inch]	9,18x11,81x7,34
System	3ph Grounded/Ungrounded
Display type & size [Inch]	Digital display/3,5

PQA comes with NEMA 4X-style enclosure.

Eager to learn more?
Check-out our website For more information and contact details

PREMIUM 3 YEARS WARRANTY QUALITY

PQA

POWER QUALITY ANALYZER

Rogowski Coil Flexible Transducers

The PQA uses high flexible Rogowski coils for system current reading with an accuracy of 5%. This is a flexible solution when space is limited, or the conductor has an irregular shape. The Rogowski coil has a high grade of accuracy, with a current range of 5-50 000 Amps. The wide frequency range makes it an excellent choice in terms of harmonics and power quality readings. It comes in 4 standard length selections: 16, 24, 36 and 47 inches.

Model Type	RCT16	RCT24	RCT36	RCT47
Current rating [A]	5-50000	5-50000	5-50000	5-50000
Window diameter [Inch/mm]	4,17/106	7,01/178	10,67/271	14,53/369
Length [Inch/mm]	15,75	23,62	35,43	47,24
Accuracy [%]	5	5	5	5

Size and rating for various standard Rogowski models types

PQA Flexible Rogowski Coil.

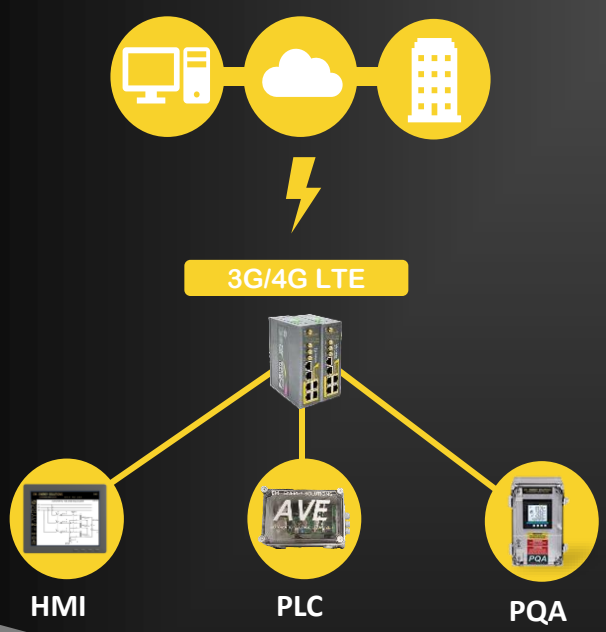
Eager to learn more?
Check-out our website For more information and contact details

PREMIUM 3 YEARS WARRANTY QUALITY

Industrial 4G Router

EM Energy Solutions voltage balancing products is fitted with state-of-the-art cellular router designed for applications requiring faultless connectivity. It provides a secure, reliable, real-time, and remote connectivity for our units. Software-defined, multi-carrier networking, dual SIM models, 802.11n, and global 2.5G/3G/HSPA+/LTE options make it easy to get connected from anywhere in the world.

TOPOLOGY



Topology showing AVE LAN can be reach from anywhere in the world.

Latest technology 4G Industrial Router.

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Check-out our website For more information and contact details

PREMIUM QUALITY 3 YEARS WARRANTY

CLOUD SOLUTION

EM Energy Solutions' cloud-based solution provides our customers with live and historical data from the Power Quality Analyzer. The cloud solution enables users to import, export, and analyze system data from anywhere in the world.

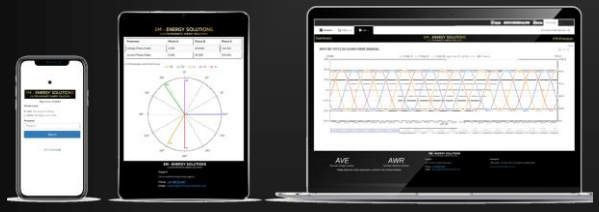
Data Storage
Power quality data such as voltage, current, power, energy, power factor, and demand is stored in 5-minute intervals. Users can download historical data for offline analysis.

Trigger Point Functionality
The system has multiple trigger point functionality, which enables the user to track specific events if this is needed. The Email notification functionality will notify when a trigger event occurs,

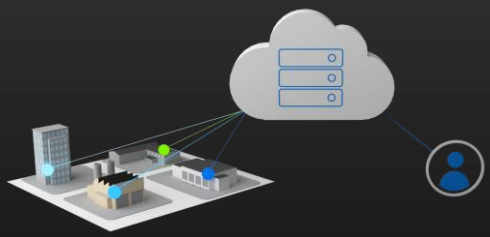
Analyze Your Data
Use user-friendly analytics tools such as trending, energy profile analysis, waveform logging, energy usage trends, demand analysis, and more.

Reports
Download and email reports to your colleagues for collaborative analysis.

Analyze data.



Available on a wide range of platform.



World wide access through the cloud solution.

Cyber secure.

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APPLICABLE INDUSTRIES

- Maritime Industry
- Oil & Gas
- Military and Defense
- Public Transportation Buildings
- Industrial Automation
- Communication Systems
- Paper Mill Industry
- Water Treatment Facilities
- Renewable Energy
- Power Plants
- Chemical Industry
- Automotive Industry
- Food Processing Plants
- Office Buildings
- Data Centers
- Housing Areas

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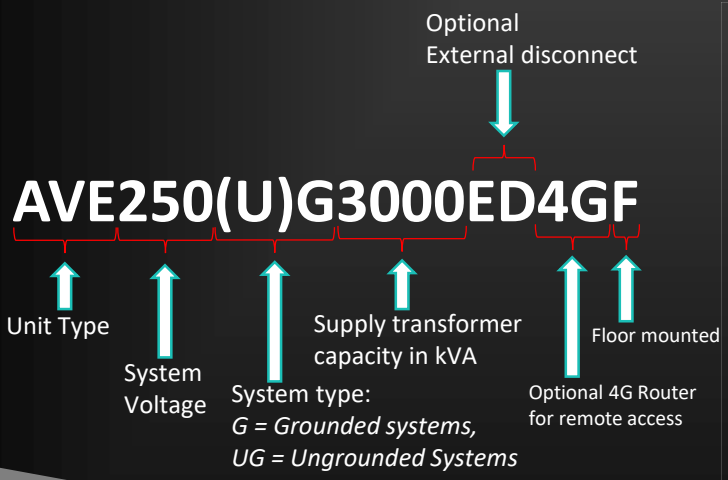
UNIT SIZING

For us to properly size your Automatic Voltage Equalizer, our engineers need you to answer a couple of simple questions:

- What is the system phase to phase voltage?
- Available space for installation?
- Type of system, grounded, ungrounded, resistor grounded etc.?
- Distance from Transformer to preferred installation location. Ideally, AVE should be installed as close as possible to transformer secondary side.
- What is the power rating in kVA of the supply Transformer? (If you don't know the kVA rating, the secondary side main circuit breaker rating can give an indication by calculating the kVA using the formula below.

$$\frac{Circuit\ Breaker\ Rating\ \ in\ amps * square\ root\ of\ 3}{1000}$$



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UNIT SIZING

AVE (Auto Variable Transformers) Model Selection
AVE model is selected based on system voltage and transformer kVA

3-Phase voltage [Vac]	Design Capacity [kVA]	Amperage of Distribution system [A]	Cabinet Size WxHxD [Inch/mm]	AVE model number G: Grounded System UG: Ungrounded System
250	3000	6900	31,5×47,2×15,8/800x1200x400	AVE250(U)G3000
250	6000	13800	31,5×47,2×15,8/800x1200x400	AVE250(U)G6000
480	3000	3600	31,5×47,2×15,8/800x1200x400	AVE480(U)G3000
480	6000	7200	31,5×47,2×15,8/800x1200x400	AVE480(U)G6000

ED: External Disconnect, 4G: 4G Router, F: Floor mounted.

AVE – FIXED Model Selection
AVE model is selected based on system voltage and transformer kVA

3-Phase voltage [Vac]	Design Capacity [kVA]	Amperage of Distribution system [A]	Cabinet Size WxHxD [Inch]	AVE model number G: Grounded System UG: Ungrounded System
250	1200	2700	23,6×39,37×15,8/600x1000x400	AVE-F250(U)G1200
250	3000	6900	31,5×47,2×15,8/800x1200x400	AVE-F250(U)G3000
250	6000	13800	31,5×47,2×15,8/800x1200x400	AVE-F250(U)G6000
480	1200	1400	23,6×39,37×15,8/600x1000x400	AVE-F480(U)G1200
480	3000	3600	31,5×47,2×15,8/800x1200x400	AVE-F480(U)G3000
480	6000	7200	31,5×47,2×15,8/800x1200x400	AVE-F480(U)G6000
690	1200	1000	23,6×39,37×15,8/600x1000x400	AVE-F690(U)G1200
690	3000	2500	31,5×47,2×15,8/800x1200x400	AVE-F690(U)G3000
690	6000	5000	31,5×47,2×15,8/800x1200x400	AVE-F690(U)G6000

ED: External Disconnect, 4G: 4G Router, F: Floor mounted.

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UNIT SIZING

AVE - Mini Model Selection
AVE model is selected based on system voltage and transformer kVA

3-Phase voltage [Vac]	Design Capacity [kVA]	Amperage of Distribution system [A]	Cabinet Size WxHxD [Inch]	AVE model number G: Grounded System UG: Ungrounded System
250	400	900	23,6x29,9x13,77/600x760x350	AVE-M250(U)G400
250	800	1800	23,6×39,37×15,8/600x1000x400	AVE-M250(U)G800
250	1200	2700	23,6×39,37×15,8/600x1000x400	AVE-M250(U)G1200
480	400	480	23,6x29,9x13,77/600x760x350	AVE-M480(U)G400
480	800	950	23,6×39,37×15,8/600x1000x400	AVE-M480(U)G800
480	1200	1400	23,6×39,37×15,8/600x1000x400	AVE-M480(U)G1200
Single phase unit [Vac]				
250	200	410	14,96x23,62x13,78/380x600x350	AVE-1M250(U)G200
480	200	800	14,96x23,62x13,78/380x600x350	AVE-1M480(U)G200

ED: External Disconnect, R: WAN-Router, 4G: 4G Router, F: Floor mounted, PQA: Power Quality Analyzer.

AVE – High Voltage Model Selection
AVE model is selected based on system voltage and transformer kVA
For correct sizing and dimensioning of high voltage units please contact our engineering department

3-Phase voltage [Vac]	AVE model number
1500	AVE-HV1500/(kVA)
5000	AVE-HV5000/(kVA)
7500	AVE-HV7500/(kVA)
15000	AVE-HV15000/(kVA)

ED: External Disconnect, 4G: 4G Router, F: Floor mounted.

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"We cannot solve our problems with the same thinking we used when we created them." -*Albert Einstein*

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