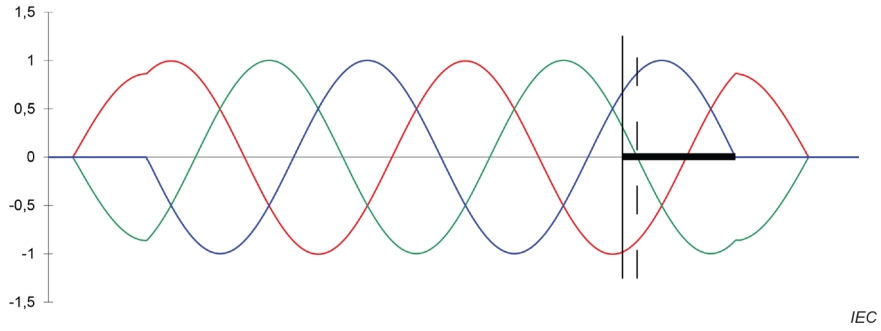
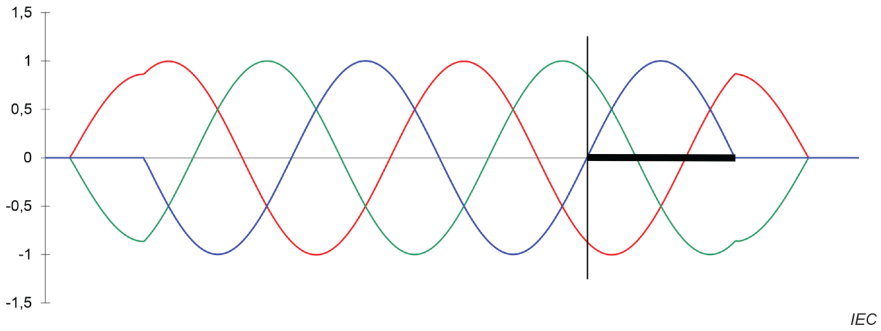
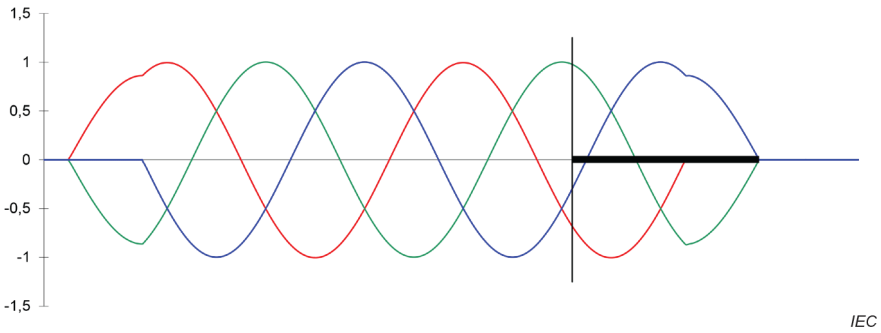


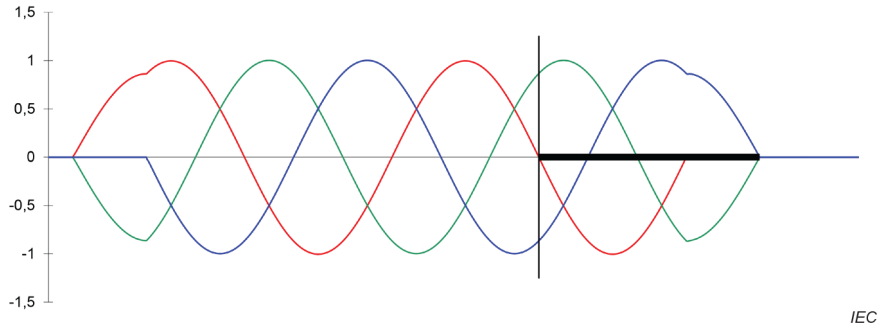
Tests No. 1 and No. 2: Application of the TRV on the first-pole-to-clear



Test No. 3: Application of the TRV on the first-pole-to-clear



Test No. 4: Application of the TRV on the last-pole-to-clear with extended loop



Test No. 5: Application of the TRV on the last-pole-to-clear with extended loop

Figure D.3 – Representation of the testing conditions of Table D.2

Table D.3 – Demonstration of arcing times for k_{pp} = 1,3

Test no.	Test sequence [a]	Arc duration (additional to $t_{arc\ min}$ of the first-pole-to-clear for the phase subjected to the TRV) [b]	Test condition (with reference to the three-phase system)	TRV		Injected current
				Application (with reference to the three-phase current circuit)	u_c value p.u.	di/dt %
1	Os	0	$t_{arc\ min}$ on the first-pole-to-clear	first-pole-to-clear	1,0	100
2	Os	$-T$ × dα / 360°	Re-ignition in the first-pole-to-clear to confirm the $t_{arc\ min}$	first-pole-to-clear	1,0	100
3	Od-t-CdOs	T × 162° / 360° (T × 42° / 360° related to the first-pole-to-clear)	$t_{arc\ max}$ on the third-pole-to-clear [c]	third-pole-to-clear	1,0	100
4	CdOs	T × 81° / 360° (T × 4° / 360° related to the first-pole-to-clear)	$t_{arc\ med}$ [c]	second-pole-to-clear	1,0	100

Demonstration of the arcing times as per 7.104.3.2 of IEC 62271-100:2021.

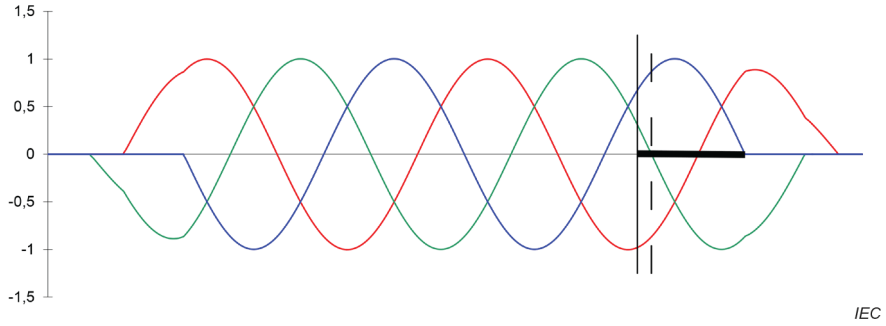
Interrupting window as per Figure 40 of IEC 62271-100:2021.

Figure D.4 gives a representation of the testing conditions.

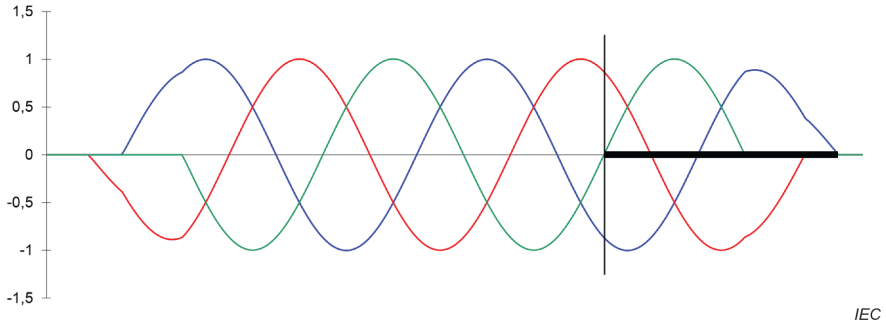
[a] Abbreviations are in accordance with Table 6.

[b] Where dα = 18°.

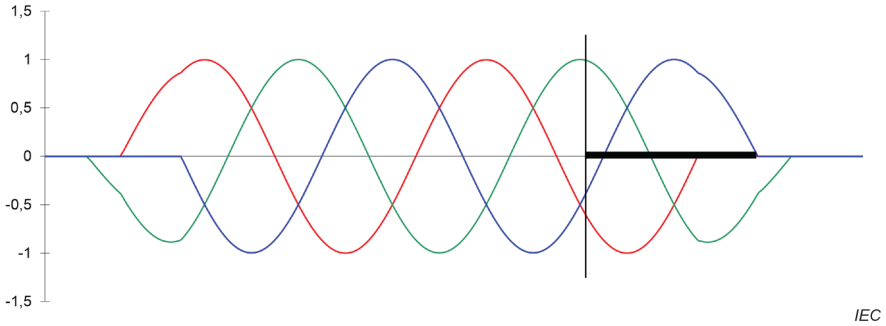
[c] Arcing times for test 3 and test 4 can be interchanged.



Tests No. 1 and No. 2: Application of the TRV on the first-pole-to-clear



Test No. 3: Application of the TRV on the third-pole-to-clear



Test No. 4: Application of the TRV on the second-pole-to-clear

Figure D.4 – Representation of the testing conditions of Table D.3

Table D.4 – Alternative demonstration of arcing times for k_{pp} = 1,3

Test no.	Test sequence [a]	Arc duration (additional to $t_{arc\ min}$ of the first-pole-to-clear for the phase subjected to the TRV) [b]	Test condition (with reference to the three-phase system)	TRV		Injected current (di/dt) %
				Application (with reference to the three-phase current circuit)	u_c value p.u.	
1	Os	0	$t_{arc\ min}$ on the first-pole-to-clear	first-pole-to-clear	1,0	100
2	Os	$-T$ × dα / 360°	Re-ignition in the first-pole-to-clear to confirm $t_{arc\ min}$	first-pole-to-clear	1,0	100
3	(Cd)Os	T × 42° / 360°	$t_{arc\ max}$ on the first-pole-to-clear	first-pole-to-clear	1,0	100
4	Od–t–CdOs	T × 77° / 360°	$t_{arc\ min}$ on the second-pole-to-clear [c]	second-pole-to-clear	0,97	89
5	CdOs	T × 119° / 360°	$t_{arc\ max}$ on the second-pole-to-clear [c]	second-pole-to-clear	0,97	89
6	(Cd)Os	T × 162° / 360°	$t_{arc\ max}$ on the third-pole-to-clear	third-pole-to-clear	0,77	57

Demonstration of the arcing times as per 7.104.3.5 of IEC 62271-100:2021.

Interrupting window as per Figure 40 of IEC 62271-100:2021.

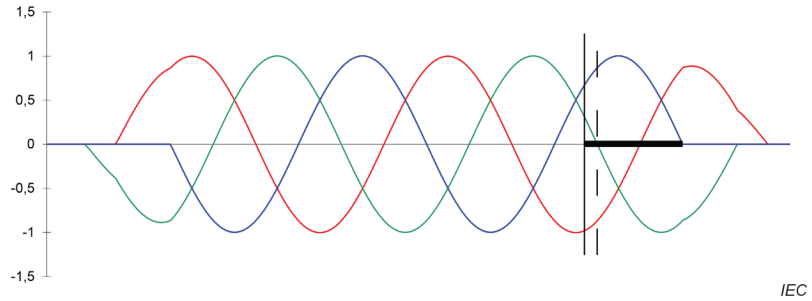
Figure D.5 gives a representation of the testing conditions.

In case of failure during test 5 or 6, the circuit-breaker can be reconditioned and test 4 to test 6 shall be repeated. The test series is passed if no further failure occurs.

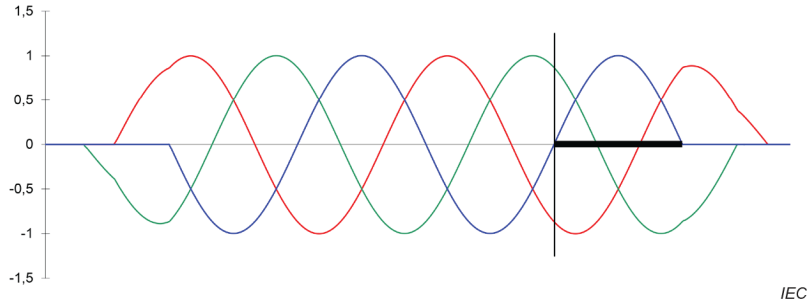
[a] Abbreviated terms are in accordance with Table 6.

[b] Where dα = 18°.

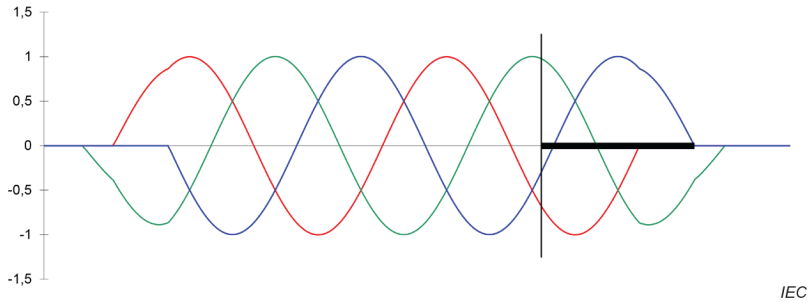
[c] Arcing times for test 4 and test 5 can be interchanged.



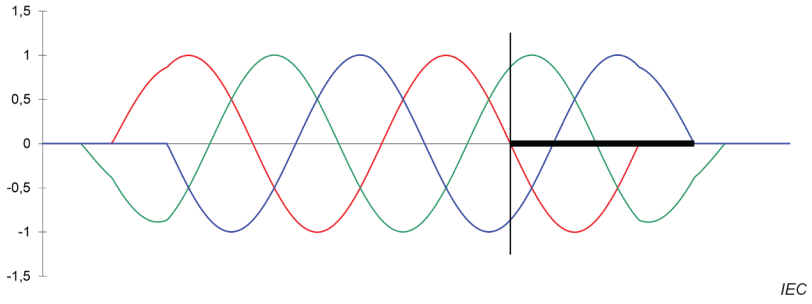
Tests No. 1 and No. 2: Application of the TRV on the first-pole-to-clear



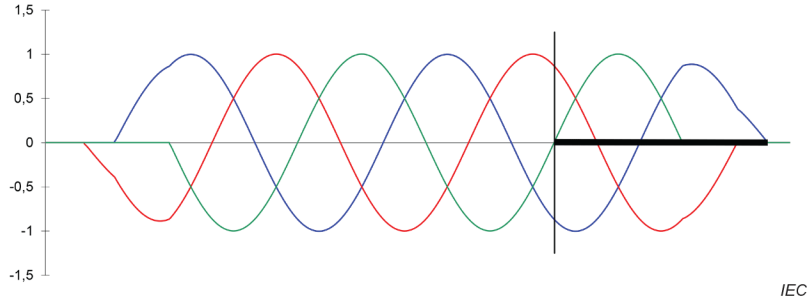
Test No. 3: Application of the TRV on the first-pole-to-clear



Test No. 4: Application of the TRV on the second-pole-to-clear



Test No. 5: Application of the TRV on the second-pole-to-clear



Test No. 6: Application of the TRV on the third-pole-to-clear

Figure D.5 – Representation of the testing conditions of Table D.4

D.2.3 Test duty T100a

The three-phase test procedure for demonstration of arcing times according to 7.104.2.2 is given in Table D.5 and Table D.6 for a first-pole-to-clear factor of 1,5 and in Table D.7 and Table D.8 for a first-pole-to-clear factor of 1,3.

It is recognized that the tests of Table D.5 and Table D.7 are more severe than three-phase tests because the arcing time of the last-pole-to-clear or second-pole-to-clear is used together with the TRV of the first-pole-to-clear. As an alternative, the manufacturer can choose to split each test duty into two or three separate test series for demonstration of the arcing times in accordance with 7.104.3.5 of IEC 62271-100:2021. The procedures are given in Table D.6 for a first-pole-to-clear factor of 1,5 and in Table D.8 for a first-pole-to-clear factor of 1,3. For tests performed in accordance with Table D.6 and Table D.8, each test series shall demonstrate a successful interruption with the minimum and maximum arcing time for each pole-to-clear with its associated TRV. Re-conditioning of the circuit-breaker after each test series is permitted and shall comply with the requirements of 7.102.9.6 of IEC 62271-100:2021.

If a failure occurs while demonstrating the maximum arcing time on the second- or last-pole-to-clear using the procedure of Table D.5 or Table D.7, then it is permissible to continue testing using the test procedure of Table D.6 or Table D.8. In this case, provided no re-conditioning of the circuit-breaker has taken place, the tests demonstrating minimum and maximum arcing time on the first-pole-to-clear can be omitted.

To avoid changing the connection of the high-voltage circuit between tests on the first, second and third-pole-to-clear, all the required arcing times can be applied on the same pole with the same polarity of the recovery voltage.

Table D.5 – Demonstration of arcing times for k_{pp} = 1,5

Test no.	Test sequence	Asymmetry condition	Arc duration (additional to $t_{arc\ min}$ of the first-pole-to-clear for the phase subjected to the TRV)[a]	Test condition (with reference to the three-phase system)	TRV		Injected current (di/dt) %
					Application (with reference to the three-phase current circuit)	u_c value p.u.	
1	Os	Major loop – intermediate (Table E.12 or Table E.15 col. 7 and 8)	0	$t_{arc\ min}$ on first-pole-to-clear Required asymmetry on the last-pole-to-clear with extended major loop	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 9)
2	Os	Major loop – intermediate (Table E.12 or Table E.15 col. 7 and 8)	$-T \times d\alpha/360°$	Re-ignition in the first-pole-to-clear to confirm the $t_{arc\ min}$ Required asymmetry on the last-pole-to-clear with extended major loop	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 9)
3	Os	Major loop – rated (Table E.12 or Table E.15 col. 3 and 4)	$\Delta t_{a1} - T \times d\alpha/360°$	t_{arc1} with major loop and required asymmetry on the first-pole-to-clear	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 5)
4	Os	Major loop – rated (Table E.12 or Table E.15 col. 10 and 11)	$\Delta t_{a2} - T \times d\alpha/360°$	t_{arc2} and required asymmetry on the last-pole-to-clear with extended major loop	last-pole-to-clear with extended loop	1,0	(Table E.12 or Table E.15 col. 12)

Figure D.6 gives a representation of the testing conditions.

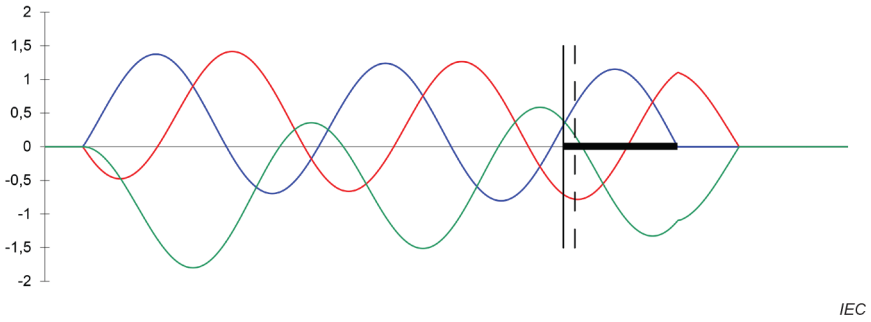
Values for the TRV reduction due to asymmetry can be found in Annex A.

[a] Where

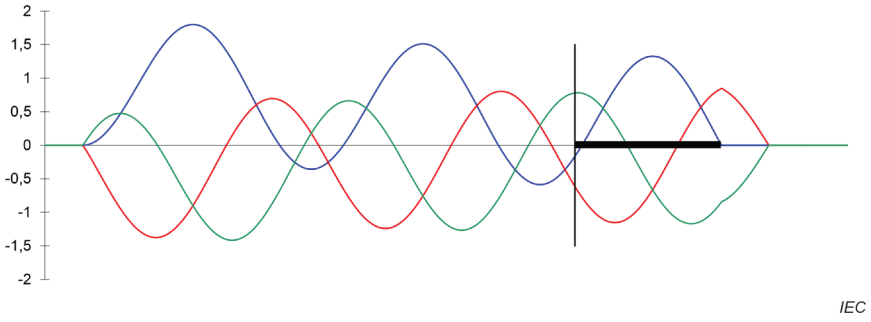
Δt_{a1} is the relevant parameter to be selected from Table E.12 or Table E.15 column 6;

Δt_{a2} is the relevant parameter to be selected from Table E.12 or Table E.15 column 14;

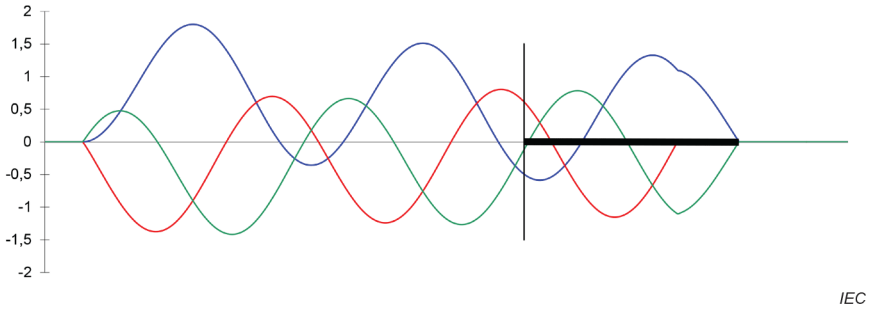
$d\alpha$ = 18°.



Tests No. 1 and No. 2: Application of the TRV on the first-pole-to-clear



Test No. 3: Application of the TRV on the first-pole-to-clear with major loop



Test No. 4: Application of the TRV on the last-pole-to-clear with extended major loop

Figure D.6 – Representation of the testing conditions of Table D.5

Table D.6 – Alternative demonstration of arcing times for k_{pp} = 1,5

Test no.	Test sequence	Asymmetry condition	Arc duration (additional to $t_{arc\ min}$ of the first-pole-to-clear for the phase subjected to the TRV)[a]	Test condition (with reference to the three-phase system)	TRV		Injected circuit (di/dt) %
					Application (with reference to three-phase current circuit)	u_c value p.u.	
1	Os	Major loop – intermediate (Table E.12 or Table E.15 col. 7 and 8)	0	$t_{arc\ min}$ on first-pole-to-clear Required asymmetry on the last-pole-to-clear with extended major loop	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 9)
2	Os	Major loop – intermediate (Table E.12 or Table E.15 col. 7 and 8)	$-T \times d\alpha/360°$	Re-ignition in the first-pole-to-clear to confirm the $t_{arc\ min}$ Required asymmetry on the last-pole-to-clear with extended major loop	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 9)
3	Os	Major loop – rated (Table E.12 or Table E.15 col. 3 and 4)	$\Delta t_{a1} - T \times d\alpha/360°$	t_{arc1} with major loop and required asymmetry on the first-pole-to-clear	first-pole-to-clear	1,0	(Table E.12 or Table E.15 col. 5)
4	Os	Major loop – rated (Table E.12 or Table E.15 col. 10 and 11)	(Table E.12 or Table E.15 col. 13) °	$t_{arc\ min}$ on the last-pole-to-clear and required asymmetry on the last-pole-to-clear with extended major loop	last-pole-to-clear with extended loop	0,58	(Table E.12 or Table E.15 col. 12)
5	Os	Major loop – rated (Table E.12 or Table E.15 col. 10 and 11)	$\Delta t_{a2} - T \times d\alpha/360°$	t_{arc2} and required asymmetry on the last-pole-to-clear with extended major loop	last-pole-to-clear with extended loop	0,58	(Table E.12 or Table E.15 col. 12)

Figure D.7 gives a representation of the testing conditions.

Values for the TRV reduction due to asymmetry can be found in Annex A.

If tests are performed after a failure of test 4 in Table D.5 and no re-conditioning of the circuit-breaker has taken place, then tests can continue from test 4 in Table D.6.

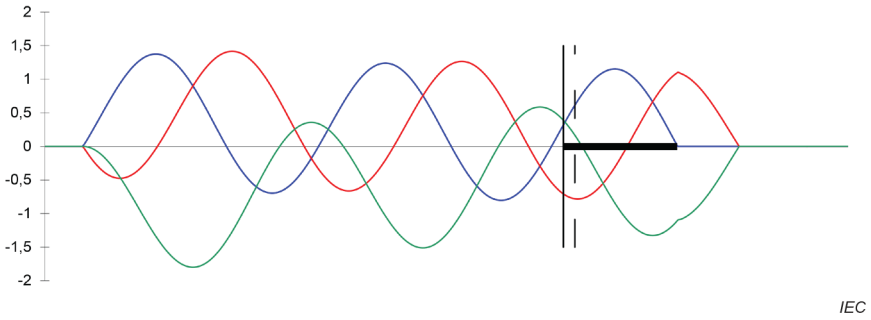
In case of failure during test 5, the circuit-breaker can be reconditioned and test 3 to test 5 shall be repeated. The test series is passed if no further failure occurs.

[a] Where

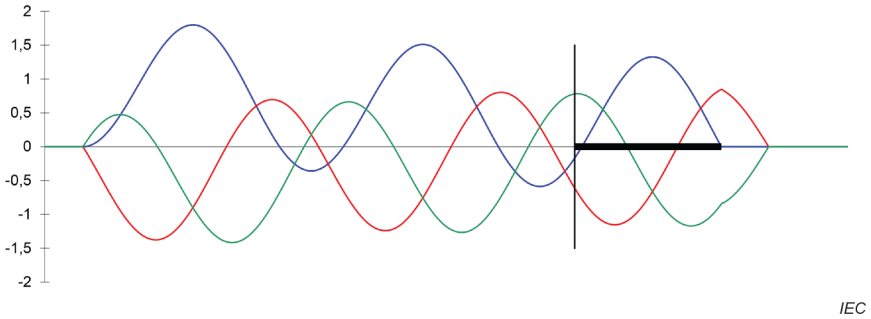
Δt_{a1} is the relevant parameter to be selected from Table E.12 or Table E.15 column 6;

Δt_{a2} is the relevant parameter to be selected from Table E.12 or Table E.15 column 14;

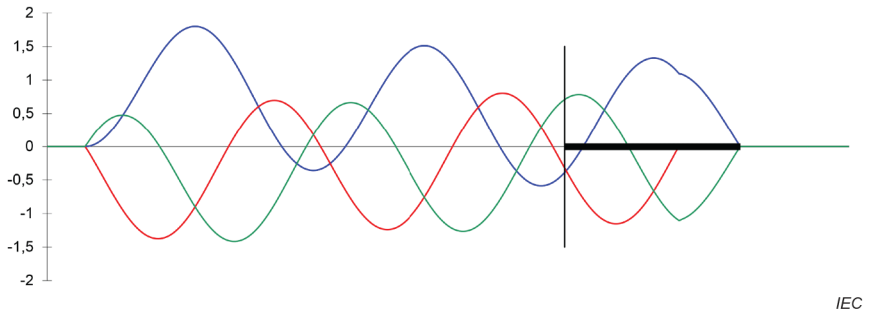
$d\alpha$ = 18°.



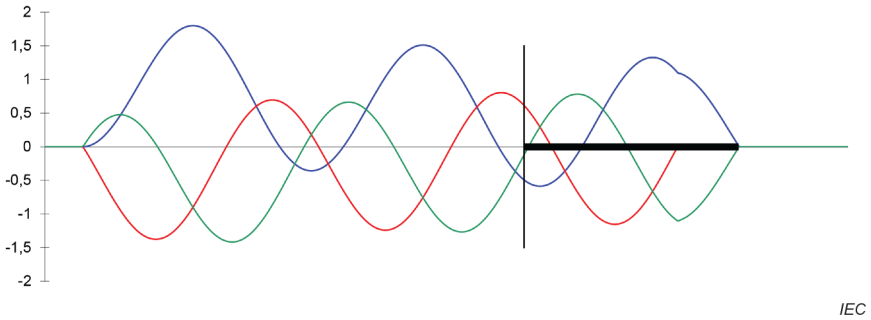
Tests No. 1 and No. 2: Application of the TRV on the first-pole-to-clear



Test No. 3: Application of the TRV on the first-pole-to-clear with major loop



Test No. 4: Application of the TRV on the last-pole-to-clear with extended major loop



Test No. 5: Application of the TRV on the last-pole-to-clear with extended major loop

Figure D.7 – Representation of the testing conditions of Table D.6