

## Auto-reclosing function in VAMP protection relays

The modern numerical VAMP protection relays include a sophisticated Auto-reclosing (AR) function. The AR function is normally used in feeder protection relays that are protecting an overhead line. Most of the overhead line faults are temporary in nature. Even 85% can be cleared by using the AR function.

### General

The basic idea is that normal protection functions will detect the fault. Then the protection function will trigger the AR function. After tripping the circuit-breaker (CB), the AR function can reclose the CB. Normally, the first reclose (or shot) is so short in time that consumers cannot notice anything. However, the fault is cleared and the feeder will continue in normal service.

### Terminology

Even though the basic principle of AR is very simple, there are a lot of different timers and parameters that have to be set.

In VAMP relays, there are five shots. A shot consists of open time (so called "dead" time) and close time (so called "burning" time or discrimination time). A high-speed shot means that the dead time is less than 1 s. The time-delayed shot means longer dead times up to 2-3 minutes.

There are four AR lines. A line means an initialization signal for AR. Normally, start or trip signals of protection functions are used to initiate an AR-sequence. Each AR line has a priority. AR1 has the highest and AR4 has the lowest one.

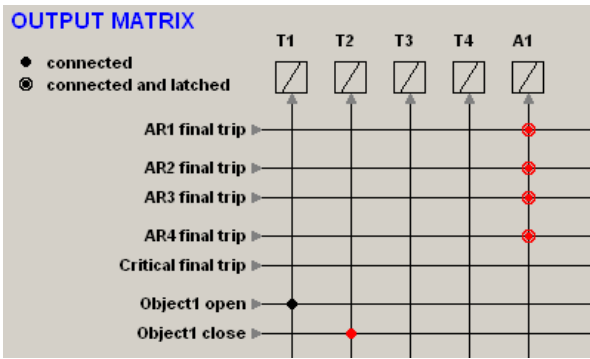
This means that if two lines are initiated at the same time, AR will follow only the highest priority line. A very typical configuration of the lines, is that the instantaneous overcurrent stage will initiate the AR1 line, time-delayed overcurrent stage the AR2 line and earth-fault protection will use lines AR3 and AR4.

### Circuit-breaker configuration

The status of the circuit breaker must be known by the AR function to operate correctly. The status is taken automatically from the object 1. Therefore, the statuses must be connected to the object 1. Normally, two digital inputs are recommended to be used for the status; one for the open status and one for the close status. However, if two free inputs are not available, then also one input is enough, the close status. Then the open status is left without any inputs (See the screenshot below, submenu "objects"). Please note that using only one input, there is no way to know any intermediate state of the breaker.

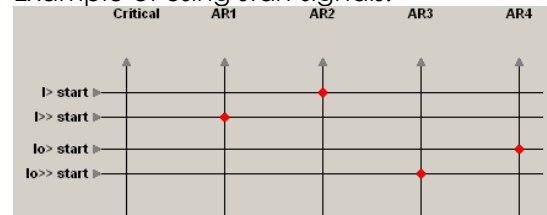
CTRL OBJECT 1	
Obj1 state	Open
DI for 'obj open'	DI1
DI for 'obj closed'	-
DI for 'obj ready'	-
Max ctrl pulse length	0.20 s
Completion timeout	10.00 s
Object 1 control	-

As the status is now known, we need to configure also the opening and reclosing of the breaker. Again, this happens "thru" the object 1. The open and close commands for the object 1 can be linked to any output relays in the submenu "Output matrix" (See the screenshot below).

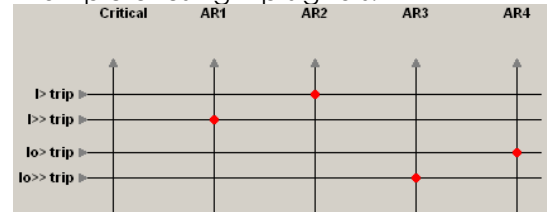


shot. On the other hand, the using of the trip signals enables easier setting and no coordination problems with the protection stages.

Example of using start signals:



Example of using trip signals:



The critical signal can be used the interrupt the AR sequence.

## AR general settings

There are many general settings for AR under the submenu "Auto reclosings". There it is possible to enable/disable the function, or use an input to enable. However, the most important setting here is the "reclaim time". This time specifies, how long the relay waits the fault to happen again.

For example, we had a phase-to-phase fault, so the overcurrent stage opens the CB. Then the AR will reclose the CB after 0.3 seconds. When the CB closes, the reclaim timer starts and waits, if the fault happens again. If the overcurrent stage trips again, then the AR will move to the shot 2 with a different settings. If there is no fault during the reclaim time, then the AR will reset and return to the standby stage, waiting for the next fault.

There are also a lot of AR counters that are available in this menu. The setting "AR info for mimic display" has no effect in VAMP 40. However, if a feeder manager is used, then this enables that the user can see the status of the AR at the main display.

## AR matrix setting

The AR matrix specifies which protection functions will initiate the AR function. Typically, there are two different "schools". Some prefer using start signals of the protection stages, some use the trip signals.

The benefit using start signals, that the burning times can be different from the time delays of the protection stages and they can also be different for each

## AR shots settings (trip signals)

There are 5 shots available for settings. If the trip signals are used, then the start delay and all the discrimination times can be ignored and left to their default values (0.02 s is the minimum setting and it means that there are no additional delays). The most important setting is the dead time settings. Each shot has its own dead time setting. The dead time means, how long the AR keeps the CB open, before the reclosing. Typically, shot 1 has very short dead time, like 0.3 or 0.4 seconds and then shot2 a longer dead time, like 60 or 120 seconds and then the final trip. Then one has to determine which AR lines will use shots. This is done easily clicking the text "Off". Then the clicked line will activate the current shot. For example, if instantaneous overcurrent does not have any shots, do not select any shots ON to the line AR1. If there are two shots for time-delayed overcurrent, select shot 1 and shot 2 to be ON, for the AR2 line. Then if the earth fault has only one shot (shot2), then select the lines AR3 and AR4 to be ON for the shot2. As there are no AR lines

ON for the shot 3, it means that the final trip is made after the shot 2.

Please see the example below:

AR Shot settings 79

Shot 1				
Enable	AR	Start delay	Dead time	Discrimination time
Off	1	0.02 s	0.3 s	0.02 s
On	2	0.02 s	0.3 s	0.02 s
Off	3	0.02 s	0.3 s	0.02 s
Off	4	0.02 s	0.3 s	0.02 s

Shot 2			
Enable	AR	Dead time	Discrimination time
Off	1	60 s	0.02 s
On	2	60 s	0.02 s
On	3	60 s	0.02 s
On	4	60 s	0.02 s

Shot 3			
Enable	AR	Dead time	Discrimination time
Off	1	5.00 s	0.02 s
Off	2	5.00 s	0.02 s
Off	3	5.00 s	0.02 s
Off	4	5.00 s	0.02 s

Another typical setting is to use three shots with the same dead time setting, like 5 seconds for each shot. Please see example below:

AR Shot settings 79

Shot 1				
Enable	AR	Start delay	Dead time	Discrimination time
Off	1	0.02 s	5 s	0.02 s
On	2	0.02 s	5 s	0.02 s
On	3	0.02 s	5 s	0.02 s
On	4	0.02 s	5 s	0.02 s

Shot 2			
Enable	AR	Dead time	Discrimination time
Off	1	5 s	0.02 s
On	2	5 s	0.02 s
On	3	5 s	0.02 s
On	4	5 s	0.02 s

Shot 3			
Enable	AR	Dead time	Discrimination time
Off	1	5.00 s	0.02 s
On	2	5.00 s	0.02 s
On	3	5.00 s	0.02 s
On	4	5.00 s	0.02 s

## AR shots settings (start signals)

The using of the start signals means, that each reclosing can have a different burning time. This feature is good, when

it is needed to burn tree branches, but keeping in mind the cooling of the conductor.

The selection of the used shots and the dead time setting is done as when using trip signals. However, now the start delay and discrimination times define the burning times. Please note the these times should be, at least 100 ms shorter than the delay of any protection stages. For example, if the definite time setting for the overcurrent stage is 0.4 seconds, then the maximum delay for the AR function is 0.3 seconds. If an inverse time characteristic is used, then the minimum tripping time has to be defined to determine the AR delay. An example using the delays. Firstly, we can have a longer burning time, as the conductor is not heated, yet. Secondly, after the first shot, we already decrease the burning time, not to heat the conductor too much. If also the shot 2 fails, the we use a short burning time. Please see this example next:

AR Shot settings 79

Shot 1				
Enable	AR	Start delay	Dead time	Discrimination time
Off	1	0.02 s	0.3 s	0.02 s
On	2	0.3 s	0.3 s	0.2 s
On	3	0.3 s	0.3 s	0.2 s
On	4	0.3 s	0.3 s	0.2 s

Shot 2			
Enable	AR	Dead time	Discrimination time
Off	1	60 s	0.1 s
On	2	60 s	0.1 s
On	3	60 s	0.1 s
On	4	60 s	0.1 s

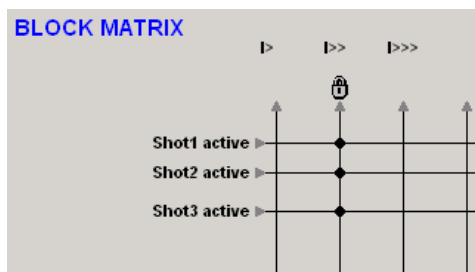
Shot 3			
Enable	AR	Dead time	Discrimination time
Off	1	5.00 s	0.02 s
Off	2	5.00 s	0.02 s
Off	3	5.00 s	0.02 s
Off	4	5.00 s	0.02 s

Please also make sure that none of the protection functions does a nuisance start. For example, it is very typical that the magnetizing inrush will start the overcurrent stage and then also the AR sequence. Therefore, the overcurrent stage should be blocked, if there is any inrush current. The stage 2. harmonic can be used for the blocking purposes.

## Blocking of the protection

In some cases, the AR function must be coordinated with downstream protection functions. Fuse protection is a very typical example. If there are fuses in the MV line, this could cause changes in the AR settings.

As an example, if all the branches are protected by fuses, it might be required to block the instantaneous protection after the first shot. Therefore, if the fault is on one of the branch, then the blocking will give time for a fuse to burn. The blocking can be done easily in the blocking matrix using the signal "Shot 1 active". This signal activates, when the first shot is started.



## Testing of the AR function

The testing is done as with any other stage. A secondary current injection device is needed. The important note is that the current injection must be stopped when the CB opens. Therefore, it is good to use the aux contacts of the CB to stop the current flowing, when the CB is in the open status. The correct operation times can be measured by starting the timer of the testing device, when the current injection starts. Then the timer is stopped when the CB change the status. Then the actual burning time is got. This time is the relay setting + the operation time of the CB.

## AR function availability

The AR function is available in the VAMP feeder managers VAMP 245, VAMP 230, VAMP 255 and VAMP 257. The function is also available in the feeder protection relay VAMP 40. Please note that the application setting must be "feeder".

This document applies firmware 5.56.

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Auto-reclosing, overload feeder, high and slow speed auto-reclosing

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