Protection & Control

1 I 2008

We keep
electricity running

Vamp Ltd

Vamp Ltd specialises in protection relays, arc protection systems and measuring and monitoring systems for power distribution networks. The company's Vamp medium-voltage and sub-transmission protection relays are used in a number of applications, from overhead line feeders and substations to power plants and industrial power systems. Their unique integrated arc fault protection functionality enhances the safety of both people and property and has made Vamp a leading brand in arc protection worldwide. The company's measuring and monitoring systems cover a wide range of measurement functions for industry and utility applications and for secondary power distribution substations.

With its headquarters in Vaasa, Finland, Vamp has an international network of subsidiaries and partners. R&D operations are based on close cooperation with customers and leading universities and research institutes. Customer and market requirements are closely followed and efficiently transferred into product features in terms of accuracy, user-friendliness and easy communication.

All Vamp products meet the latest international standards and regulations. They are flexible and widely customisable and come with 24-hour after sales support. They are also based on a certified quality system according to ISO 9001:2000.

ISO 9001
BUREAU VERITAS
Certification

VAMP
+358 20 753 3264
24 h
Technical Support

Vaasa Electronics Group

VAMP

Vamp Ltd, Vaasa
P.O.Box 810, FI-65101 Vaasa
Visiting address: Yrittäjänkatu 15, Vaasa, Finland
Tel: +358 20 753 3200, Fax: +358 20 753 3205

Vamp Ltd, Vantaa
Postal and visiting address:
Äyritie 8C, 5th Floor, 01510 Vantaa, Finland
Tel: +358 20 753 3200, Fax: +358 20 753 3205

Vamp Ltd
Email: vamp@vamp.fi
www.vamp.fi




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Jarkko Holmlund, product manager for the Vamp 50 protection relay.
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Protection & Control

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The magazine for business partners of Vamp Ltd

Editor-in-chief: Pekka Hämäläinen, pekka.hamalainen@vamp.fi

Editorial board:
Erkki Raunio, Pekka Hämäläinen, Merja Pohtola, Anneli Frantzén

Editorial assistance by Impact Communications
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Tommi Evilä, holder of the Finnish long jump record. Tommi made his record jump of 819 cm in 2005. He also took third place in the 2005 IAAF World Championships in Athletics, which were held in Helsinki.

Photo by permission of Tommi Evilä and Lehtikuva Oy.

Refined technique

New technology
– the basis for future growth

Vamp Ltd's operations continue to expand. All key markets recorded growth in sales and revenues for both protection relays and arc protection systems during 2007. Growth in the arc protection segment was especially rapid with a 50% increase in volume. There were projects on all continents with major orders from Europe, Asia and the Middle East. In light of this positive development, we are proud to say that Vamp is today one of the top ten suppliers in its league globally.

Strong research and product development have always been the basis of our growth. This was proven once again in 2007 by a number of innovative new products and technology solutions. And new market introductions will continue this year. In April we will launch our new technology platform, the result of a long-term effort by our R&D team. The new technology will initially add to our existing product offering. It includes many innovative solutions, such as a new mechanical structure, a new type of processor and a new outlook. The first products based on the platform are the Vamp 50 series protection relays described in more detail elsewhere in this magazine. The Hanover exhibition in April will mark the kick-off for worldwide marketing of the series, which will gradually be completed with new products. Another important task for our R&D team will be further implementation of the IEC 61850 and the Ethernet communication standards to their full extent.

Growth and strengthening of international operations will continue to be our key targets in the future. The worldwide relay market is estimated at 750 million euros and the arc protection market at 30 million euros and we are determined to take our fair share of both segments. We aim to double our turnover during the next few years and to expand our network with several new partners annually. We will also continue to develop our technical support services and strengthen the presence of the parent company internationally.

Jerker Kullberg
President, Vamp Ltd

The Vamp 50
– a new protection relay for high-volume markets

The year 2008 will witness the launch of the Vamp 50, a new low-end type of protection relay in the Vamp product range. Based on a proven technology concept, the Vamp 50 was developed in close cooperation with customers.

The introduction of Vamp 40 feeder and motor protection relays in early 2006 was a big success for Vamp Ltd and brought new business opportunities and customer relationships in the high-volume market segment.

Encouraged by this positive trend and feedback, Vamp Ltd decided to continue on the chosen path by developing a completely new range of low-end relays – the Vamp 50 series. The Vamp 50 will naturally bring more benefits in terms of complementary products to our customers and will also create new business opportunities.

The Vamp 50 overcurrent and earth fault protection relay is the first product in the new series.

Jarkko Holmlund, product manager for the Vamp 50.

Picture 1. Vamp 50 local HMI elements

Vamp 50 – Main features

- Comprehensive feeder protection
- Circuit breaker control (local & remote)
- Primary equipment condition monitoring
- Power quality assessment
- Ultra-fast arc protection (< 7ms) as a standalone configuration or as part of the Vamp 221 arc protection system
- Extensive communication support
- Easy handling and installation
- Flexible I/O option concept
- Flexible communication option concept
- Native IEC 61850 supporting GOOSE
- Easy to configure via USB port in front
- Free-of-charge Vampset setting and configuration SW connectivity

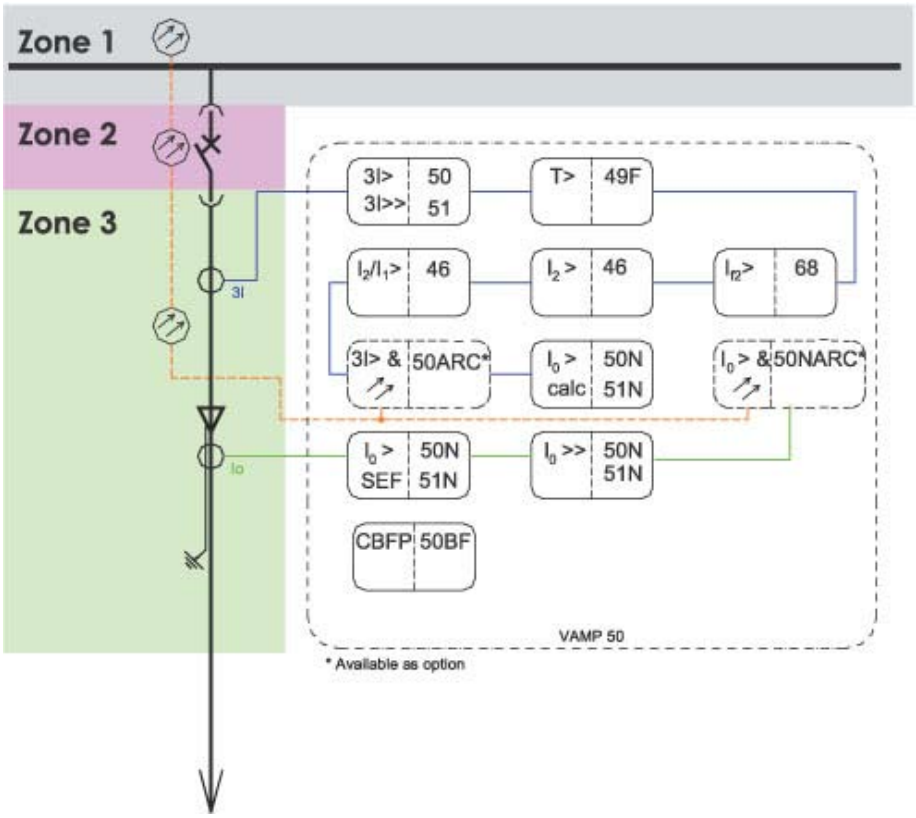


Figure 1. Complete feeder protection functionality and support for three arc flash protection zones (busbar, circuit breaker and cable compartment).

The first product of the new series is the Vamp 50 overcurrent and earth fault protection relay developed to cover the specific requirements of basic protection for OEM, utility and industrial applications. Thanks to its cost-effective and flexible design, the Vamp 50 is an excellent alternative for low-end protection applications worldwide.

The Vamp 50 arc option is designed to provide the means for extremely rapid exchange of light and current information with other Vamp 50 devices or the Vamp 221 arc protection system via a modular inter-station bus in the substation. In total, 3 supervised arc point sensors can be connected to the arc option module (figure 1). Trip contact activation is accomplished in less than 7 ms from the occurrence of an arc flash fault.

User-friendliness has always described Vamp products. The Vamp 50 will not be an exception. A great deal of effort has gone into further development of operational features.

As a result, Vamp 50 will offer the following advantages:

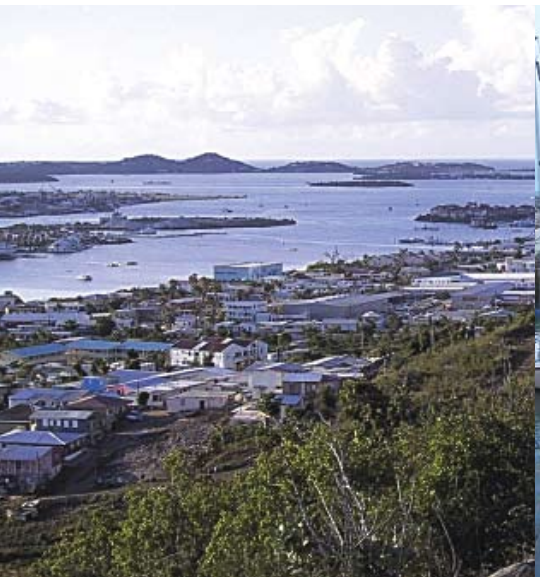
– Completely new HMI with clear middle-sized display and 8 LEDs to indicate the necessary information to the operator, 2 user-defined function buttons and a USB port for local configuration.

– Multilingual support on HMI made available by Unicode display and user configurable legend texts for the LEDs and function buttons.

– Flexible I/O option concept, including additional DI/DO channels or complete arc protection functionality or mA output. All functionality related to I/O options is self-adaptive.

– Flexible communication option concept, including interface to support RS 232, RS 485, fiber optics, Ethernet and IEC 61850. All functionality related to communication options is self-adaptive.

The dimensions of the Vamp 50 are perfect for retrofits since the panel door cutout properties are the same as or similar to many relays that were rectified 20-30 years ago.



Great market potential

in the Middle East, Africa and the Americas

Juha Arvola
Sales Director

We stepped up our marketing effort in the Middle East in 2007. We have also completed a market survey and an action plan for the region. The survey shows that both the Vamp product portfolio and the company strategy suit this market very well. Many customers emphasized the need for constant, quick and personalized support. And in addition to cost-effectiveness and high-quality products, this is exactly where Vamp's competitive edge lies. New technical features such as integration of arc protection in protection relays are also seen as interesting solutions in this market area.

Marketing and sales take off in the Middle East

Participation in the Middle-East Electricity Exhibition (MEE) 2008 in Dubai was the first major marketing event for us in the region and the customer response was very encouraging. A number of time-demanding product approval processes for key customers are now underway as are expansion and development of the sales network. Last year we also succeeded in expanding our market share in Iran where we have already been present for a number of years through a qualified local partner. The Vamp 40 has proven to be a very successful product on this market.

Expanding business in South Africa

We have been able to hold our market position and to gain new customers in South Africa. The latest success is a frame contract for the supply of arc flash protection to Eskom power stations. This year we are going to launch some exciting new products to widen our offering; they will further boost our position in this important marketplace. Together with the Vamp 259, a recently launched sub-transmission distance relay, the new products will also support our growth strategy throughout the North African market.

Increasing demand for arc protection systems in North America

North America is an increasingly interesting market place for us. Workplace safety standards like the NFPA 70 E and the coming Canadian adaptation CSA-Z462 will increase investment in a safer arc flash hazard approach. As a leading supplier of arc protection systems, Vamp provides a solid solution for reducing arc flash incident energy levels. Our growing number of North American users demonstrates that arc protection is now widely accepted as a solution for complying with more stringent safe working practices. And Vamp's solution also provides the highest degree of equipment protection – a feature that is highly appreciated by our safety-oriented customers.

Strong growth in Latin America

In Latin America, our presence has been further strengthened by hiring our own local professionals and expanding our sales network. This development resulted in over 20% growth in turnover in 2007. Our investments in the region continue and even stronger growth in key economies like Brazil is foreseen for 2008.

Busy times for Vamp in Asia & the Pacific

Risto Lehto
Regional Sales Director
Asia & Pacific

Asia & the Pacific is a major export area for Vamp. After years of steady growth, however, a minor slowdown was apparent last year in some key markets. In response, we took immediate action to strengthen our position, especially in the enormous markets of China and India. In China we made significant changes at the beginning of the year by opening our own office in Shanghai and employing a skilled professional to lead our efforts there. Also, we can already see significant benefits from targeting more segments and areas with new local partners. In India our main thrust is in market research and in building up a multi-channel network by negotiating with local partner candidates.

Marketing efforts pay off

For several years, South Korea has been one of our biggest markets and Vamp is already enjoying high brand recognition there. Our latest actions on this market include introduction of arc protection to various customers, both for domestic and export projects. Interest was very high in this field last year and we expect it to remain so this year. In Malaysia, a breakthrough was made last year in arc protection and at the moment we are in the process of obtaining approval for our protection relays. In Thailand, Vamp has gained a leading market position in arc protection and also achieved steady sales of protection relays. Indonesia, where we have landed contracts for some prestigious projects, is one of the fastest growing markets for protection relays. In Australia, Taiwan and Japan we have a stable market position with well-established partners. Both the mining industry in Australia and marine panel builders in Japan have recognized Vamp as a desirable brand and accepted supplier. In the future we will also focus on Vietnam as a future growth market and we have already taken the initial steps needed to achieve a market position there.

Local partners in key position

Vamp is a well-known brand all over Asia today thanks to the commitment and performance of our local partners and their efforts together with the parent company. According to our growth strategy, local partners will play an increasingly important role in achieving our business targets. Hence selecting and developing value-adding partners will be emphasized in the future. Vamp Ltd will take an active role in reviewing and developing local activities, and consequently, authorized partners will gain more from Vamp Ltd with regard to certification and marketing support. Our market development plan and our partner meetings will provide the communication tools necessary for mutual understanding on each market.

Demand for arc protection grows rapidly in Europe

Marko Kuokkanen
Regional Sales Director
Europe

The past year marked a breakthrough for Vamp in large arc protection projects. Siemens won the contract to modernise the Tusimice Power Station in the Czech Republic and Vamp 221 systems were chosen for arc protection in the medium voltage switchgear. The Areva NP nuclear power plant project was also a significant step forward for Vamp and opened an entirely new sector of the market for us. The popularity of arc protection as a standard has continued to grow and will do so in the future as well. The growth rate has in fact exceeded our expectations. We believe that new nuclear power projects and modernisations of existing installations will rapidly increase demand for our arc protection systems in this exacting segment.

Expanding the partnership network

In protection relays we have achieved a significant position in the Estonian, Lithuanian and Romanian markets with our 200 series feeder managers and our sales in Germany have also proceeded favourably. One of the engines for this growth has been the Vamp 40 relay, for which Siemens has been the largest single customer.

In Europe, building a sales organization will be the biggest challenge in the future. In keeping with our strategy, Vamp will grow along with its partners, and steady growth in Europe can only be achieved by expanding our partnership network. Our customers are demanding more from us and we in turn must constantly demand more from ourselves and from our representatives. Our goal is to meet and even exceed the expectations of our customers. As our sales in Europe grew last year by more than 50%, we are definitely on target strategically.

Vamp 50 launch at the Hanover exhibition

The Hanover fair is an important show window for our company and this year it is even more significant because the new-generation Vamp 50 protection relay will be on display there for the first time. The latest technical solutions and a sophisticated appearance will ensure the success of the Vamp 50 for a long time. In the coming years our product family will otherwise expand and undergo renewal. User-friendliness and cost effectiveness will remain, however, the hallmarks of Vamp products.

Intermittent transient earth fault protection

Seppo Sauna-aho
R&D Senior Application Engineer

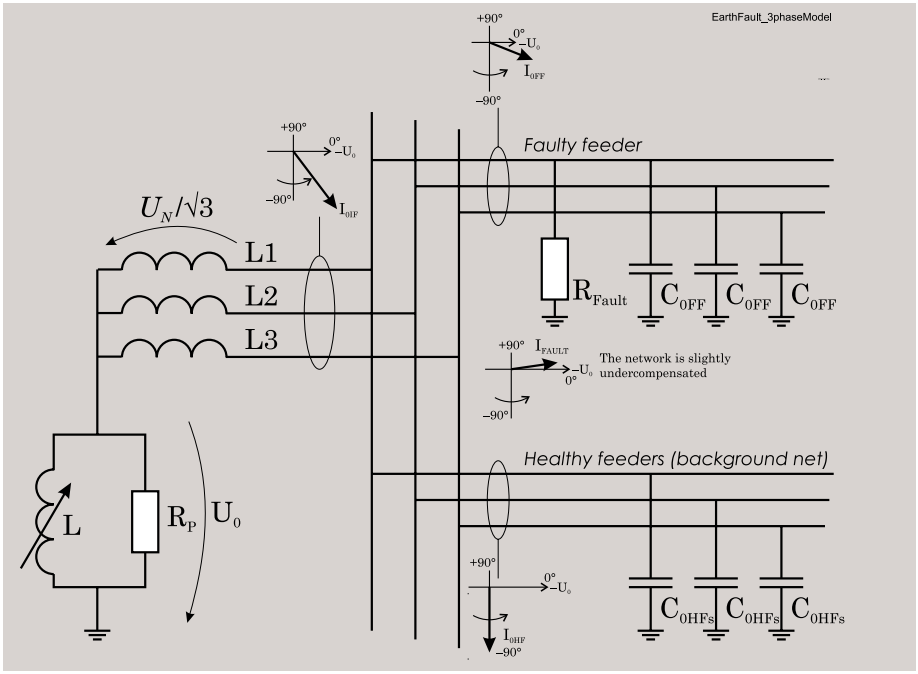


Figure 1. Compensated network.

The directional intermittent transient earth fault protection is used to detect short intermittent transient faults in compensated cable networks (figure 1). The transient faults are self-extinguishing at a zero crossing of the transient part of the fault current IFault and the fault duration is typically only 0.1 ms ... 1 ms.

Such faults may be caused by old cables with degraded water tightness. The earth fault resistance of cable earth faults are typically only a few ohms and the amplitude of the measured residual fault current spikes are high – up to several hundred amperes. Figure 2 shows a typical transient earth fault current pulse measured at the feeding substation (I_{0FF}).

Although a single transient fault usually self-extinguishes within less than one millisecond, in most cases a new fault occurs when the phase-to-earth voltage of the faulty phase has recovered (figure 3). While recovery in a fully compensated network may take hundreds of milliseconds or more (figure 4), in under-compensated networks (figure 5) or over-compensated networks (figure 6) the next fault may already occur within the same or the next half cycle. Such short intermittent faults cannot be correctly identified with the normal directional earth fault function using only the fundamental frequency components of I_0 and U_0.

Over a longer period, such repetitious transient faults can develop into steady earth faults that a normal directional earth fault function will eventually be able to detect.

However, in a compensated network a sufficiently repetitious transient fault will keep up a continuous residual voltage as in figures 5 and 6; this will eventually activate the U_0> backup protection. Unless the faulty feeder with the transient fault has been detected and isolated, the incoming feeder of the substation will trip unselectively.

Direction algorithm

The function is sensitive to the instantaneous sampled values of the residual current and residual voltage. The selected voltage measurement mode has to include a direct $-U_0$ measurement.

When both I_0 peak value and the fundamental frequency value of U_0 exceed their settings, the samples of both signals around the I_0 peak are copied to a work buffer. If the I_0 peak

sample value exceeds the peak value of the calculated fundamental frequency component, the signals are processed with a patent pending correlation algorithm, which indicates the direction of the fault.

I_0 pick-up sensitivity

The sampling time interval of the relay is 625 µs at 50 Hz (32 samples/cycle). The I_0 current spikes can be quite short compared with this sampling interval. Fortunately the current spikes in cable networks are high and while the anti-alias filter of the relay is attenuating the amplitude the filter also makes the pulses wider. Thus, when the current pulses are high enough, it is possible to detect pulses with a duration of less than twenty per cent of the sampling interval. Although the measured amplitude can be only a fraction of the actual peak amplitude, it does not disturb the direction detection because the algorithm is more sensitive to the sign and timing of the I_0 transient than to the absolute amplitude of the transient.

Co-ordination with U_0> back up protection

Especially in a fully compensated situation, as in figure 4, the residual voltage backup protection stage U_0> for the bus may not release between consecutive faults and the U_0> may eventually make an unselective trip if the intermittent transient stage I_{0T}> does not operate fast enough. The actual operation time of the I_{0T}> stage is very dependent on the behaviour of the fault and the intermittent time setting. To simplify the co-ordination between U_0> and I_{0T}>, the start signal of the transient stage I_{0T}> in an outgoing feeder can be used to block the U_0> backup protection.

Co-ordination with the normal directional earth fault protection based on fundamental frequency signals

The intermittent transient earth fault protection stage I_{0T}> should always be used together with the normal directional earth fault protection stages $I_0\varphi$>, $I_0\varphi$>>. In the worst case, the transient stage I_{0T}> may detect the start of a steady earth fault in the wrong direction, but not trip because the peak value of a steady state sine wave I_0 signal must also exceed the peak value of the corresponding base

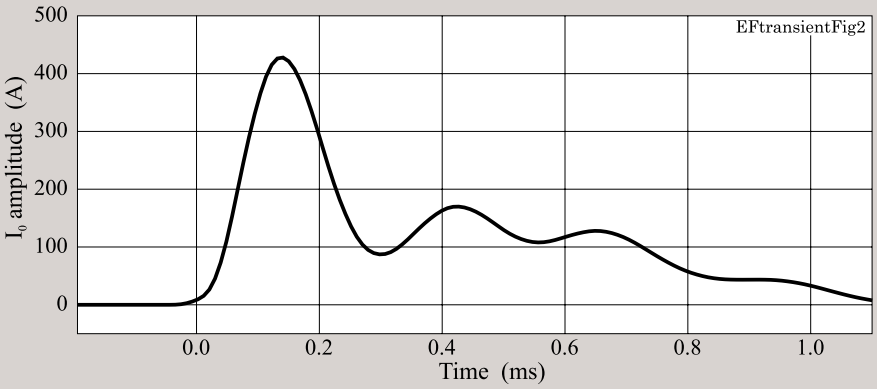


Figure 2. A typical transient earth fault current pulse.

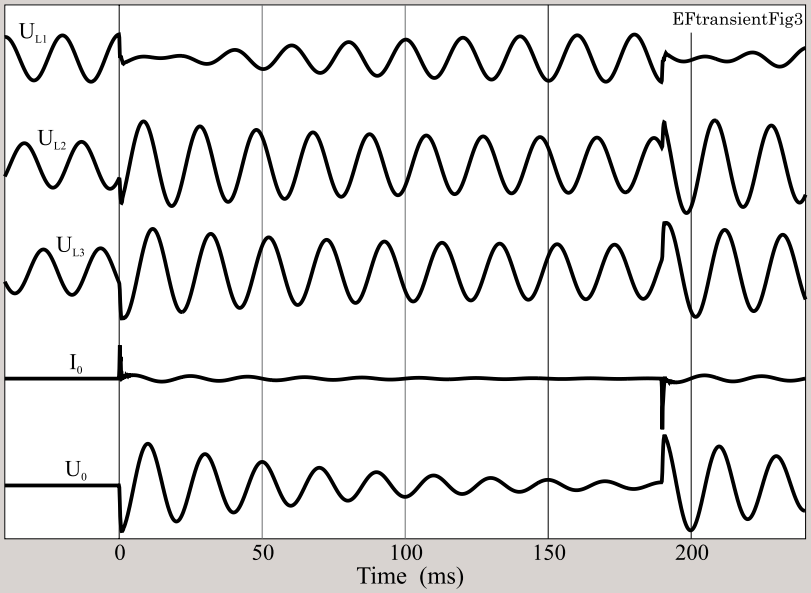


Figure 3. Typical phase to earth voltages, residual current of the faulty feeder and the zero sequence voltage U_0 during two transient earth faults in phase L1. In this case the network is compensated.

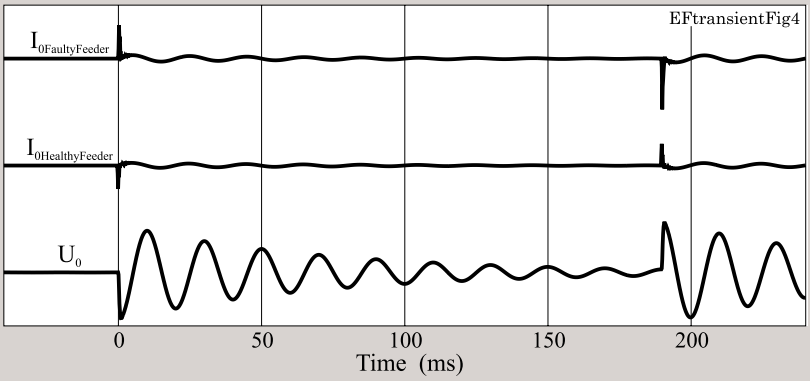


Figure 4. A typical residual current in the faulty feeder, one of the healthy feeders and the zero sequence voltage U_0 during a transient earth fault in a fully compensated (100 %) network.

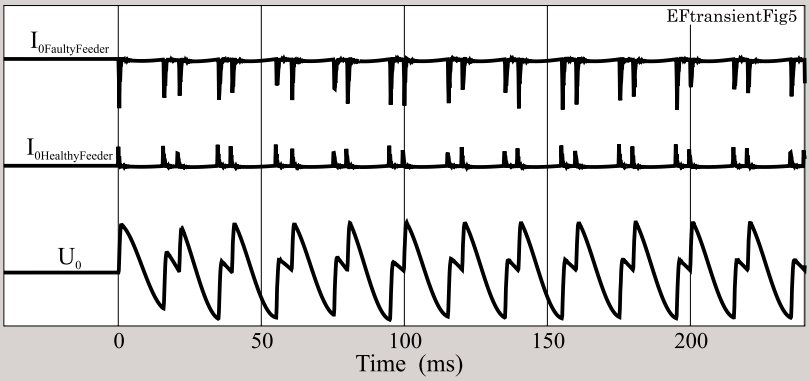


Figure 5. A typical residual current in the faulty feeder, one of the healthy feeders and the zero sequence voltage U_0 during a transient earth fault in an under- compensated (30 %) network.

frequency component in order to make the I_{0T}> trip.

The operation time and U_0 setting of the transient stage I_{0T}> should be higher than the settings of any $I_0\varphi$> stage to avoid any unnecessary and incorrect start signals from the I_{0T}> stage.

Auto reclosing

The start signal of any $I_0\varphi$> stage initiating auto reclosing (AR) can be used to block the I_{0T}> stage to avoid the I_{0T}> stage with a long intermittent setting to interfere the AR cycle in the middle of the discrimination time.

Usually the I_{0T}> stage itself is not used to initiate any AR. For transient faults, the AR will not help because the fault phenomena itself already includes repeated self-extinguishing.

Intermittent time

Single transient faults makes the protection to pick up, but do not cause a trip if the time between two successive faults is enough long for the stage to release and to reset the operation time counting. However, when the faults do occur often enough, such irregular faults can be cleared using the intermittent timer feature.

When a new fault happens within the set intermittent time, the operation delay counter is not cleared between adjacent faults and the stage will eventually trip. A single transient fault is enough to start the stage and increase the delay counter by 20 ms. For example, if the operating time is 140 ms and the time between two peaks does not exceed the intermittent time setting, then the seventh peak will cause a trip (figure 7).

Operation time setting and the actual operation time

When the algorithm detects the direction of the fault outwards from the bus, the stage picks up and the operation delay counter is incremented with 20 ms, and a start signal is issued. If the time between successive faults is less than 40 ms, a trip signal is issued when the operation time is full. Figures 5 and 6 are examples of fault types that provide such straightforward operation delay counting.

When the time between successive faults is more than 40 ms (figure 4), the stage releases between the faults and the delay counting is restarted from zero for every single fault and no trip is issued. For such cases, the intermittent setting can be used. Figure 7 shows an example of how the intermittent setting works. The upper start and trip signals have an intermittent setting of zero. The lower signals are another case with an intermittent setting of 0.12 s. The operation time setting is 0.14 s in both cases, which corresponds to seven 20 ms time slots with faults.

The time between the second and the third fault exceeds the release time + intermittent time. Thus the operation delay counter is cleared in both cases: with an intermittent time of zero and with an intermittent time of 0.12 s.

The fourth and the next faults occur after the release time but within the release time + the intermittent time.

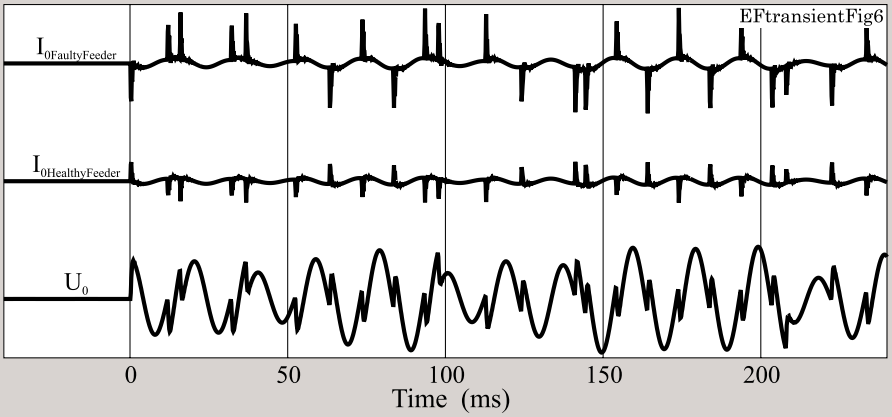


Figure 6. A typical residual current in the faulty feeder, one of the healthy feeders and the zero sequence voltage U_0 during a transient earth fault in an over-compensated (170 %) network.

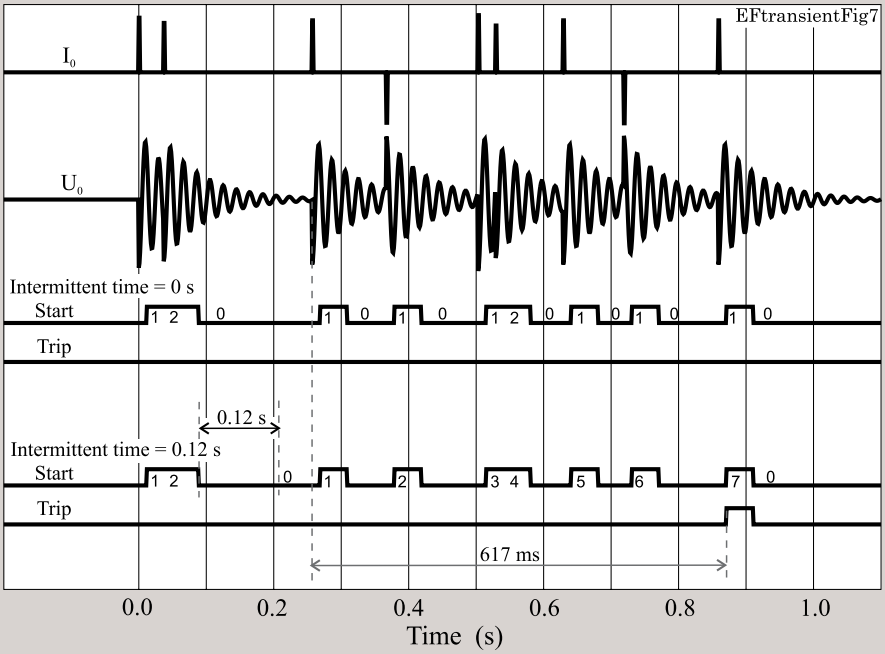


Figure 7. Effect of the intermittent time parameter. The operation delay setting is 0.14 s = 7x20 ms. The upper start and trip status lines are for a case with the intermittent time set at zero. No trip will occur. The lower start and trip status lines show another case with an intermittent time setting of 0.12 s. In this case a trip signal will be issued at t=0.87 s.

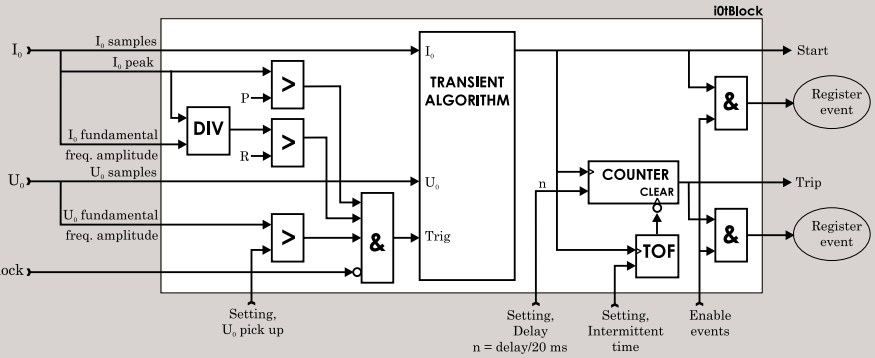


Figure 8. Block diagram of the directional intermittent transient earth fault stage I_{0T}>.

Thus the operation delay counter is advanced at every fault when the intermittent time setting is more than 100 ms (the lower status lines in the figure) and a trip signal is eventually issued at t=0.87 s.

When faults occur at intervals of more than 20 ms, every single fault will increment the operation delay counter by 20 ms. In this example the actual operation time starting from the third fault will be 617 ms although the setting was 140 ms. If the intermittent setting had been 0.2 s or more, the first two faults would have been included and a trip would have been issued at t=0.64 s.

The intermittent transient earth fault protection is available in Vamp 40, 245, 230, 255, 257 and 259 units having a firmware greater than v.6.28.

Vamp representative office established in Denmark

At the beginning of April a Vamp representative office was established in Denmark. The new company, Vamp Protection Systems APS, will focus on marketing and sales of Vamp products to the international wind turbine industry. Another focus area will be the utility, power plants and marine segments in Denmark. The ownership of the company is divided between Vamp's long-time representative in Denmark, Dansk Styrningsteknik AS, Vamp Ltd and the management. Mr. Troels Davidsen has been appointed President of the company. He has earlier been responsible for sales and marketing of Vamp products at Dansk Styrningsteknik AS. Mr. Jens B. Jensen has been appointed sales director. He has a solid background in sales and marketing from various industrial segments in Denmark.

Centre for wind power operations

Vamp Protection Systems APS will benefit from Denmark's position as the global hub for wind power. The world's leading manufacturers and consultants in the industry are within three hours' driving distance. Wind power is the fastest growing energy source in the world today. The reason for this dramatic growth is the increased focus on renewable energy sources that do not contribute to global warming.

Furthermore, development of wind turbine technology has brought to the market standard turbines in categories of 3-4 MW with tower heights of up to 100 meters and wing lengths of up to 65 meters. Large wind farms with many turbines located offshore can have power outputs like those of medium-sized power plants. The world's largest offshore wind farm with a power output of 180 MW is located in the North Sea, at Horns Rev, west of Denmark.

Danish world record in wind power

Since the early 1970s wind turbines have been designed and installed in Denmark and the country is considered a world centre for development and production of wind turbines. Today, some 2000 units cover 25% of Denmark's annual power demand. This is a world record – no other country has such a high percentage of wind energy connected to its national power grid. At the beginning of 2008, the Danish government decided to install two new offshore wind farms of 200 MW each and to install further wind farms onshore. This will increase the wind power connected to the Danish grid by 1200 MW.

Troels Davidsen,
President of Vamp Protection Systems APS

In Denmark 21,000 people are working in the wind turbine industry, mainly in manufacturing and research & development. This represents 50% of worldwide production. All leading consultants and wind turbine design companies are also present in Denmark.

Vamp Protection Systems APS
Stigborgvej 36 ST.
DK-9400 NR.
Sundby, Denmark

Vamp Representative Office Shanghai
10/F, Central Plaza, No. 381 Huai Hai Road (C)
Shanghai, P. R. China
ZIP : 200020

Tel: +86 21 639 15177
Fax: +86 21 639 16377
Email: jason.ma@vamp.fi

Vamp proceeds to full ownership of their Shanghai representative office

In line with its expanding operations Vamp Ltd. has acquired full ownership of their representative office in Shanghai, China. The office will focus on development of Vamp's partnership network and customer support in China. Mr. Jason Ma has been appointed manager of the office with responsibility for coordination of sales and marketing and technical support to customers. Mr. Risto Lehto has been appointed country manager.

As a part of the reorganization, Vamp Ltd has signed a significant distribution agreement with Shantou Zhongyeda Electrical Appliances Co., Ltd for sales and marketing of Vamp protection relays in China. A contract has also been signed with Shanghai Flying Power to target project business and sales of all Vamp products in a number of specified markets.

Of Vamp Ltd's existing partners, Hong Kong Cheaho remains the biggest distributor of Vamp arc protection systems. To continue and further strengthen cooperation in certain segments and export projects worldwide, the contract with Jiangsu Lanbo Power Co. has been renewed. In addition to the existing network, new distributors will also be selected in various segments and areas in the future

According to Mr. Jerker Kullberg, president of Vamp Ltd, acquisition of the representative office is an important step that will further strengthen Vamp's presence in China. "Business growth has made it necessary to further expand our partnership network since it is essential to maintain good support in both technology and marketing with direct coordination by the headquarters. China is and will be one of Vamp's major export markets," he summarizes.

Mr. Risto Lehto, regional sales director and country manager, emphazises the new setup as a part of customer service. "Since 2002, we have had steady growth in China, especially in the arc protection segment. Now the protection relay business is also increasing and in this situation, despite having very reliable and good local partners, it is important for us as the manufacturer to ensure smooth cooperation and technical support to both partners and end customers. We also aim to strenghten the Vamp brand with active marketing efforts," Mr. Lehto explains.

Over the years, Vamp has gained a leading role in the Chinese arc protection market and has at the moment more than a 70% share of the power plant market. Other heavy industries like metallurgy, especially aluminium and steel manufacturing, increasingly specify arc protection for their new and retrofit projects. Utilities also appreciate the benefits of arc protection. Vamp protection relays are of great interest to these customers because of their integrated arc protection and unique features.

APPOINTMENT

Mr. Jason Ma, B.Sc. Eng., has been appointed manager for the Vamp representative office in Shanghai. His area of responsibility comprises coordination of Vamp business in mainland China including sales, projects and customer support. Before joining Vamp he was with the technology company Naeg Ltd.

Vamp appoints JNP Tech Pte. Ltd. as its distributor in Vietnam

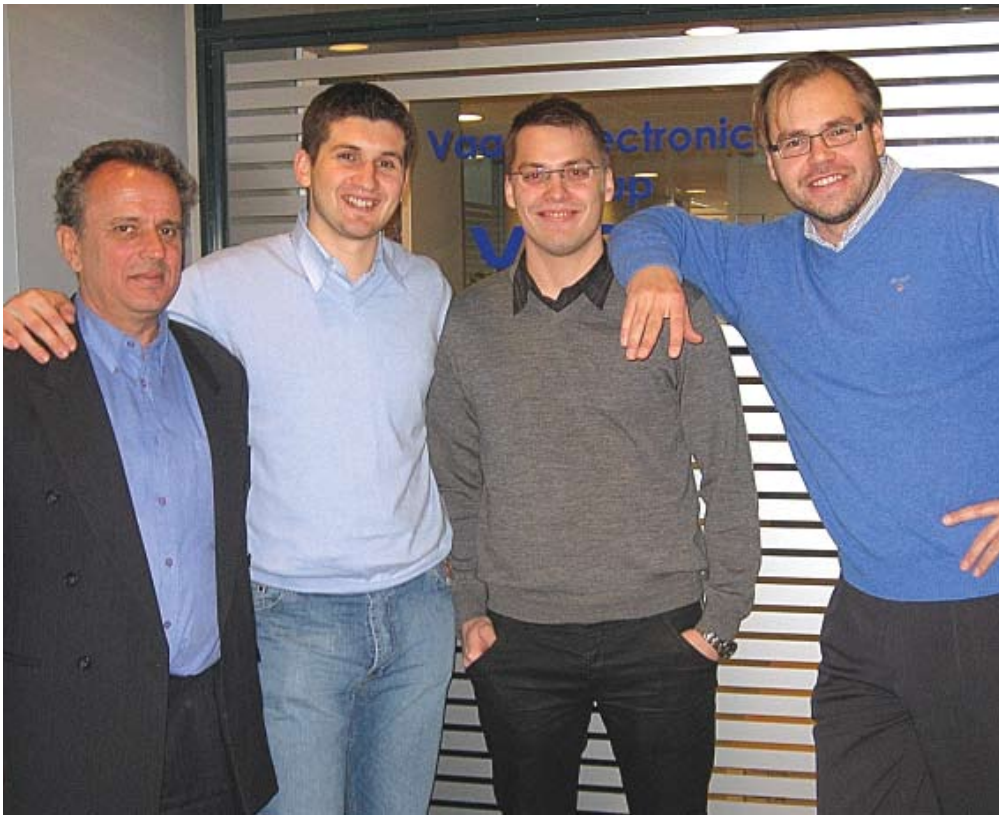
The JNP Tech team with Mr. Paul Jeong in the middle.

Vamp has signed an agreement with JNP Tech Pte. Ltd. for distribution of Vamp products in Vietnam. The agreement took effect at the beginning of March and includes sales, marketing and support for all Vamp products throughout Vietnam. The engineering company JNP Tech is based in Ho Chi Minh City and currently employs six specialists. Mr. Paul Jeong, the company's managing director, is very confident about Vamp's success in his country. "The Vietnamese market is growing rapidly and there is a lot of potential for the Vamp-type of versatile technology in both the protection relay and arc protection sectors," he says.

Kosovo Energy Corporation retrofits with Vamp 255

Kosovo Energy Corporation, KEK, has chosen Vamp 255 feeder manager relays for their substation retrofit projects. The orders comprise 35 units of the basic Vamp 255. In addition to the internal communication cards, the choice of equipment will also permit later inclusion of external communication modules after the decision on the possible communication protocol has been made. This was one of the reasons why KEK decided to select Vamp relays for their next generation installations. In January 2008, KEK representatives completed a training course on Vamp protection relays. Thanks to the training, KEK will be able to commission the relays themselves. All relays will be operational by spring 2008.

With some 370,000 customers, Kosovo Energy Corporation is the main electric utility in the Kosovo area. The company has a distribution network of almost 14,000 km and uses three different voltage levels – 35/20/10kV – for distribution. Networks are mainly overhead lines and there are more than 60 medium voltage substations.



KEK representatives and their hosts in connection with the training course. From the left, Mr. Basri Gashi, protection supervisor for the 110/10 kV electric network and Mr. Ardian Shala, engineer responsible for protection and measurement at KEK's 35/10 kV substations, Mr Jussi Vihersalo, sales engineer at Vamp and Mr Marko Kuokkanen, Sales Director, Europe.

Vamp 255s protect Venezuelan refineries

The refinery PDVSA Pefineria Puerto la Cruz of the Venezuelan petroleum company Petróleos de Venezuela, S.A. has selected Vamp protection relays for their El Chaure substation. Since 2005, 60 Vamp 255 units with integrated arc protection have been delivered to the plant, the latest at the beginning of this year. The Vamp 255 was chosen for the project because of the integrated arc protection function and user-friendliness.

AREC to choose Vamp 40 for high-voltage back-up

AREC, the Azerbaidžan Regional Electricity Company, has ordered 170 Vamp 40 protection relays as back-up units for their existing substations. The units will be used as 132 kV back-up and 20 kV primary overcurrent protection in the utility company's network in northern Iran. The contract was made through Vamp's local representative Runin FG and the deliveries were made at the end of last year. The choice of Vamp for the project was based on an advantageous quality/price ratio and on certifications from other utility companies in the region. Prior to the deliveries, the end customer's representatives, who visited both Vamp and Vamp's manufacturing partner Enics Finland Oy, made a quality audit.

Oulun Seudun Sähkö selects Vamp

The Finnish utility company Oulun Seudun Sähkö Verkkopalvelut Oy has equipped all their existing substations with Vamp arc protection systems. Since 2003, a total of 5 substations have been retrofitted with Vamp 221 arc protection systems in order to improve the protection degree and to extend the life cycle of the power distribution equipment.

Besides the retrofit program, Vamp feeder managers have been selected for the company's new substations. Vamp systems are part of Vaasa Engineering Oy's deliveries; one of the latest of these is for the substation in Oulunsalo, south of the city of Oulu. Commissioned in November 2007, the 110/20 kV substation comprises 13 feeders, a 20 MWA main transformer and 20 kV Veke switchgear built in a modular substation housing. Vamp's delivery to the project includes 13 Vamp 255-type feeder managers, each with a fibre optic serial interface and a separate service bus over an Ethernet network. For Vamp, the Oulunsalo substation marks a technological milestone since it is the first installation where Vamp protection relays have been used in conjunction with a COM 610 communication gateway from ABB. After completion of the Oulunsalo project, a similar set-up has been ordered for the Oulun Seudun Sähkö Verkkopalvelut Oy's substation in the municipality of Kempele and there are options for two further substations.

According to Mr. Yrjö Vilhunen, managing director at Oulun Seudun Sähkö Verkkopalvelut Oy, the choice of equipment for the recent projects was based on several factors. "The main reasons for the choice of suppliers were the extensive scope of the delivery and the positive experience we, and also other utility companies, have gained from earlier projects with both companies," he summarises.

The Oulunsalo substation is equipped with 13 Vamp 255 protection relays.

Vamp protection relays for Palm Islands, Dubai

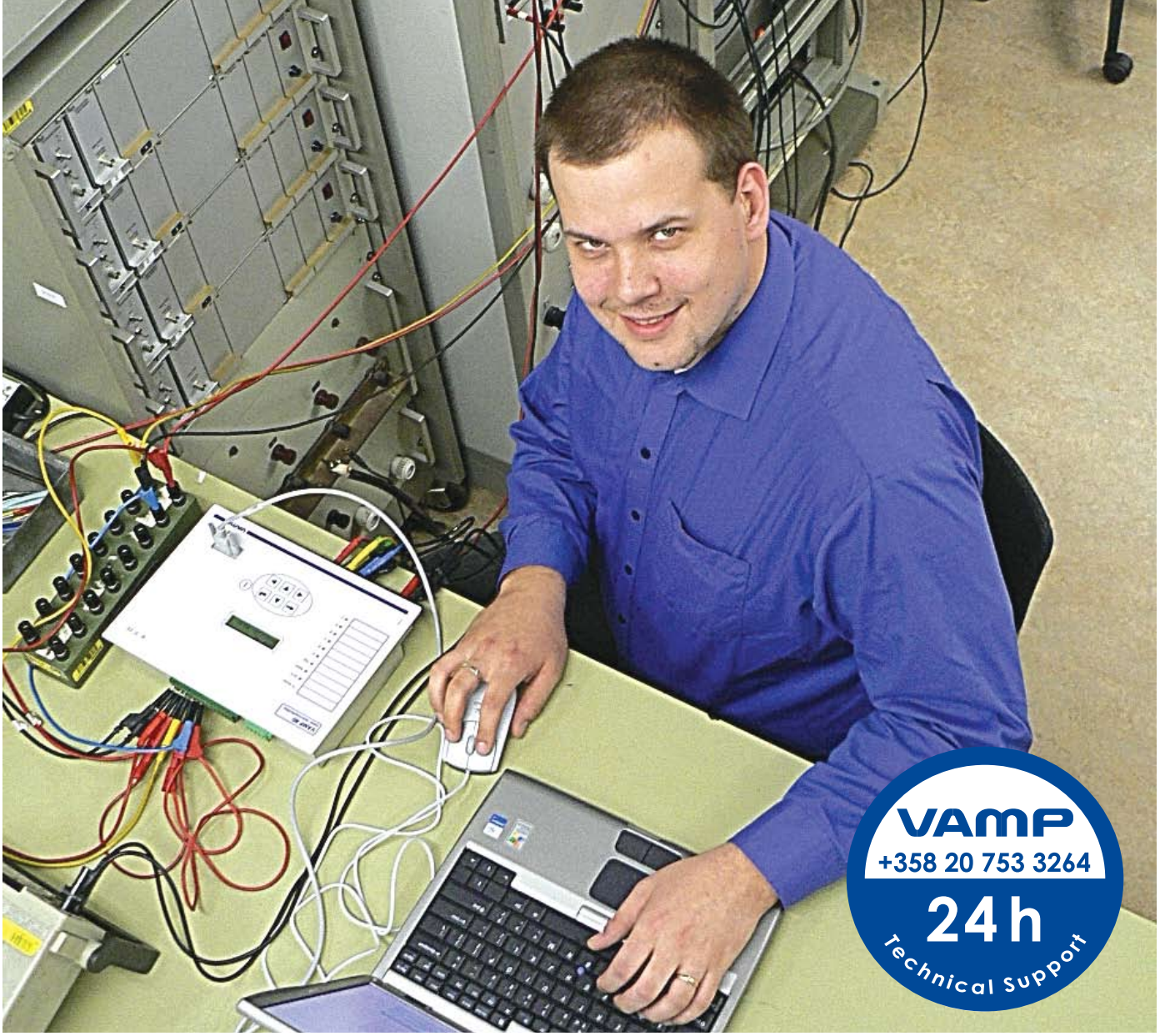
Vamp 40 protection relays will take care of the motor protection at the Palm Islands' sewage treatment plant in Dubai, United Arab Emirates. Totally 20 units were delivered to the end customer Palm Water through the local integrator Bloudan Control System LLC and installed in low-voltage MCCs. The deliveries took place at the end of 2007 and the project was commissioned at the beginning of this year by the integrator. Vamp 40 was chosen for the projects due to its combination of modest price and user-friendliness, thanks to which all training could be arranged on site.

The Palm Islands located in the Persian Gulf are artificial islands on which major commercial and residential infrastructure will be constructed. The islands, sometimes also called the 8th wonder of the world, are the largest land reclamation projects in the world. Each of the three

settlements will be in the shape of a palm tree, topped with a crescent, and will have a large number of residential, leisure and entertainment centers.

Vamp protection relays for Colombian utility company

The Colombian utility company Central Hidroelectrica de Caldas S.A. ESP have installed 30 Vamp protection relays in their power plant and network feeding the Caldas region, which is located to the west of the country's capital Bogotá. The contract included Vamp 255, Vamp 140, Vamp 257 and Vamp 265 type units that were delivered during 2007, with the latest addition in January this year. The relays are connected to an ABB MicroSCADA using a SPA-Bus with a fibre optic interface. Vamp relays were chosen for the project because of their user-friendliness, including the Vampset relay management software, and the service and customer support offered by Vamp. Based on the positive experience gained so far, add-on features to the existing installations are being considered by the customer.



Technical support 24/7

Pekka Hämäläinen
Marketing Director and After-Sales Manager

Vamp's 24-hour technical support has been available to customers for the last five years. The service is targeted mainly to Vamp partners while end customers receive support from their local Vamp representative. End customers may contact the service directly if the partner is not available.

Vamp's 24-hour technical support is available every day of the year. At the headquarters in Vaasa, specialists answer phone calls and emails during office hours (Finnish time is GMT +2). For non-critical issues email is the preferred means of communication. On weekdays and during weekends a continuous telephone service is also available. Technical support is designed to handle questions not covered by the product manual. Typical questions concern the use of the products and sometimes technical commissioning issues as well.

The technical support service has been highly appreciated by Vamp partners. We've received some very encouraging feedback and also good grades in our customer satisfaction surveys. Our aim is to make a fast response – during the week preferably on the same day. For power system malfunctions and disturbances it helps a lot if we get the disturbance recording and Vampset file from the relay at the first contact. Each case is given a service number which is then followed throughout the communication between Vamp and client. We also monitor the types of questions received. This information is analysed and used in our product development for even more user-friendly products.
There is also demand for including power system fault analysis, simulation of distribution network faults and recommendations for arc protection system scheme studies in the scope of after sales service. This service will be launched in the near future.

Vamp Technical Support,
+358 20 753 3264
Email: vampsupport@vamp.fi


EVENTS

	Event	Location	Date	Exhibitor / host
April	Exhibition – Hannover Messe 2008	Hanover, Germany	21.-25.4.2008	Vamp Ltd
May	Product training – English	Vaasa, Finland	6.-8.5.2008	Vamp Ltd
	Africa Utility Week	Cape Town, South Africa	20.-23.5.2008	Vamp Solutions
	Seminar – Vaasa	Vaasa, Finland	22.5.2008	Vamp Ltd
	Exhibition – Eliaden	Lillestrøm, Norway	26.-28.5.2008	CEE Energiteknik AS
	Exhibition	Osaka, Japan	28-30.5.2008	Hikari Trading
June	EEA New Zealand	New Zealand	20-22.6.2008	Digsilent Pacific Ltd
	Sales Meeting 2008	Vaasa, Finland	25.-26.6.2008	Vamp Ltd
August	Seminar – Kaohsiung	Kaohsiung, Taiwan	19.8.2008	Baufarm Ltd
	Seminar – Taichung	Taichung, Taiwan	20.8.2008	Baufarm Ltd
	Seminar – Taipei	Taipei, Taiwan	22.8.2008	Baufarm Ltd
	EESA in Brisbane	Brisbane, Australia	20.-22.8.2008	Digsilent Pacific Ltd
September	Product training – Finnish	Vaasa, Finland	2.-4.9.2008	Vamp Ltd
	Electra Mining Show	Johannesburg, South Africa	8.-12.9.2008	Vamp Solutions
	Product training – English	Vaasa, Finland	30.9.-2.10.2008	Vamp Ltd
November	Product training – Finnish	Vaasa, Finland	11.-13.11.2008	Vamp Ltd
	South African Power System Protection Conference	Johannesburg, South Africa	12-14.11.2008	Vamp Solutions
December	Product training – English	Vaasa, Finland	9.-11.12.2008	Vamp Ltd

Kari Järvinen

receives Medal of Merit

Vamp Ltd's hardware design team engineer, Mr. Kari Järvinen, has been awarded the bronze medal of the Central Chamber of Commerce in Finland for his career at the company. During his 10 years with Vamp, Mr. Järvinen has been responsible for development of the testing systems and software for Vamp products. He is also the specialist responsible for Vamp's test laboratory equipment and electricity safety procedures.

The Medal of Merit of the Central Chamber of Commerce is a highly regarded recognition awarded for work well done. It is a personal acknowledgement and token of appreciation for commitment to a company's operations and goals. By rewarding an employee with the medal of merit, a company shows its appreciation for commitment and professionalism.

Vamp products

Arc protection systems

Vamp offers extremely fast arc protection systems for LV and MV switchgears. They are designed especially to maximize personnel safety and to minimize material damage caused by arc faults. Minimized damage also means less repair work and rapid restoration of the power supply.

A Vamp arc protection system can be implemented in four different ways: as an autonomous central unit system, as part of a Vamp protection relay system, as an integration of these two, or as a system based solely on light detection.

Protection relays

Vamp protection relays are used for selective protection of overhead line feeders, cable feeders, motor feeders, transformer feeders, capacitor banks, reactors and busbars in power system distribution substations, power plants, industrial power systems, and marine and offshore installations. In addition to a comprehensive range of standard protection functions, the Vamp series also offers bay control, measurements, primary circuit monitoring and communication functionality.

Measuring and monitoring units

Vamp metering devices are designed for industrial and utility applications where power quality or energy consumption and billing are monitored by cost centre. Demand and power factor control, equipment monitoring, alarms for preventive maintenance and disturbance capturing are standard features in Vamp 96 and Vamp 260 units.

Wimo measuring and monitoring units are optimized for secondary power distribution substations.

ARC PROTECTION SYSTEMS

Vamp 120 unit

Vamp 221 system

PROTECTION RELAYS

Vamp 40 series

Vamp 100 series

Vamp 200 series

MEASURING AND MONITORING UNITS

Vamp 96

Wimo 6CP10

Vamp 260

Communication in Vamp relays

All protection relays and measuring and monitoring units come with a wide range of communication protocols, including IEC 60870-5-103, DNP 3.0, Modbus TCP, Modbus RTU, Profibus DP, TCP/IP, SPA bus slave, and as the latest additions IEC 61850 and IEC 60870-5-101.

EXTERNAL OPTION MODULES

Vam16D LED module

The external Vam16D LED module provides 16 extra led indicators for Vamp 230, Vamp 245, Vamp 255 and Vamp 257 feeder/motor managers where a large number of alarms needs to be displayed, each on individual LED. A Vamp feeder/motor manager together with the optional Vam 16D LED module is an optimised arrangement which replaces the traditional combination of separate alarm panel/unit and feeder protection relays. Mounting of the Vam 16D is flexible since it can either be done directly on the feeder/motor manager or directly beside it in the switchgear door. The module is normally connected to the serial port of the relays front panel.

External communication modules

A complete set of communication adaptor modules are available to ensure that all needed substation communication bus and media requirements are met. The modules offered provide interfaces varying from traditional electrical RS485 (twisted pair) and fibre optics to modern Ethernet enabling new possibilities in terms of data rates and bandwidth. Some of the available communication modules also support flexibility in terms of multiple interfaces, e.g. one for the substation process bus and another for relay maintenance i.e. uploading and downloading of settings and uploading of disturbance recordings. All communication modules are easy to install with simple dip-switch settings.

		Communication media:	Fiber optic	RS-485			Ethernet/RS-485		Profibus	Ethernet	IEC 61850
Relay	VAM 16D	Protocol	VSE 001	VSE 002	VSE 003	VSE 004	VSE 005-1	VSE 005-2	VPA 3CG	VEA 3CG	VSE 006
VAMP 135		SPA	X(1)				X				
VAMP 140		IEC 60870-5-103	X(1)				X				
VAMP 150		Modbus		X			X				
		Modbus TCP								X	
		Profibus DP							X		
		IEC 61850									X
		Ethernet Vampset					X			X	
VAMP 40		SPA	X				X				
VAMP 96		IEC 60870-5-103	X								
		IEC 60870-5-101		X		X	X				
		Modbus		X		X	X				
		Modbus TCP								X	
		Profibus DP							X		
		DNP 3.0		X		X	X				
		IEC 61850									X
		External I/O				X	X				
		Ethernet Vampset					X	X		X	
VAMP 210	X(2)	SPA	X(1)								
VAMP 260	X(2)	IEC 60870-5-103	X(1)								
VAMP 265	X(2)	IEC 60870-5-101		X(1)	X			X			
VAMP 230	X(2)	Modbus		X(1)	X			X			
VAMP 245	X(2)	Modbus TCP								X	
VAMP 255	X(2)	Profibus DP							X(1)		
VAMP 257	X(2)	DNP 3.0		X(1)	X			X			
		IEC 61850									X(1)
		External I/O			X			X			
		Ethernet Vampset						X		X	

External communication and LED module selection table

(1 Integrated communication modules are optional. External modules VSE001 and VSE002 have support for external auxiliary power supply to prevent communication bus interruption due to relay maintenance etc. See the relay product manuals for more information about the integrated modules.
(2 The LED module is optional.

SOFTWARE TOOLS

VAMPSET

Vampset is user-friendly, free-of-charge relay management software for setting, parameterising, and configuring of Vamp relays. Via the Vampset software relay parameters, configurations and recorded relay data can be swapped between the operator's PC and the Vamp relays. Apart from supporting the Comtrade format, Vampset also incorporates tools for analysing relay events, waveforms and trends from data recorded by the relays, e.g. during a network fault situation.

VAMP COLLECT

Vamp Collect is a substation monitoring system (SMS) software implemented utilising Vamp relays' TCP/IP communication capability. The software automatically collects events, measurements, voltage sag & swell information and disturbance records through TCP/IP protocol allowing more comprehensive data for planning and operating networks.

Selection table for Vamp protection relays

				Feeder protection								Machine protection								Other			
Type of fault	IEEE Device No.	IEC Symbol	Protection function/measurement	VAMP 40	VAMP 135	VAMP 140	VAMP 230	VAMP 245	VAMP 255	VAMP 257	VAMP 259	VAMP 40	VAMP 150	VAMP 210	VAMP 230	VAMP 245	VAMP 255	VAMP 257	VAMP 265	VAMP 121	VAMP 220	VAMP 221	VAMP 260
Short circuit	50/51	3I >	Three-phase non-directional overcurrent, low-set stage, definite or inverse time	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	50/51	3I >>	Three-phase non-directional overcurrent, high-set stage, definite time	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	50/51	3I >>>	Three-phase non-directional overcurrent, high-set stage, definite time	x		x	x	x	x	x	x	x	x	x	x	x	x	x					
	67N or 50N/51N	3I > →	Three-phase directional or non dir. o/c, low-set stage, definite or inverse time				x		x	x	x			x	x		x	x					
	67N or 50N/51N	3I >> →	Three-phase directional or non dir. o/c, high-set stage, definite or inverse time				x		x	x	x			x	x		x	x					
	67N or 50N/51N	3I >>> →	Three-phase directional or non dir. o/c, high-set stage, definite time				x		x	x	x			x	x		x	x					
	67N or 50N/51N	3I >>>> →	Three-phase directional or non dir. o/c, high-set stage, definite time				x		x	x	x			x	x		x	x					
	21	Z<	Distance protection, 5 zones polygonal characteristic								x												
Earth-fault	50N/51N	I_0 >/ SEF	Non-directional earth-fault, low-set stage, sensitive, definite or inverse time	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	50N/51N	I_0 >>	Non-directional earth-fault, high-set stage, definite time	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	50N/51N	I_0 >>>	Non-directional earth-fault,high-set stage, definite time	x			x	x	x	x	x	x		x	x	x	x	x	x				
	50N/51N	I_0 >>>>	Non-directional earth-fault, high-set stage, definite time	x			x	x	x	x	x	x		x	x	x	x	x	x				
	67N or 50N/51N	$I_{0\varphi}$ >/ SEF	Directional or non dir. earth-fault, low-set stage, sensitive, definite or inverse time	x			x	x	x	x	x	x		x	x	x	x	x					
	67N or 50N/51N	$I_{0\varphi}$ >>	Directional or non dir. earth-fault, high-set stage, definite or inverse time	x			x	x	x	x	x	x		x	x	x	x	x					
	59N	U_0>	Residual overvoltage, low-set stage	x	x		x	x	x	x	x	x		x	x	x	x	x					
	59N	U_0>>	Residual overvoltage, high-set stage	x	x		x	x	x	x	x	x		x	x	x	x	x					
Overload	49M	T>	Three-phase thermal overload (motors & generators)									x	x	x	x	x	x	x	x				
	49F	T>	Three-phase thermal overload (feeders & cables)	x		x	x	x	x	x	x												
Voltage	59	1U>/3U>	One-/Three-phase overvoltage, low-set stage	1	3		3		3	3	3	1		3	3		3	3					
	59	1U>>/3U>>	One-/Three-phase overvoltage, high-set stage	1	3		3		3	3	3	1		3	3		3	3					
	59	1U>>>/3U>>>	One-/Three-phase overvoltage, high-set stage	1	3		3		3	3	3	1		3	3		3	3					
	27	1U</3U<	One-/Three-phase undervoltage, low-set stage	1	3		3		3	3	3	1		3	3		3	3					
	27	1U<</3U<<	One-/Three-phase undervoltage, high-set stage	1	3		3		3	3	3	1		3	3		3	3					
	27	1U<<</3U<<<	One-/Three-phase undervoltage, instantaneous stage	1	3		3		3	3	3	1		3	3		3	3					
	27P	U, <, U, <<	Positive sequence undervoltage for generator applications											3									
Arc protection	50ARC/50NARC	3 I> / I_0>, L>	Electrical arc protection stage, point sensors, Optional	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
	50ARC/50NARC	3 I> / I_0>, L>	Electrical arc protection with point sensor slave																	x	x	x	
	50ARC/50NARC	3 I> / I_0>, L>	Electrical arc protection with point, fiber or current sensors slave																			x	
Other functions	79	O → I	Auto-reclosure	x			x	x	x	x	x												
	68	I_2 >	Inrush and cold load detection	x		x	x	x	x	x	x	x		x	x	x	x	x					
	46	I_2/I_1 >	Phase unbalance / discontinuity protection (broken conductor)	x		x	x	x	x	x	x												
	46	I_2 >	Phase unbalance protection									x		x	x	x	x	x	x				
	47	U_2 >>	Phase sequence / reversal protection									x			x	x	x	x					
	48	$I_{2\varphi}$ >	Stall protection									x	x		x	x	x	x					
	37	3I<	Loss of load / under current protection	x			x	x	x	x	x	x	x	x	x	x	x	x					
	87	3 d I>	Three phase biased differential stage, low-set stage, 2nd harmonic blocking																x				
	87	3 d I>>	Three phase differential stage, high-set stage																x				
	66	N>	Frequent start protection									x	x		x	x	x	x					
	64F3	U_{0f3} >	100% stator earth fault protection											x									
	40	Q <	Underexcitation protection											x									
	40	X<, X<<	Loss of excitation protection											x									
	32	P<,P<<	One-/Three-phase reverse power and underpower protection	1			3		3	3	3			3									
	24	U/f>	Volts/hertz overexcitation protection											x									

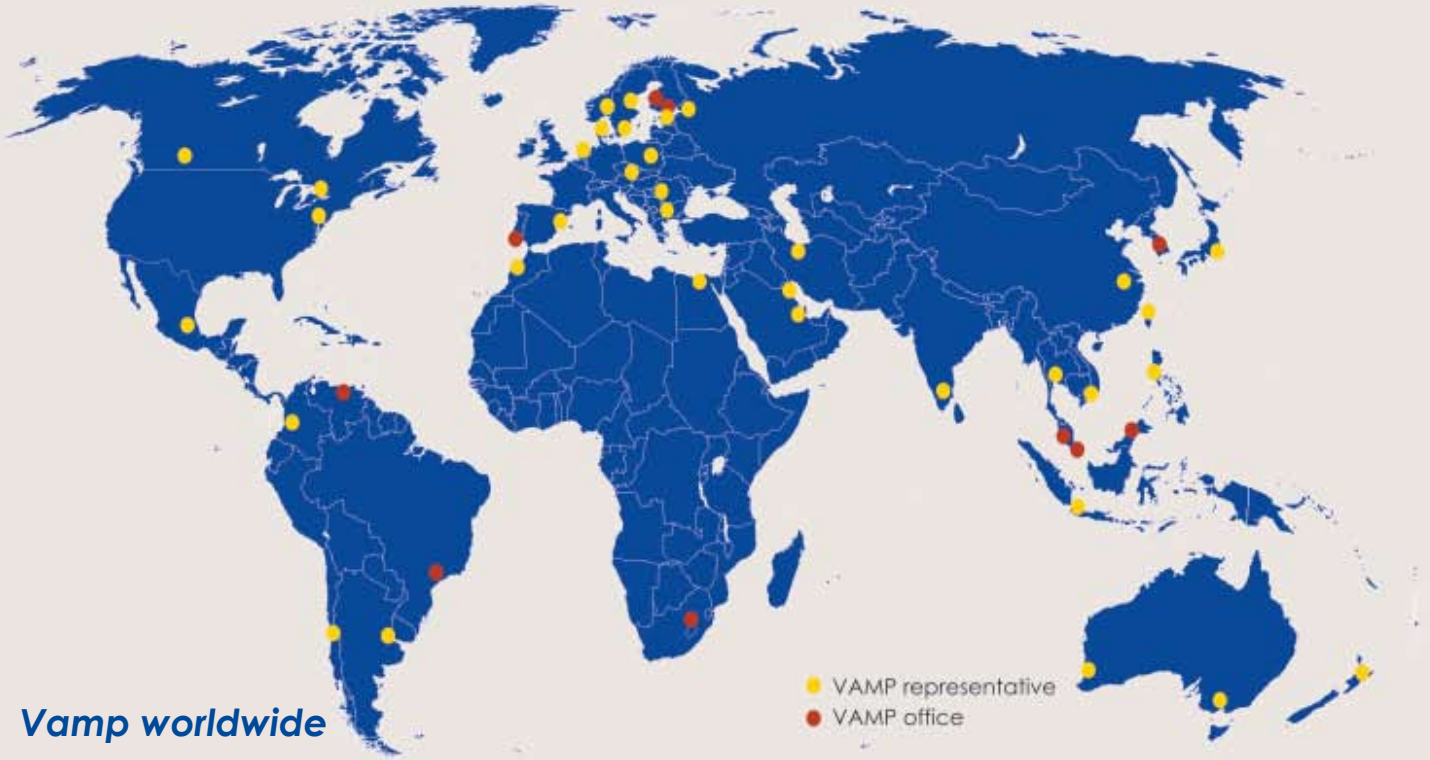
	50BF	CBFP	Circuit breaker failure protection	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	
	81H/81L	f >, f >>, f >>>	Overfrequency and underfrequency protection		x		x		x	x	x			x	x		x	x					
	81L	f<, f<<	Underfrequency protection		x		x		x	x	x			x	x		x	x					
	81R	df/dt	Rate of change of frequency (ROCOF) protection				x		x	x	x			x	x		x	x					
	21	Z<, Z<<	Under-impedance protection, circle characteristic											x									
	51V	I_s >	Voltage restrained or controlled overcurrent protection											x									
	25	df,dv	Synchrocheck				x		x	x	x				x		x	x					
			Short circuit fault location				x		x	x	x				x		x	x					
			8 Programmable stages	x			x	x	x	x	x	x		x	x	x	x	x	x				x
		DR	Disturbance recorder	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Type of measurement																							
Primary current		3I	Three-phase current	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
		3 d I >	Three-phase differential current																x				
		I_0	Neutral current	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
		I_2	Current unbalance	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
		IL	Average and maximum demand current	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Primary voltage		U/3U	One-/Three-phase and line voltages	1	3		3		3	3	3	1		3	3		3	3					3
		U_0	Residual voltage	x	x		x	x	x	x	x	x		x	x	x	x	x					x
		U_2	Voltage unbalance				x		x	x	x				x		x	x					x
Short-circuit fault reactance		Xfault	Short-circuit fault reactance				x		x	x	x				x		x	x					
Frequency		f	System frequency	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Power		P	Active power	(x)			x		x	x	x	(x)		x	x		x	x					x
		Q	Reactive power	(x)			x		x	x	x	(x)		x	x		x	x					x
		S	Apparent power	(x)			x		x	x	x	(x)		x	x		x	x					x
Energy		E+, E-	Active Energy, exported / imported	(x)			x		x	x	x	(x)		x	x		x	x					x
		Eq+, Eq-	Reactive Energy, exported / imported	(x)			x		x	x	x	(x)		x	x		x	x					x
Power factor		PF	Power factor	(x)			x		x	x	x	(x)		x	x		x	x					x
Harmonics		I	2nd to 15th and THD of phase currents	x			x	x	x	x	x	x		x	x	x	x	x	x				x
		U	2nd to 15th and THD of measured voltages				x		x	x	x			x	x		x	x					x
Voltage sags / swells		U	Voltage sags / swells				x		x	x	x			x	x		x	x					x
Analog mA output, 1 channel		AO	Any measured or calculated value, freely scalable		x	x							x										
Analog mA output, 4 channels		AO	Any measured or calculated value, freely scalable, Optional				x	x	x						x	x	x						x

(x) : Based on one-phase voltage measurement

Control																							
Digital inputs			Number of digital inputs (max), including arc option with DI19 & DI20	2	1	1	8	8	20	28	28	2	1	8	8	8	20	28	8				8
Output relays			Number of trip relays	4	2	2	2	2	4	8	8	4	2	2	2	2	4	8	2				2
			Number of alarm relays	1	3	3	5	5	5	5	5	1	3	5	5	5	5	5	5				5
Object status indication			Single line diagram, 8 objects				x	x	x	x	x				x	x	x	x	x				
Local and remote control			Number of controllable objects	6			6	6	6	6	6	6		6	6	6	6	6	6				
Interlocking and logic			Configurable	x			x	x	x	x	x			x	x	x	x	x	x				
Condition monitoring																							
Trip circuit		TCS	Trip circuit supervision	x	x	x	x	x	x			x	x	x	x	x	x		x				
CT Supervision			CT Supervision	x			x	x	x	x	x	x		x	x	x	x		x				
VT Supervision	60		VT Supervision/Fuse failure supervision				x		x	x	x			x	x		x						
CB Wear			Breaker wear	x			x	x	x	x	x	x		x	x	x	x		x				
Communication																							
IEC 60870-5-103				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Modbus TCP				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Modbus RTU				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Profibus DP				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
DNP 3.0				x			x	x	x	x	x	x		x	x	x	x	x	x				x
SPA-bus communication				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
IEC 61850				(x)	(x)	(x)	x	x	x	x	x	(x)	(x)	x	x	x	x	x	x				x
IEC 60870-5-101				x			x	x	x	x	x	x		x	x	x	x	x	x				x
Man-Machine-Communication, display				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Man-Machine-Communication, PC				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x

(x) : with external IEC 61850 interface module

General functions																							
Selfsupervision				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Annunciating, event generating and value recording				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Measurement and parameter display				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Real time clock			Year, month, day, hour, minutes, seconds, milliseconds	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x



Vamp worldwide

EUROPE

Finland
Vamp Ltd
+358 20 753 3200
vamp@vamp.fi
www.vamp.fi

Czech Republic
EL-INSTA
+420 777 550 189
akarban@el-insta.cz
www.el-insta.cz

Denmark
Vamp Protection Systems Aps
+45 51 53 89 25
td@vamp.dk
www.vamp.dk

Estonia
AS Martem
+372 639 7979
andres.kask@martem.ee
martem@martem.ee
www.martem.ee

The Netherlands
Santon Holland B.V.
+31 10 283 26 72
gvzeijl@santonswitchgear.com
www.santonswitchgear.com

Norway
CEE Energiteknik As
+47 6791 1950
svein.weideborg@cee.no

Poland
SAE Sp.z.o.o
+48 22 853 86 01
j.noga@sae.com.pl

Romania
S.C. Comranado S.R.L.
+40 25 141 8220
gmarinescu@comranado.ro
office@comranado.ro
www.comranado.ro

Russia
Vacon Business Centre
+7 812 915 8876
igor.chistov@vacon.spb.ru
www.vacon.spb.ru

Spain
Electromediciones Kainos, S.A.
+34 93 474 23 33
sballus@kainos.es
www.kainos.es

Sweden
Jowic Elteknik AB
+46 73 507 40
rickard.johansson@jowic.se
www.jowic.se

European Electric Technology
+46 40 711 42
thomas.hansson@eet-teknik.se
www.eet-teknik.se

THE AMERICAS

Argentina
SAAT Electro Power
+5411 4545 9559
energia@saatelectropower.com.ar
saat@saatelectropower.com.ar
www.saatelectropower.com.ar

Brazil
Vamp Brazil
+5511 8357 6066
evaldo.sousa@vamp.fi

Canada East
CD Nova Ltd
(Arc Flash Protection only)
+1 905 940 8338
sbonser@cdnova.com
www.cdnova.com in

Canada West
Eecol Electric Corp.
(Arc Flash Protection only)
+1 403 253 1952
marcusce@eecol.com
www.eecol.com

Chile
Tecmel
+56 2 596 2540
ibarraza@tecmelchile.cl
www.tecmelchile.cl

Colombia
P.T.I. Ltda.
+57 2 3366461
wrmontes@ptiltda.com
www.ptiltda.com

Mexico
Allectro S.A de CV
+52 55 5688 5912
martha.leonm@allectro.com
contacto@allectro.com
www.allectro.com

USA
MET Test / Substation Solutions
(Arc Flash Protection only)
+1 301 967 3500
john.matthews@met.lincfs.com
www.met-test.com

Venezuela
Inversiones MR Vamp VE CA
+58 212 373 6776
marcosrondonr@cantv.net

AFRICA

Egypt
EGEMAC
+202 2 283 3768
egemac2@link.net
www.egemac.com.eg

South-Africa
Vamp Solutions Pty
+27 11 914 2393
bristowr@mweb.co.za
info@vamp.co.za
www.vamp.co.za

Morocco
Maghreb-Electro-Technique (M-E-T)
+212 22 240 883
m.elghani@met.ma

MIDDLE EAST

Iran
Runin FG
+91 21 763 63 61 & 2
runin_fg@parsonline.net

Kuwait
Rezayat Trading Co
+965 481 6836
kmoryani@rezayatkwt.com

Saudi-Arabia
Al-Mashariq
+966 388 78017
adeebrahmeh@almashariq.com

ASIA & PACIFIC

Australia
Digsilent Pacific Pty Ltd
+61 3 9690 0081
koos@digsilent.com.au
info@digsilent.com.au
www.digsilent.de/pacific

China
Vamp Ltd Shanghai Rep. Office
+86 21 63915177
jason.ma@vamp.fi

India
Megawin Switchgear Pvt Ltd
+91 427 233 0498
info@megawinswitchgear.com
www.megawinswitchgear.com

Indonesia
P.T. Winindo Karya Dinamika
+62 21 750 7767
winindo@cbn.net.id

Japan
Hikari Trading
+81 3 357 31392
koji.nakamura@hikari-gr.co.jp
www.hikari-gr.co.jp

Korea
Vamp Korea Ltd
+82 31 715 3101
jbkim@vamp.co.kr
www.vamp.co.kr

Malaysia
Vamp Malaysia
+603 6187 2045
gan@vamp.com.my
sales@vamp.com.my

Philippines
Taurex Exponent
+63 88 859 2604
taurex88@yahoo.com.ph

Taiwan
Baufarm Enterprise Co., Ltd
+886 2 2753 1109
baufarm@ms32.hinet.net

Thailand
Power Testing Product
+66 2 447 6228
sales@ptp.co.th

Vietnam
JNP Tech Vietnam
+84 8 9802 520 955
pauljeong@jnptech.com