Capacitor bank controller and protection using VAMP 260 power monitoring unit and VAMP 40 protection relay

The new VAMP 40 feeder and motor protection relay has many applications in the electrical distribution and industrial markets. One of the applications is for capacitor, filter and reactor bank protection. The use and applications are described in this article.

Unbalance protection

The VAMP 40 relay has 5 current inputs as well as a single voltage input. Normally two of these inputs can be used for earth or residual current inputs. In double star unearthed capacitor bank applications, these inputs can be used for unbalanced current detection. The unbalance protection is measured with a dedicated current transformer between the star points of the banks as shown in the figure below. The unbalance current is not affected by system unbalance. However, due to capacitor manufacturing tolerances, some amount of natural unbalance current exists between the star points.

In the VAMP 40, this unbalance current is compensated so that the net current measured becomes zero. This compensation is triggered manually at commissioning. The phasors of the unbalance current and one phase current are recorded (the latter for a polarising to zero measurement). As the initially existing unbalance current is compensated to zero in the VAMP 40 relay, the unbalance setting can be very sensitive. Should the unbalance current change due to failure in the bank, this functionality can be used to also located the branch of the faulty element which would typically be a blown fuse.

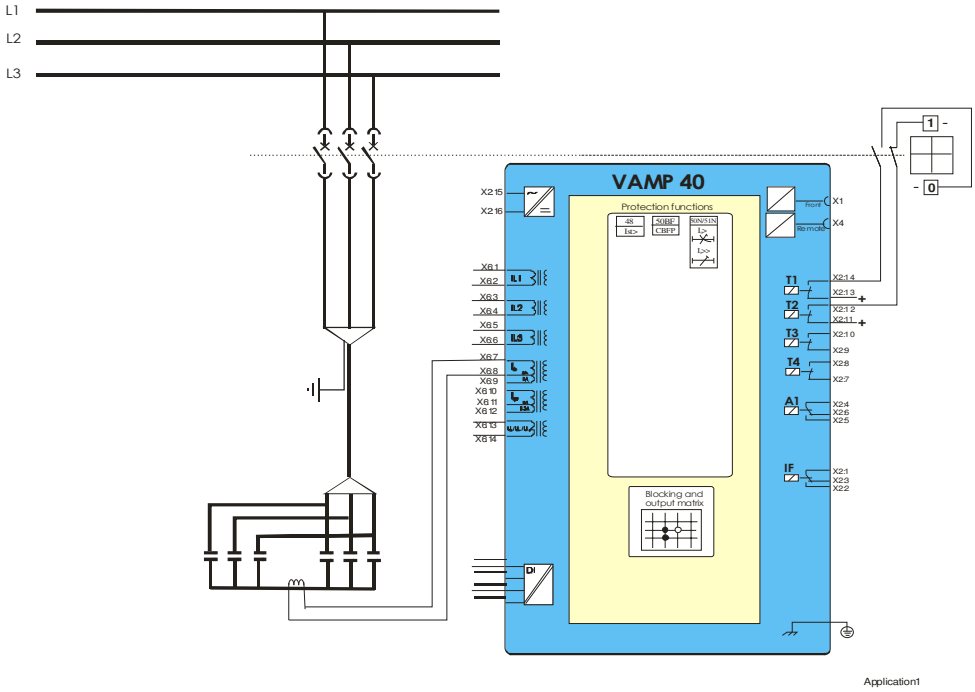
Two current stages can be set for unbalance alarm and trip respectively. Following a blown fuse, a time setting would determine how long the unbalance condition has to prevail before it is determined to be a faulty fuse. After a fuse failure has been detected, new compensation is added automatically so that the unbalance current "seen" by the relay yet again becomes zero. A faulty element counter is also increased simultaneously. The user can set the number of tolerable faulty elements before a trip is initiated.

Five unbalance inputs

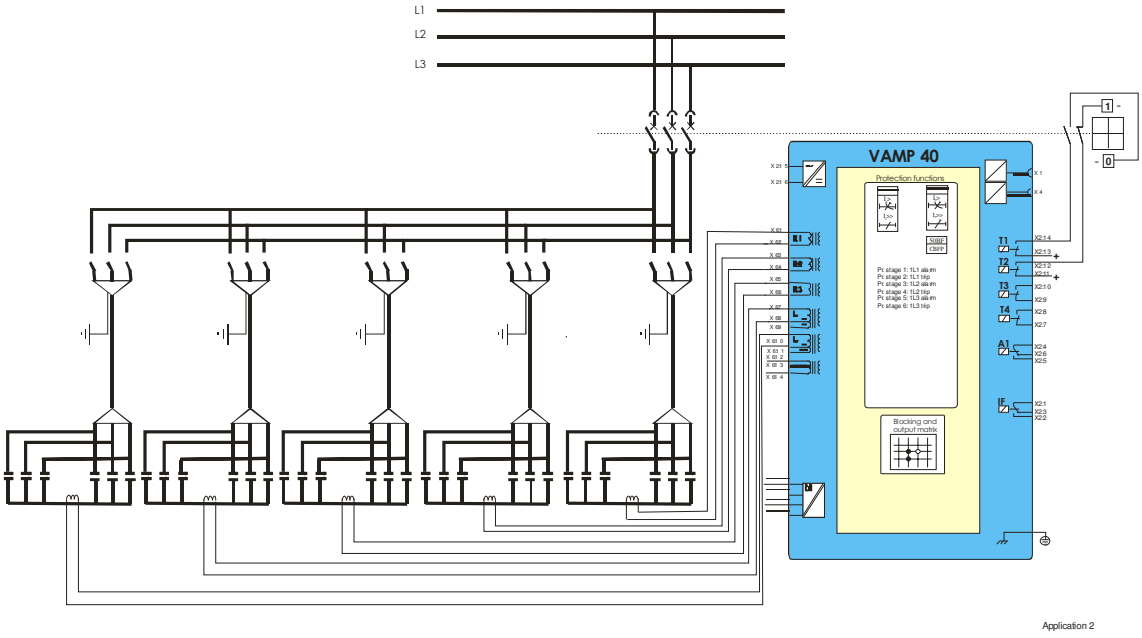
Figure "Application 4, 6, and 8" also measures phase currents into the capacitor banks. However, the three phase inputs can also be used for unbalance detection, making it possible to have up to five unbalance inputs into a single VAMP 40 relay.

This is achieved with another novel feature of the VAMP 40 which contains up to eight programmable stages or virtual protection elements. This makes it possible to define additional protection elements of any available type within the relay, hence making it possible to have five unbalance current inputs rather than phase currents. Of course, without a phase current input there would not be any current polarisation.

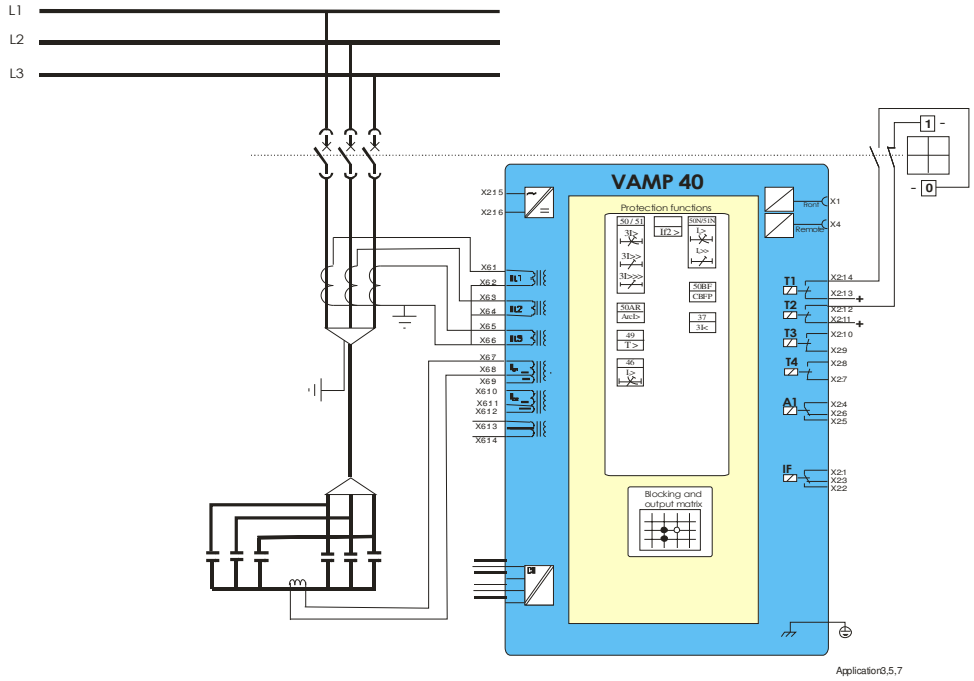
Application 1
Capacitor bank- unbalance protection for a fixed bank



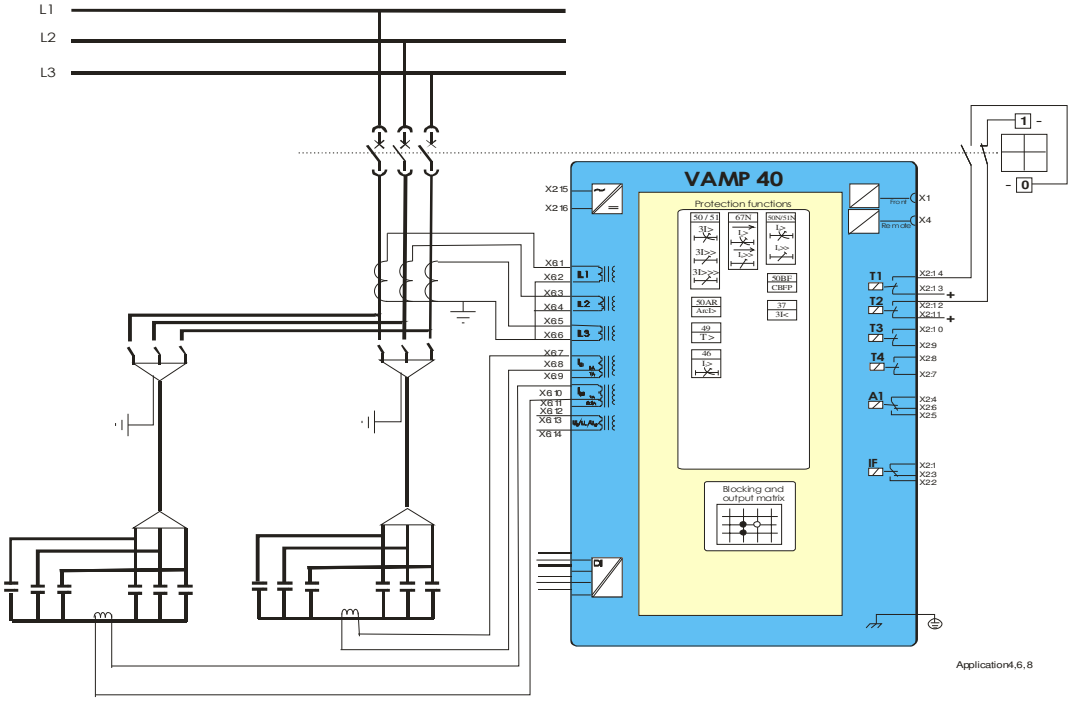
Application 2
Capacitor bank- unbalance protection for an automatic bank (2-5 steps)



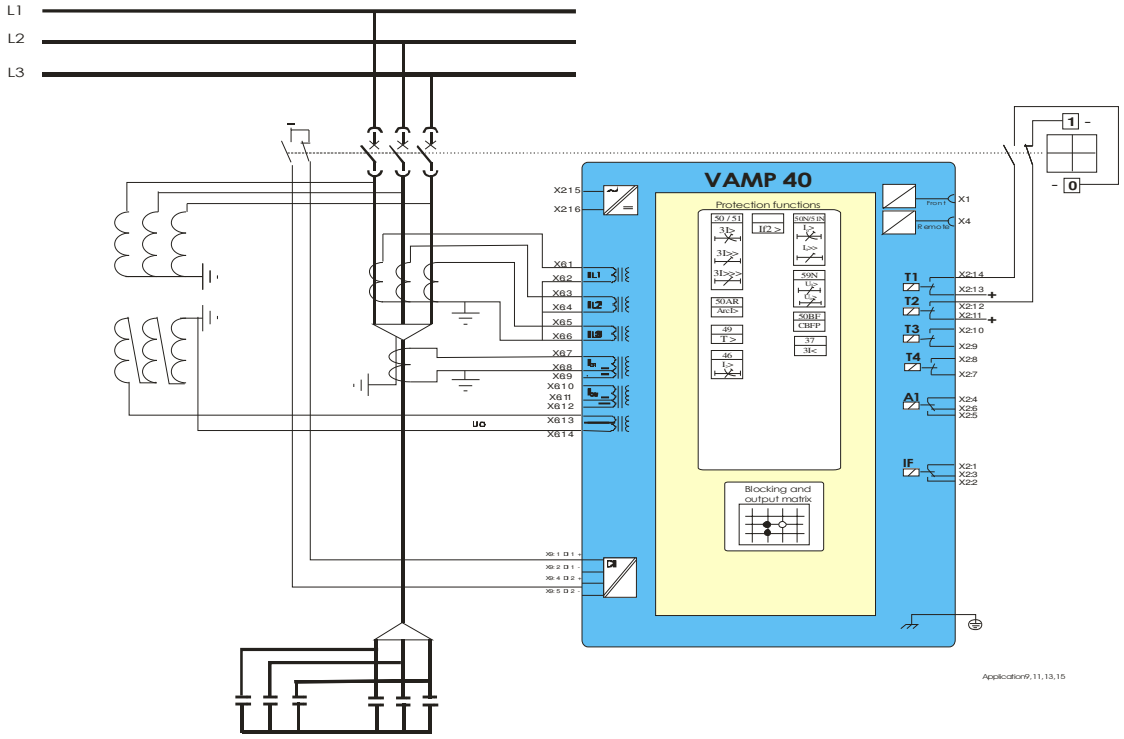
Application 3, 5 and 7
Capacitor bank- overcurrent, earthfault, overload and unbalance protection for a fixed bank



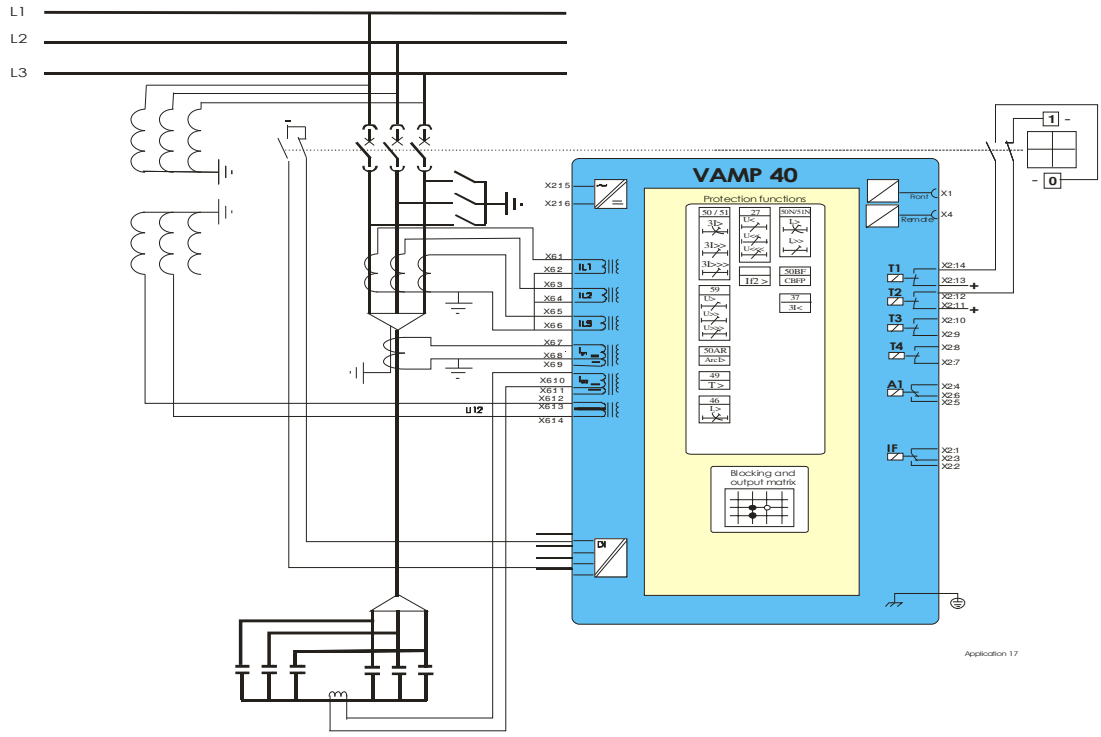
Application 4, 6, and 8
Capacitor bank- overcurrent, earthfault, overload and unbalance protection for an automatic bank (2 steps)



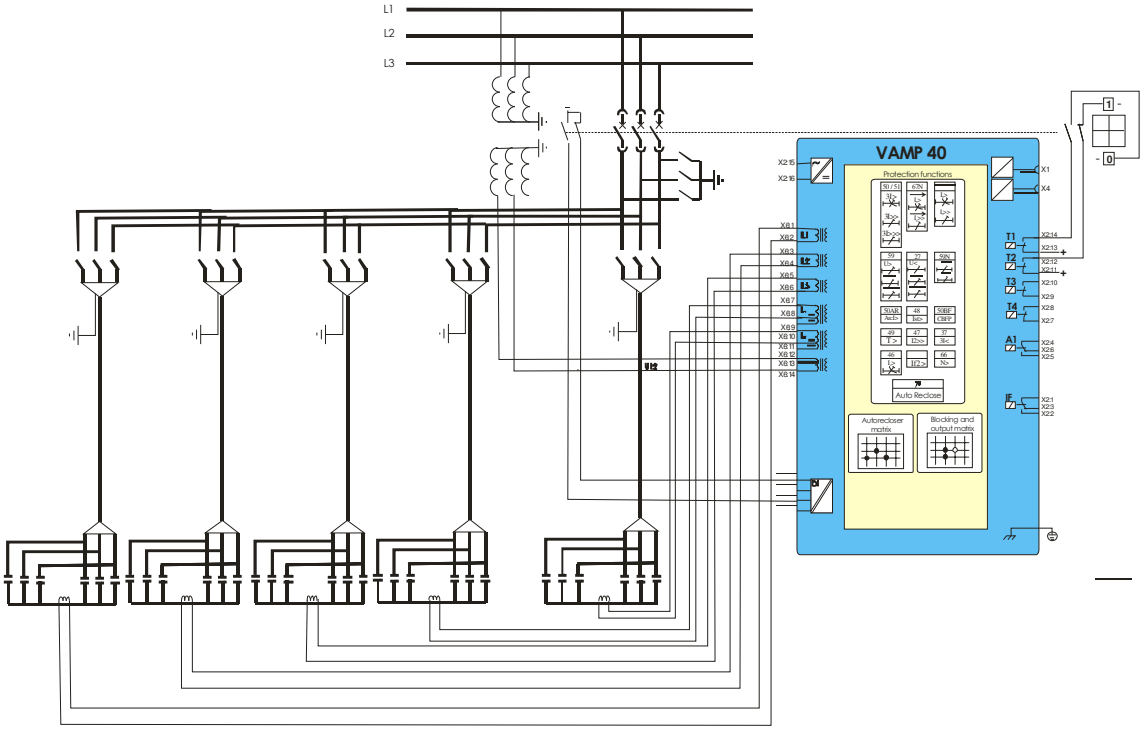
Application 9,11,13 and 15
Capacitor bank- unbalance voltage, overcurrent earthfault and overload protection for a fixed bank



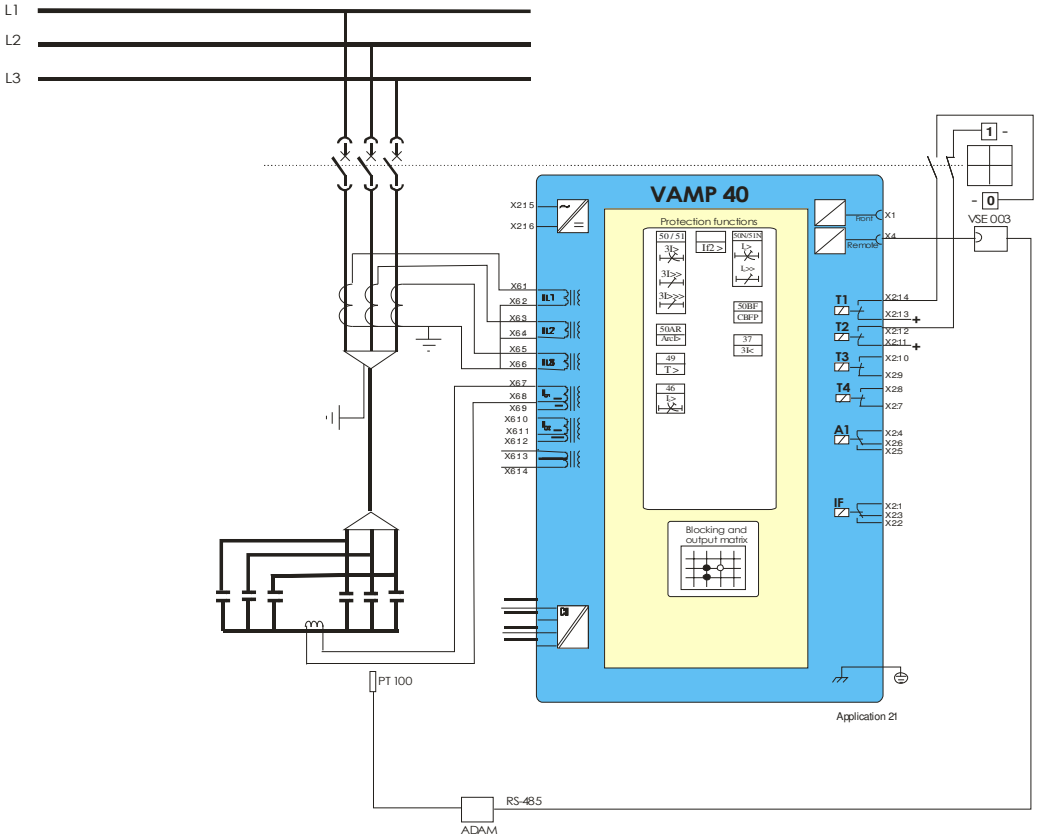
Application 17
Capacitor bank- over/undervoltage protection with unbalance protection for a fixed bank



Application 18
Capacitor bank- over/undervoltage protection with unbalance protection for an automatic bank (2-5 steps)



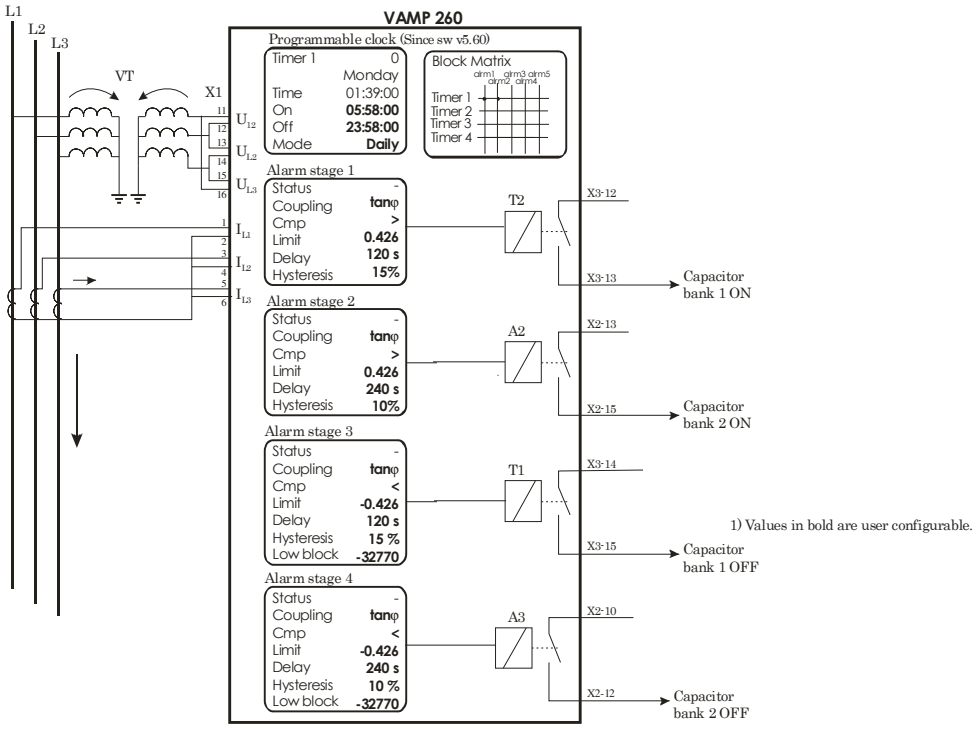
Application 21
Connection of temperature alarm and trip



P.F controller application

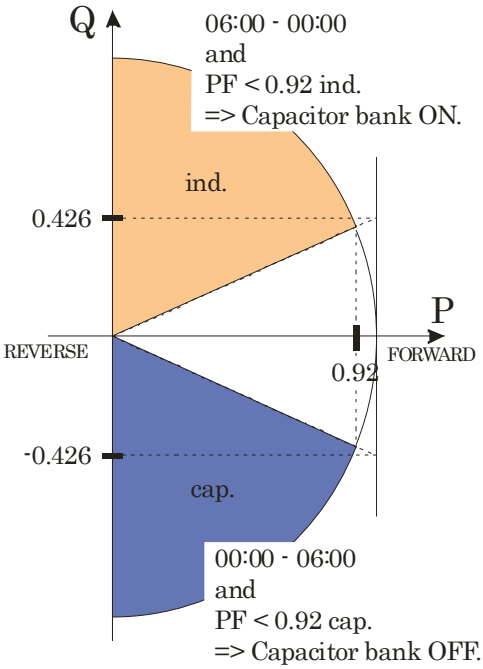
Two-stage clock controlled power factor controller

The following figure demonstrates the use of the VAMP 260 for controlling capacitor switching. In such an application the VAMP 260 could be used to control reactive power compensation depending on the time of the day or to other measured criteria. Of course this control could be used in isolation or combined with voltage control to provide a very flexible shunt bank controller, be it a reactor or capacitor. With the aid of an RTD input, temperature measurements could also be used for protection and/or control applications.



Power factor controller

Time of day and power factor criteria of the clock controlled power factor controller



Time of day	Power factor	tanj	Timer1	T2	T1	Capacitor
00:00 - 06:00	< 0.92 cap.	< -0.426	off		on	OFF
00:00 - 06:00	0.92 cap. .. 0.92 ind.	-0.426 .. +0.426	off		off	-
00:00 - 06:00	< 0.92 ind.	> +0.426	off		off	-
06:00 - 24:00	< 0.92 cap.	< -0.426	on	off		-
06:00 - 24:00	0.92 cap. .. 0.92 ind.	-0.426 .. +0.426	on	off		-
06:00 - 24:00	< 0.92 ind.	> +0.426	on	on		ON

Summary

The VAMP 40 relay has many more measured quantities and functionalities than the few described in this article. As VAMP places the highest priority on user-friendliness, all these functionalities are extremely easy to apply. It can be concluded that the VAMP 40 can be used on its own or in combination with the VAMP 260 to provide comprehensive capacitor bank protection and/or control.

Keywords : Capacitor bank controller, Capacitor bank protection relay, Capacitor bank unbalance protection, Capacitor bank short circuit protection, Capacitor bank p.f. protection

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