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APPLICATION GUIDE

SYNCHRONISING GUARD LOGIC – GENERAL APPLICATION NOTES – MICOM P14X

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SUMMARY

Traditionally when manual closure of a circuit breaker is required, a synchronism check relay is used to ensure that the voltages either side of the breaker are in a suitable state to permit closure. However, additional precautions are also taken such that an operator cannot pre-empt the indication from the synchronism check and to ensure that correct operational procedures are followed. In other words, making sure that synchronism is achieved BEFORE an attempt is made to close the breaker rather than initiating the close command and then waiting for synchronism. This additional precautionary step is performed by the synchronising guard function.

This application note looks at how this guard function can be implemented in the MiCOM P14x feeder management IEDs but could be used as a basis for similar designs in other MiCOM Px4x products with suitable manual CB control facilities.

Title	Name	Signature	Date
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1. INTRODUCTION

Traditionally when manual closure of a circuit breaker is required, a synchronism check relay is used to ensure that the voltages either side of the breaker are in a suitable state to permit closure. However, additional precautions are also taken such that an operator cannot pre-empt the indication from the synchronism check and to ensure that correct operational procedures are followed. In other words, making sure that synchronism is achieved BEFORE an attempt is made to close the breaker rather than initiating the close command and then waiting for synchronism. This additional precautionary step is performed by the synchronising guard function.

Alstom Grid Automation Business have provided a number of alternative devices based upon combinations of simple VAA auxiliary units for this function, culminating in the MVAZ03 in its current product portfolio. This application note looks at how this guard function can be implemented in the MiCOM P14x feeder management IEDs but could be used as a basis for similar designs in other MiCOM Px4x products with suitable manual CB control facilities.

This application note does not provide information about auto-synchronising or check synchronising functionality, other than that required to understand the operation of the guard functionality.

2. REFERENCES

REF.	DOC. NUMBER	DOC. NAME / TITLE
A	R6078C	Type MVAZ03 Auxiliary Guard Relay publication
B	R6045	Type MAVS 01, 02, 03 Check Synchronising Relay
C	P14x/EN OP/Dd5	CB Control logic from P14x service manual. See section 2.10, (OP)5-100

3. TRADITIONAL SOLUTION USING MVAZ03 AUXILIARY GUARD RELAY

3.1. TYPICAL APPLICATION

Figure 1 shows a typical application of the MVAZ03 auxiliary guard relay in conjunction with an MAVS check synchronising relay.

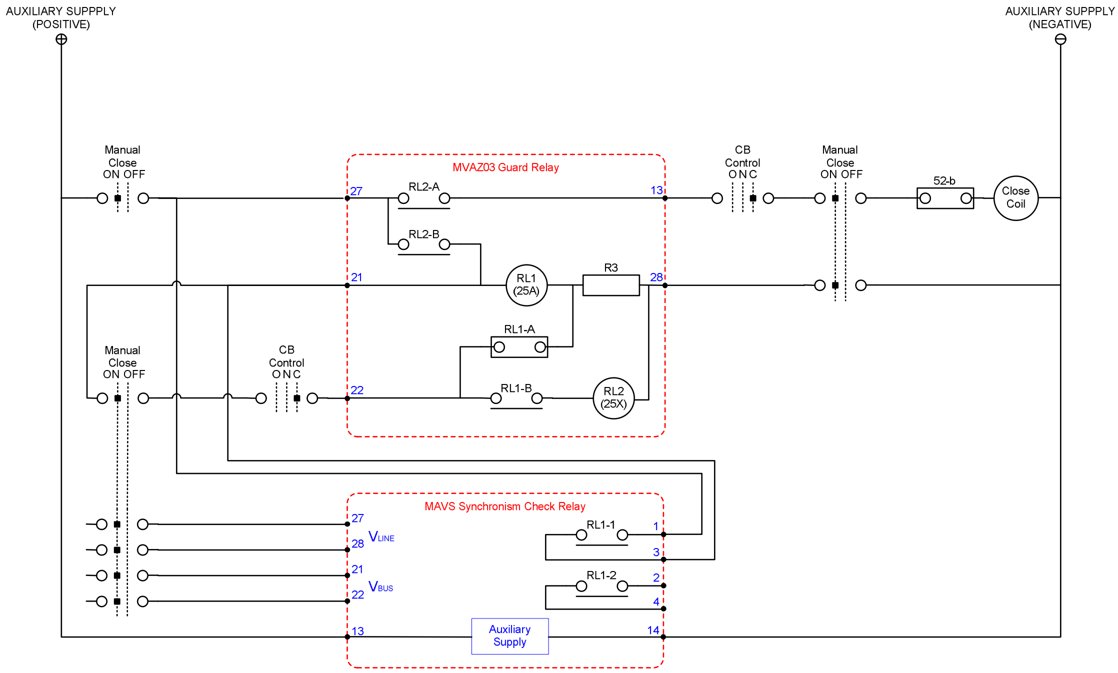

Figure 1: Typical check synchronising scheme with Auxiliary Guard Relay

In this application, the circuit is prepared by selecting the "Manual Close" switch into the ON position. When the external check synchronising relay (MAVS) detects a suitable closing condition, its contacts on terminals 1-3 and 2-4 close and allows element RL1 (25A) to operate in the MVAZ03. The two contacts labelled RL1-A and RL1-B within the MVAZ03 now change state, preparing the circuit for auxiliary element RL2 (25X). At this stage, element RL1 (25A) is not "sealed" in and will reset if the check synchronising relay contacts open before the CB Control ONC switch is operated.

When the operator has determined from external indicators that the closure conditions are satisfied, the CB Control ONC switch is operated. Provided the synchronising check relay contacts are still closed and the RL1 (25A) element is operated, element RL2 (25X) can now operate. Contact RL2-A in the MVAZ03 now completes the circuit to the CB closing coil whilst contact RL2-B prevents element RL1 (25A) resetting whilst the closing operation is in progress.

If the operator attempts to pre-close the circuit and wait for synchronising conditions to be satisfied, the MVAZ03 guard relay prevents the circuit being completed. If the CB Control ONC switch is operated and the contacts on terminals 1-3 of the MAVS are open, element RL1 (25A) is bypassed through its own normally closed contact. Since element RL1 (25A) is not able to operate, the circuit for element RL2 (25X) can also not operate and therefore closure can not occur.

3.2. TYPICAL APPLICATION WITH ADDITION "SYN" CONTACT PRE-CHECK

Some utilities have a concern that the synchronising contacts may be damaged and remain closed even though synchronising conditions are not satisfied. If this occurred, the guard function as described in clause **Error! Reference source not found.** would be bypassed since the RL1 (25A) element would be permanently permitted to operate. To prevent this happening, two additional auxiliary units were utilised to switch the AC voltage supplies to the synchronising relay and bypass any permanently closed check synchronising contact (see *Figure 2*).

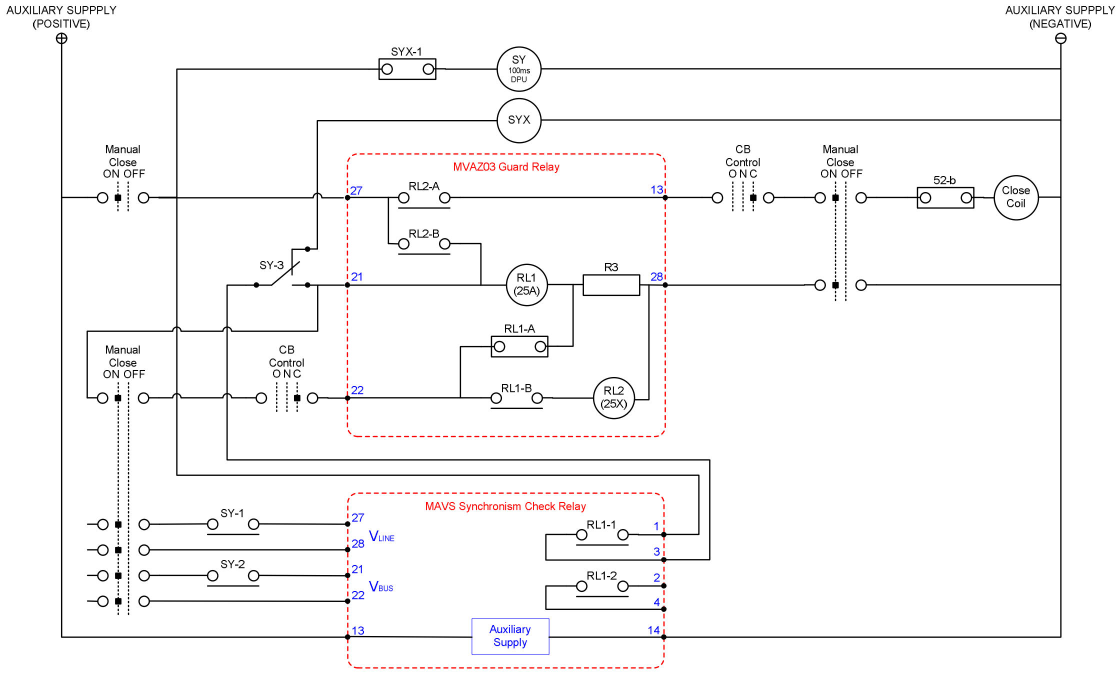

Figure 2: Typical check synchronising scheme with Auxiliary Guard Relay & "SYN" Contact Pre-check

In this application, the circuit is prepared by selecting the "Manual Close" switch into the ON position. If the external check synchronising relay contact is initially closed when the "Manual Close" switch is operated (indicative of a faulty check sync contact or relay), auxiliary element SYX is energised via the normally-closed SY contact (SY-3). Operation of the SYX element opens the normally-closed contact (SYX-1) and prevents the time delayed SY element from being energised. This prevents the positive voltage supply being routed to terminal 21 of the MVAZ03 guard relay and prevents operation of the RL1 (25A) element. As such the closing process is inhibited.

If the external check synchronising relay contact is initially open when the "Manual Close" switch is operated, auxiliary element SYX remains de-energised and auxiliary element SY operates after a short time delay. This connects the AC voltage supplies to the check synchronising relay but also opens the normally-closed contact (SY-3) and allows the normal sequence of operation of the MVAZ03 guard relay to continue (see clause **Error! Reference source not found.** for detailed explanation).

4. SOLUTIONS USING MICOM P14X FUNCTIONALITY

4.1. APPLICATION OF FIXED CB CONTROL LOGIC

The MiCOM P14x devices with check synchronising facilities (P143 / P145) have complex integral logic to control the manual operation of the CB. This includes anti-pumping (prevention of simultaneous open & close signals), manual close delay (permits operators to move away from the CB during closing process) and arguably guard relay functionality. Figure 3 shows the complete logic for the relay (see ref [C]).

Tracing this logic it may be seen that the closure of the CB can be initiated from a logic (opto-) input, user interface (local or remote) depending upon the settings in the “CB Control by” cell of the CB Control menu column. Provided that an auto-reclose (DAR) cycle isn’t in progress and the CB is seen as being open, the Control Close delay timer will be permitted to start timing. As such, although a request for closure has been made, no output is currently available to actually close the CB. On completion of the Control Close Delay time, two additional checks are made to assess whether it is safe to issue a closing pulse. The first check is whether the CB has sufficient energy (springs charge, or oil/gas pressure) to permit safe closure and re-trip if necessary. The second check is whether the synchronising check conditions are satisfied (as defined by the programmable scheme logic and “System Checks” settings). If all these conditions are satisfied then a Control Close pulse is given.

It is reasonably argued by some users that given the available check synchronising settings on the relay (notably the slip frequency monitoring facility) this method of operation of the fixed CB Control logic is adequate to negate the use of any additional logic or device such as the MVAZ03 guard relay.

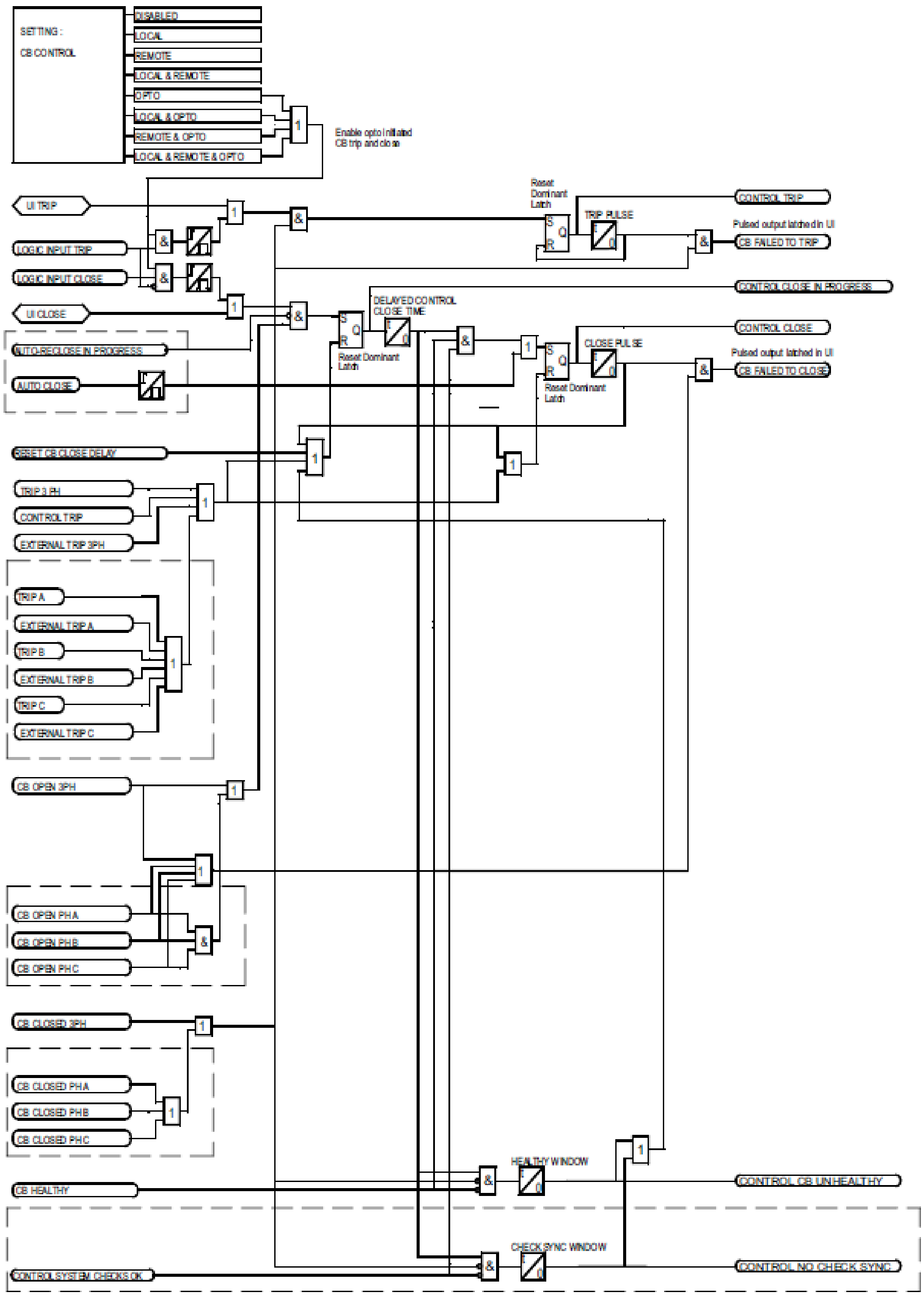

Figure 3: CB Control logic for the MiCOM P14x range of relays (see ref [C])

4.2. TYPICAL APPLICATION WITH ADDITIONAL GUARD LOGIC IN PSL

Although some users accept the internal facilities of the CB Control logic, others would prefer dedicated guard logic in line with that previously provided by the MVAZ03 guard relay. Given the powerful Programmable Scheme Logic (PSL) of the MiCOM Px4x range of devices, it is possible to provide the guard functionality without the need for external relays, as is shown in Figure 4 and Figure 5.

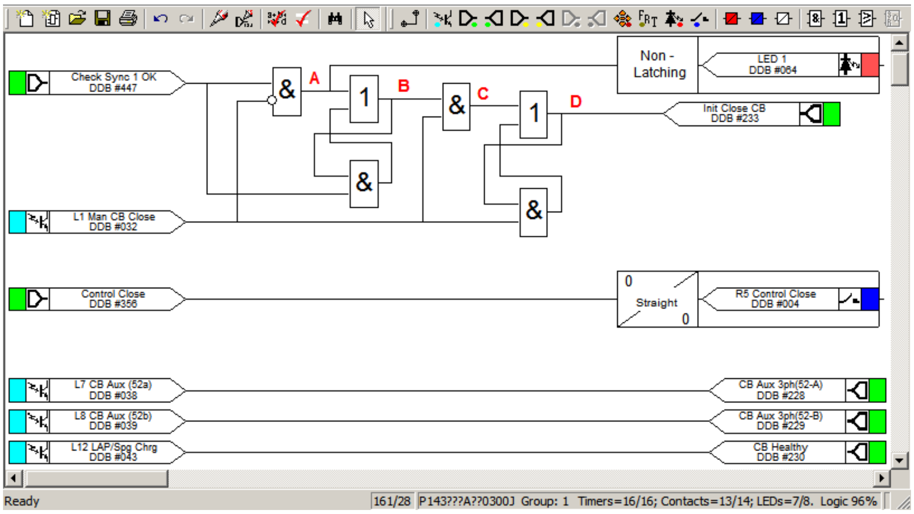

Figure 4: PSL Implementation of Guard Logic utilising conventional gate types

In the arrangement shown in Figure 4, inputs L7, L8 and L12 are required to enable the CB control facilities of the relay in conjunction with appropriate setting of the CB Control menu settings. Without these inputs, CB control using the integral logic of the relay is not possible because it is not aware of the healthy status or position of the breaker. Given that these inputs are appropriately connected, if the relay measures an in synchronism condition (DDB#447) and no request for manual closure has been received on input L1, point 'A' becomes active and LED1 is illuminated to indicate that the voltage conditions are suitable for closure. Point 'B' will also become active and will maintained as long as DDB#447 is on. When input L1 is energised, point 'C' will become active and allow point 'D' to initiate the command to close the CB, as long as the manual close input (L1) is maintained. The fixed logic of the relay (see clause **Error! Reference source not found.**) will allow closure of a suitable relay contact (R5 in the example logic).

If a user attempts to operate L1 before suitable closing conditions are available, point 'A' can never be activated and the process can not be started. Similarly, if in synchronism conditions are lost at any point during the procedure, the process is terminated, either by preventing operation of point 'D' or the fixed logic of the relay preventing closure.

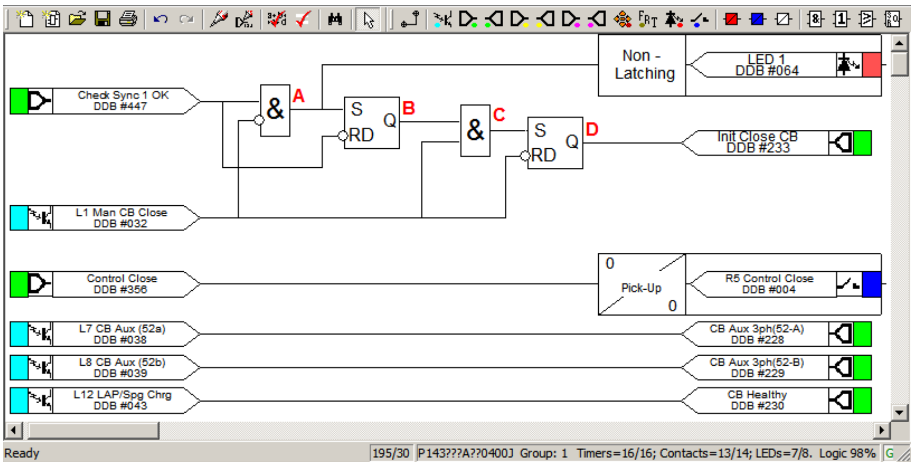

Figure 5: PSL Implementation of Guard Logic utilising S-R Latches (firmware V40 & later)

The arrangement of Figure 5 is only different from that of Figure 4 in so much as the reset dominant S-R latches are now used instead of the conventional logic gates to create the signals at points B and D.

Operationally, the logic is identical to that described previously and its advantage is that it aesthetically more attractive.

It should be considered that the logic shown in Figure 4 and Figure 5 only show the minimum detail in order to attain guard functionality. Additional checks could be made into the 'AND' gate at point A to ensure that closure was only permitted after the appropriate sequence had been followed. Additionally, the in synchronism signal could be replaced by more complex logic to allow a variety of closing conditions e.g dead-line charging conditions. Additional LED indications or user alarm messages could also be used to direct the operator in the correct sequence to be followed for successful closure.

4.3. TYPICAL APPLICATION WITH ADDITIONAL "SYN" CONTACT PRE-CHECK

As discussed in clause 3.2, additional auxiliary units were deployed to prevent incorrect CB closures if the check synchronising relay contact had been become damaged to short-circuit. In the case of the MiCOM P143 or P145, the check synchronising facilities are integrated into the relay and therefore the in-synchronism contact is only a "software" logic state and cannot suffer from this problem. However, if the additional security check is preferred, again this could be implemented using the PSL of the relay. This is shown in Figure 6.

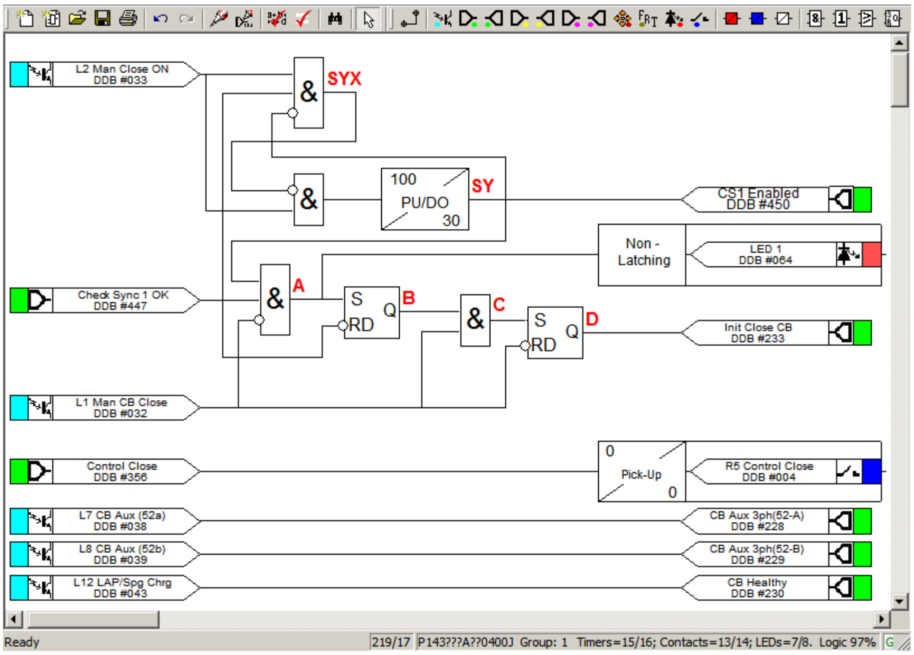

Figure 6: PSL Implementation of Guard Logic utilising S-R Latches (firmware V40 & later) with additional "SYN" contact pre-check

The arrangement of Figure 6 is the same as Figure 5 but with the addition of the "SYX" and "SY" element to control when the relay can output an in synchronism condition on DDB #447. If for any reason, DDB #477 was on when input L2 was energised at the start of the closure sequence, point SYX would be activated and prevent point SY from being on. With SY in the off state, the check synchronising element CS1 would be prevented from operating since DDB#450 remains de-energised. Additionally, point A cannot be on to allow the manual closure signal from being used on input L1. For closure to be permitted, at the start of the closure sequence the Check Sync 1 OK signal must be off such that when input L2 was energised, the point SYX remains off. This would allow the SY element to operate, thereby enabling the check synchronising element via DDB#450 and allowing point A to be activated when the appropriate synchronising conditions had been met, without input L1 being energised.

As with the arrangements of clause 4.2, the logic shown is only indicative on the minimum detail required to provide the functionality required. However, the arrangement of the “SY” and “SYX” could be used to provide other interlocking logics to prevent decisions made before activation of the closure circuit being utilised in the closing signal.

5. CONCLUSIONS

This document has shown two traditional applications of the MVAZ03 auxiliary guard relay that have found widespread use in previous years. It has shown how these traditional arrangements can be integrated into the MiCOM P14x range of devices using the Programmable Scheme Logic and without the need for independent check synchronising, or additional auxiliary relays. It is hoped that these arrangements can be utilised by end-users to further enhance the security of the circuit breaker closure signal and sequence to ensure safe operation.

REVIEW HISTORY

Issue	Name	Position
C	M Stockton	Business Development Manager

VERSION CONTROL

Issue	Author(s)	Reason for change	Date
A	M Stockton	Original	21/09/09
B	M Stockton	Formatting modifications and new document template applied in line with transition to Alstom Grid. No technical changes or modifications.	04/02/11
C	M Stockton	New format only	20/02/12