Protection
and control

Sepam range
Sepam 1000
Testing

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Sepam tests

When commissioning Sepam, it is not necessary to test the metering and protection functions individually.

Sepam has been designed and developed to provide the following functions:

- protection,
- metering,
- program logic.

Each of the functions has been fully tested. In addition, Sepam has a highly efficient self-testing system which continuously checks function integrity (e.g. no settings outside the tolerance range, etc.).

The product is ready to use, which simplifies commissioning.

By simply testing a function, the user is assured of overall device operation, provided the device has been correctly installed.

It is therefore sufficient to check that Sepam has been installed properly.

The following are checked:

- parameter setting,
- current and voltage transformer connections,
- switchgear control and annunciation connections.

The chapter entitled **commissioning tests** describes the simple, thorough method used for checking.

Individual testing of each protection and control function is no longer essential. However, should it be necessary to test a function, please refer to the section entitled **function tests**.

commissioning tests

This test procedure is used to check Sepam connections, parameter settings and adjustments prior to commissioning.

It does not involve testing individual protection functions which are factory-tested.

The use of this test method considerably reduces commissioning time.

procedure

Setting the parameters
(use the corresponding setting sheets, which are found in the appendix, to set the parameter and adjustment values)

- status
- program logic
- protection setting

Performing the tests
Use the test sheet in the appendix, which indicates:

- the tests to be performed
- the test equipment connection diagram
- the expected results (if the test results do not comply, the user should search for the cause)
  - □ parameter setting (status, microswitch settings …)
  - □ wiring
  - □ etc …
- an ☒ in a box indicates that the test has been performed and the results are satisfactory.

The following items are required for testing:

- testing equipment, refer to the chapter entitled **testing equipment**,
- Sepam 1000 documentation:
  - □ metering and protection functions (AC0396 (1)),
  - □ control and monitoring functions (AC0396 (1)),
  - □ use and commissioning (3140742 (1)),
  - □ installation (3140744 (1)).

(1) reference number followed by A for English version and F for French version

protection function tests

measurement and testing method

introduction

This chapter describes the procedures used to test the protection functions that are available in the Sepam 1000 range.

The tests call for:

■ knowledge of how to use Sepam 1000

■ a set of testing equipment

■ documentation

The tests that are described relate to the method referred to as the "current and voltage transformer secondary injection" method.

general information

Each protection function may be activated individually by disabling the set-points of the other functions. Activating and deactivating functions does not interfere in any way with function operation.

Most of the tests may be performed using a SINGLE-PHASE injection unit,

Three-phase injection is recommended for checking certain functions, in particular:

■ earth fault current measured by the sum of the 3 CTs,

■ neutral voltage displacement measured by the sum of the 3 VTs,

■ positive sequence undervoltage.

Terminal boxes (type "Entrelec, Secura, etc…) are generally used for testing in LV cubicles, which means that it is not necessary to disconnect any existing wiring connections.

checks

■ prior to energizing

Check:

□ Sepam auxiliary voltage,

□ connectors plugged in,

□ setting of microswitches on the EM, EA and ET modules,

□ connection of the core balance CT,

□ wiring of currents and voltages (rotation and matching),

□ wiring and polarization of the required inputs and ouputs.

■ after energizing

□ set the parameters in the **status** loop,

■ prior to injection

□ set the values of the protections to be tested,

□ disable the set-points of other protections that are liable to interfere with testing.

N.B.
Remember to reactivate the protections at the end of testing (protections are generally disabled by setting to 999, kA, kV, etc …).

■ tolerance ranges and injection limits

□ current:

- minimum 5% of CT In (50 mA or 250 mA) (1),
- maximum 3 times steady state In (3 A or 15 A) (1), 24 times In for 3s (24 A or 120 A) (1),
- 50 Hz (±10%) or 60 Hz;

□ voltage:

- minimum 1.5% of Un (0.86% of Vn) i.e. 1.5 V for 100 V (2),
- maximum 150% of Un,
- 50 Hz (±10%) or 60 Hz.

Remarks:
In order to simplify the presentation of examples, injection current values are given in **primary** amps (like Sepam measurements).

When the current injection unit is equipped with electronic ON/OFF controls, check that current is zero in the automatic **OFF** position (since the static contactor may allow more than 5% of the current to flow through, depending on the position of the cursor). When the starts per hour protection is being tested, in particular, the current that is broken should be less than 10% of Ib.

(1) according to microswitch 1 or 5 A setting
(2) according to VT secondary (Uns) setting
Un : phase-to-phase voltage
Vn : phase voltage
In : CT primary rated current
Ib : exact load current (manufacturer data)

phase overcurrent protection

ANSI code 50-51

equipment

■ single-phase or three-phase current generator
■ ammeters
■ adapter for EA module
■ chronometer
■ documentation

injection unit wiring

■ diagram B1 or B2 or B7 or B8
■ protective relay outputs:
low set: I >→ (10010 by default)
high set: I >>→ (10010 by default)
logic discrimination: START→ (00100 by default)

test

■ read the section entitled **measurement and testing method**

This protection is three-phase and may be tested on each phase individually with single-phase current.

■ **status** parameter setting

□ select the value of the CT primary circuits or CSP sensor

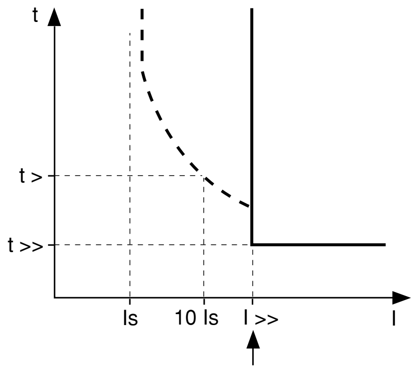
□ check the microswitches (1A or 5A) which correspond to the CT secondary circuits or check and set the microswitches on the EA module.

Remark:
■ injecting the test current in phase 2 disables the negative sequence and thermal overload protections, which only function with currents in phases 1 and 3.

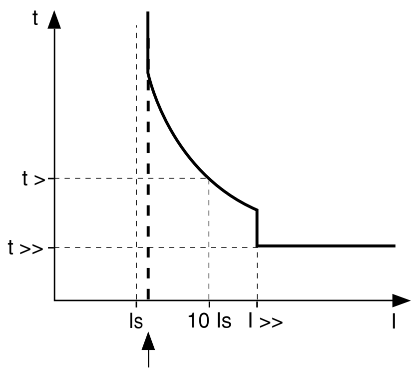
■ injecting the same current in two phases, in phase opposition, disables the earth fault protection (diagram B8).

procedure

Checking of high set-point
■ disable the low set-point if necessary by setting Is to 999 kA
■ gradually inject current until the alarm message "PHASE FAULT" appears
■ the set-point is the current value at which the message appears



Checking of low set-point
■ reset the setting current parameter Is
■ gradually inject current until the alarm message "PHASE FAULT" appears
■ the set-point is the current value at which the message appears
Reminder: With definite time (and RI curve), the set-point is at Is. With IDMT, the set-point is at 1.2Is



Remember to reactivate the protections at the end of testing.

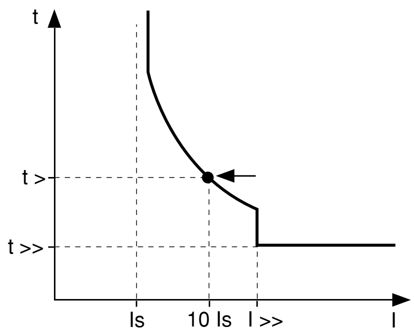
ANSI code 50-51

procedure (cont'd.)

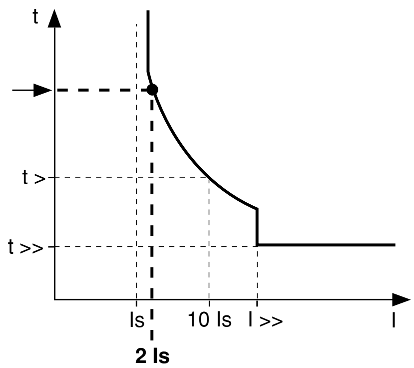
Checking of low set time delay (10Is)
For IDMT curves, the simplest method consists of measuring the time delay at 10Is in order to find the set value of t>.

■ if the high set I>> is less than or equal to 10Is, disable it during the test so as not to measure t>> instead of t>.

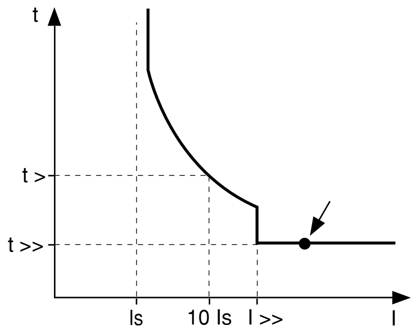
■ measure the tripping time for the current that corresponds to 10Is. Expected accuracy: ±5% or ±25 ms.



Checking of type of curve (2Is)
■ measure the tripping time for the current that corresponds to 2Is. Expected accuracy: ±12.5%.



Checking of high set time delay
■ measure the tripping time for a current greater than 1.3 times the high set-point.



earth fault protection

ANSI code 50N-51N or 50G-51G

equipment

■ single-phase or three-phase current generator

■ ammeters

■ CT

■ adapter for EA module

■ chronometer

■ documentation

injection unit wiring

■ diagram B1 or B6 or B7

■ protective relay outputs:

low set: Io >→ (10001 by default)

high set: Io >>→ (10001 by default)

logic discrimination: START→ (00100 by default)

test

■ read the section entitled **measurement and testing method**

■ **status** parameter setting

□ select the Io measurement method: interposing ring CT, core balance CT or sum of CTs

□ check the microswitches on the EM and EA modules

□ check the connection of the interposing ring CT to the connector

N.B. Do not inject current directly into the terminals of the earth fault connector (item 2A). Inject it into the primary circuit of the CSH interposing ring CT.

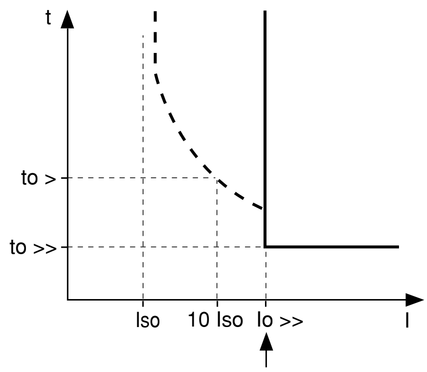
procedure

Checking of high set-point

■ disable the low set-point if necessary by setting Iso to 999 kA

■ gradually inject current until the alarm message "Io FAULT" appears

■ the set-point is the current value at which the message appears



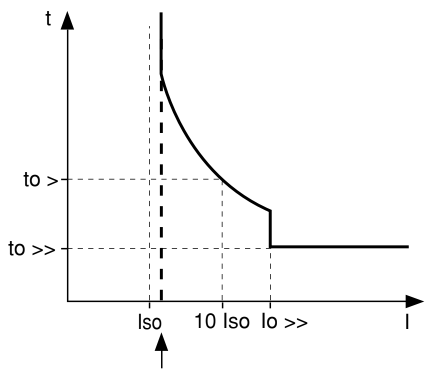
Checking of low set-point

■ reset the setting current parameter Iso

■ gradually inject current until the alarm message "Io FAULT" appears

■ the set-point is the current value at which the message appears

Reminder: With definite time (and RI curve), the set-point is at Iso. With IDMT, the set-point is at 1.2Iso.



Remember to reactivate the protections at the end of testing.

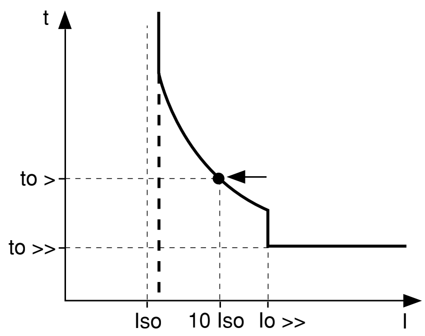
ANSI code 50N-51N or 50G-51G

procedure (cont'd.)

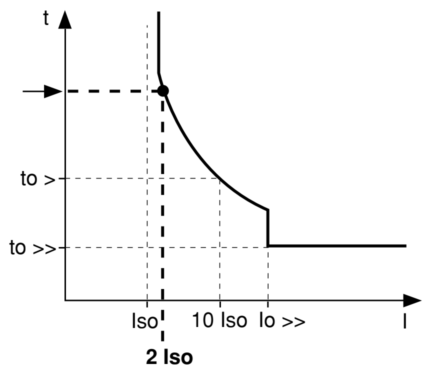
Checking of low set time delay (10Iso)
For IDMT curves, the simplest method consists of measuring the time delay at 10Iso in order to find the set value of to>.

■ if the high set Io>> is less than or equal to 10Iso, disable it during the test so as not to measure to>> instead of to>.

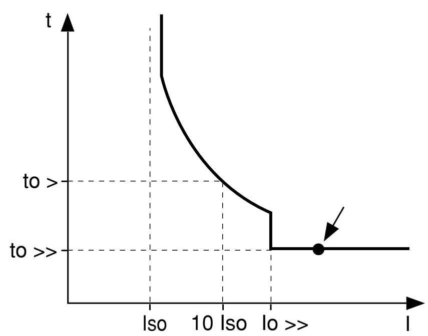
■ measure the tripping time for the current that corresponds to 10Iso. Expected accuracy: ±5% or ±25 ms (for Iso > 0.2Ino).



Checking of type of curve (2Iso)
■ measure the tripping time for the current that corresponds to 2Iso. Expected accuracy: ±12.5% (for Iso > 0.2Ino).



Checking of high set time delay
■ measure the tripping time for a current greater than 1.3 times the high set-point.



Remember to reactivate the protections at the end of testing.

ANSI code 49

equipment

■ single-phase current generator

■ ammeters

■ chronometer

■ CSP adapter

■ calculator

■ documentation

wiring

■ diagram B1 or B2 or B7 or B8

■ protective relay outputs:

tripping: E>→ (10000 by default)

alarm: ALARM→ (00000 by default)

test

■ read the section entitled **measurement and testing method**

■ To check the protection, it is sufficient to inject current in a single phase.

Phase 1 or 3 should be used.

For motor applications, consideration must be given to the fact that the negative sequence current produced has an effect on protection operation.
If I is the the current injected in phase 1 or 3, the negative sequence current Ii will be $I/\sqrt{3}$. This gives $Ieq^2 = I^2 + 4.5.I^2/3$, i.e. I/Ieq = 0.632.

For motor applications (LXM01 and LXM02), it is possible to simulate the injection of a balanced 3-phase current I by injecting a single-phase current of 0.632I.

For transformer applications, injecting single-phase current into phases 1 or 3 is equivalent to a three-phase injection.

■ **status** parameter setting

□ select the value of the CT primary circuits

□ set the value of Ib (rated current given on the manufacturer's plate of the motor or transformer)

□ check the microswitches (1 A or 5 A) that correspond to the CT secondary circuits

□ or check and set the microswitches on the EA module

■ resetting heat rise to zero

2 options:

□ wait for heat rise to drop below the E< and E> set-points, acknowledge the protection and switch off the auxiliary power supply

□ disable the protection by setting E> to 999%, acknowledge it and switch off the auxiliary power supply.

procedure

■ set **thermal protection** parameters

□ set E>, E< (% heat rise set-points)

□ set T1 (heating time constant)

□ set T2 (cooling time constant)

Checking of T1 and E> settings
T1 and E> may be checked by measuring the cold curve time delay for a current of 10Ib, for example.

It is easy to determine the theoretical value of the time delay for I = 10Ib by using the simplified cold curve equation:

$$t \approx \frac{T1.E>/100}{(I/Ib)^2} = \frac{T1.E>/100}{100}$$

■ make sure that heat rise is set to zero prior to the test

■ measure the tripping time, allowing for the effect of negative sequence current if necessary (see above)

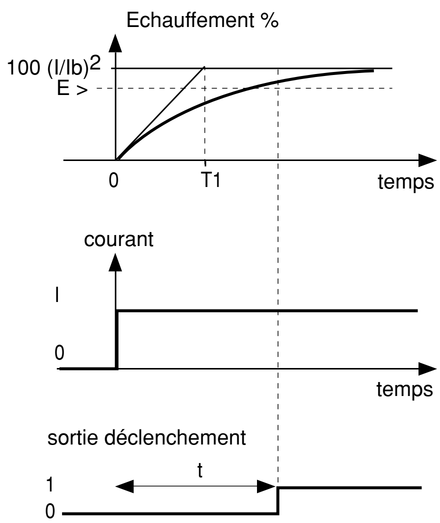
Example: for an LXM01 application, with 5 A CTs, Kb = 1,1In, T1 = 30 mn and E> = 115%

For a balanced 3-phase current of 10Ib,

t = T1.E>/10000 = 30x60x115/10000 = 20.7 s

The single-phase current to be injected into the phase 1 or 3 CT secondary is:

I = 0.632x10x5x1.1 = 34.8 A



Remember to reactivate the protections at the end of testing.

thermal overload protection

ANSI code 49

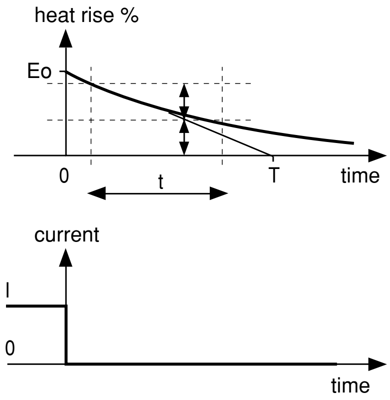
procedure (cont'd)

Checking of T2 (LXM01 and LXM02)

■ stop injecting current as soon as the protection trips during the previous test

■ read heat rise E on the display and measure the time t required for heat rise to drop by half

■ the value of T2 is given by the relation: t = T2 X Log2 in which T2 = 1.44 X t



Remember to reactivate the protections at the end of testing.

cold curves:
t/T1 = f(E>, I/Ib)

The following charts give the numerical values of the cold curves.

Example of chart use
For an operation set-point E> of 115% with a time constant T1 of 15 mn, what is the operation time when cold at 2.6 Ib?

Using the cold curve chart:

■ read the value of t/T1=0.1865 at the intersection of row E>=115 and column I/Ib=2.6

■ calculate the operation time
t=0.1865 x T
i.e. t=0.1865 x 15 x 60 = 167.8s

I/Ib **E> (%)**	**1,00**	**1,05**	**1,10**	**1,15**	**1,20**	**1,25**	**1,30**	**1,35**	**1,40**	**1,45**	**1,50**	**1,55**	**1,60**	**1,65**	**1,70**	**1,75**	**1,80**
50	0,6931	0,6042	0,5331	0,4749	0,4265	0,3857	0,3508	0,3207	0,2945	0,2716	0,2513	0,2333	0,2173	0,2029	0,1900	0,1782	0,1676
55	0,7985	0,6909	0,6061	0,5376	0,4812	0,4339	0,3937	0,3592	0,3294	0,3033	0,2803	0,2600	0,2419	0,2257	0,2111	0,1980	0,1860
60	0,9163	0,7857	0,6849	0,6046	0,5390	0,4845	0,4386	0,3993	0,3655	0,3360	0,3102	0,2873	0,2671	0,2490	0,2327	0,2181	0,2048
65	1,0498	0,8905	0,7704	0,6763	0,6004	0,5379	0,4855	0,4411	0,4029	0,3698	0,3409	0,3155	0,2929	0,2728	0,2548	0,2386	0,2239
70	1,2040	1,0076	0,8640	0,7535	0,6657	0,5942	0,5348	0,4847	0,4418	0,4049	0,3727	0,3444	0,3194	0,2972	0,2774	0,2595	0,2434
75	1,3863	1,1403	0,9671	0,8373	0,7357	0,6539	0,5866	0,5302	0,4823	0,4412	0,4055	0,3742	0,3467	0,3222	0,3005	0,2809	0,2633
80	1,6094	1,2933	1,0822	0,9287	0,8109	0,7174	0,6413	0,5780	0,5245	0,4788	0,4394	0,4049	0,3747	0,3479	0,3241	0,3028	0,2836
85	1,8971	1,4739	1,2123	1,0292	0,8923	0,7853	0,6991	0,6281	0,5686	0,5180	0,4745	0,4366	0,4035	0,3743	0,3483	0,3251	0,3043
90	2,3026	1,6946	1,3618	1,1411	0,9808	0,8580	0,7605	0,6809	0,6147	0,5587	0,5108	0,4694	0,4332	0,4013	0,3731	0,3480	0,3254
95		1,9782	1,5377	1,2670	1,0780	0,9365	0,8258	0,7366	0,6630	0,6012	0,5486	0,5032	0,4638	0,4292	0,3986	0,3714	0,3470
100		2,3755	1,7513	1,4112	1,1856	1,0217	0,8958	0,7956	0,7138	0,6455	0,5878	0,5383	0,4953	0,4578	0,4247	0,3953	0,3691
105		3,0445	2,0232	1,5796	1,3063	1,1147	0,9710	0,8583	0,7673	0,6920	0,6286	0,5746	0,5279	0,4872	0,4515	0,4199	0,3917
110			2,3979	1,7824	1,4435	1,2174	1,0524	0,9252	0,8238	0,7406	0,6712	0,6122	0,5616	0,5176	0,4790	0,4450	0,4148
115			3,0040	2,0369	1,6025	1,3318	1,1409	0,9970	0,8837	0,7918	0,7156	0,6514	0,5964	0,5489	0,5074	0,4708	0,4384
120				2,3792	1,7918	1,4610	1,2381	1,0742	0,9474	0,8457	0,7621	0,6921	0,6325	0,5812	0,5365	0,4973	0,4626
125				2,9037	2,0254	1,6094	1,3457	1,1580	1,0154	0,9027	0,8109	0,7346	0,6700	0,6146	0,5666	0,5245	0,4874
130					2,3308	1,7838	1,4663	1,2493	1,0885	0,9632	0,8622	0,7789	0,7089	0,6491	0,5975	0,5525	0,5129
135					2,7726	1,9951	1,6035	1,3499	1,1672	1,0275	0,9163	0,8253	0,7494	0,6849	0,6295	0,5813	0,5390
140						2,2634	1,7626	1,4618	1,2528	1,0962	0,9734	0,8740	0,7916	0,7220	0,6625	0,6109	0,5658
145						2,6311	1,9518	1,5877	1,3463	1,1701	1,0341	0,9252	0,8356	0,7606	0,6966	0,6414	0,5934
150						3,2189	2,1855	1,7319	1,4495	1,2498	1,0986	0,9791	0,8817	0,8007	0,7320	0,6729	0,6217
155							2,4908	1,9003	1,5645	1,3364	1,1676	1,0361	0,9301	0,8424	0,7686	0,7055	0,6508
160							2,9327	2,1030	1,6946	1,4313	1,2417	1,0965	0,9808	0,8860	0,8066	0,7391	0,6809
165								2,3576	1,8441	1,5361	1,3218	1,1609	1,0343	0,9316	0,8461	0,7739	0,7118
170								2,6999	2,0200	1,6532	1,4088	1,2296	1,0908	0,9793	0,8873	0,8099	0,7438
175								3,2244	2,2336	1,7858	1,5041	1,3035	1,1507	1,0294	0,9302	0,8473	0,7768
180									2,5055	1,9388	1,6094	1,3832	1,2144	1,0822	0,9751	0,8861	0,8109
185									2,8802	2,1195	1,7272	1,4698	1,2825	1,1379	1,0220	0,9265	0,8463
190									3,4864	2,3401	1,8608	1,5647	1,3555	1,1970	1,0713	0,9687	0,8829
195										2,6237	2,0149	1,6695	1,4343	1,2597	1,1231	1,0126	0,9209
200										3,0210	2,1972	1,7866	1,5198	1,3266	1,1778	1,0586	0,9605

thermal overload protection

I/Ib E> (%)	1,85	1,90	1,95	2,00	2,20	2,40	2,60	2,80	3,00	3,20	3,40	3,60	3,80	4,00	4,20	4,40	4,60
50	0,1579	0,1491	0,1410	0,1335	0,1090	0,0908	0,0768	0,0659	0,0572	0,0501	0,0442	0,0393	0,0352	0,0317	0,0288	0,0262	0,0239
55	0,1752	0,1653	0,1562	0,1479	0,1206	0,1004	0,0849	0,0727	0,0631	0,0552	0,0487	0,0434	0,0388	0,0350	0,0317	0,0288	0,0263
60	0,1927	0,1818	0,1717	0,1625	0,1324	0,1100	0,0929	0,0796	0,069	0,0604	0,0533	0,0474	0,0424	0,0382	0,0346	0,0315	0,0288
65	0,2106	0,1985	0,1875	0,1773	0,1442	0,1197	0,1011	0,0865	0,075	0,0656	0,0579	0,0515	0,0461	0,0415	0,0375	0,0342	0,0312
70	0,2288	0,2156	0,2035	0,1924	0,1562	0,1296	0,1093	0,0935	0,081	0,0708	0,0625	0,0555	0,0497	0,0447	0,0405	0,0368	0,0336
75	0,2474	0,2329	0,2197	0,2076	0,1684	0,1395	0,1176	0,1006	0,087	0,0761	0,0671	0,0596	0,0533	0,0480	0,0434	0,0395	0,0361
80	0,2662	0,2505	0,2362	0,2231	0,1807	0,1495	0,1260	0,1076	0,0931	0,0813	0,0717	0,0637	0,0570	0,0513	0,0464	0,0422	0,0385
85	0,2855	0,2685	0,2530	0,2389	0,1931	0,1597	0,1344	0,1148	0,0992	0,0867	0,0764	0,0678	0,0607	0,0546	0,0494	0,0449	0,0410
90	0,3051	0,2868	0,2701	0,2549	0,2057	0,1699	0,1429	0,1219	0,1054	0,092	0,0811	0,0720	0,0644	0,0579	0,0524	0,0476	0,0435
95	0,3251	0,3054	0,2875	0,2712	0,2185	0,1802	0,1514	0,1292	0,1116	0,0974	0,0858	0,0761	0,0681	0,0612	0,0554	0,0503	0,0459
100	0,3456	0,3244	0,3051	0,2877	0,2314	0,1907	0,1601	0,1365	0,1178	0,1028	0,0905	0,0803	0,0718	0,0645	0,0584	0,0530	0,0484
105	0,3664	0,3437	0,3231	0,3045	0,2445	0,2012	0,1688	0,1438	0,1241	0,1082	0,0952	0,0845	0,0755	0,0679	0,0614	0,0558	0,0509
110	0,3877	0,3634	0,3415	0,3216	0,2578	0,2119	0,1776	0,1512	0,1304	0,1136	0,1000	0,0887	0,0792	0,0712	0,0644	0,0585	0,0534
115	0,4095	0,3835	0,3602	0,3390	0,2713	0,2227	0,1865	0,1586	0,1367	0,1191	0,1048	0,0929	0,0830	0,0746	0,0674	0,0612	0,0559
120	0,4317	0,4041	0,3792	0,3567	0,2849	0,2336	0,1954	0,1661	0,1431	0,1246	0,1096	0,0972	0,0868	0,0780	0,0705	0,0640	0,0584
125	0,4545	0,4250	0,3986	0,3747	0,2988	0,2446	0,2045	0,1737	0,1495	0,1302	0,1144	0,1014	0,0905	0,0813	0,0735	0,0667	0,0609
130	0,4778	0,4465	0,4184	0,3930	0,3128	0,2558	0,2136	0,1813	0,156	0,1358	0,1193	0,1057	0,0943	0,0847	0,0766	0,0695	0,0634
135	0,5016	0,4683	0,4386	0,4117	0,3270	0,2671	0,2228	0,1890	0,1625	0,1414	0,1242	0,1100	0,0982	0,0881	0,0796	0,0723	0,0659
140	0,5260	0,4907	0,4591	0,4308	0,3414	0,2785	0,2321	0,1967	0,1691	0,147	0,1291	0,1143	0,1020	0,0916	0,0827	0,0751	0,0685
145	0,5511	0,5136	0,4802	0,4502	0,3561	0,2900	0,2414	0,2045	0,1757	0,1527	0,1340	0,1187	0,1058	0,0950	0,0858	0,0778	0,0710
150	0,5767	0,5370	0,5017	0,4700	0,3709	0,3017	0,2509	0,2124	0,1823	0,1584	0,1390	0,1230	0,1097	0,0984	0,0889	0,0806	0,0735
155	0,6031	0,5610	0,5236	0,4902	0,3860	0,3135	0,2604	0,2203	0,189	0,1641	0,1440	0,1274	0,1136	0,1019	0,0920	0,0834	0,0761
160	0,6302	0,5856	0,5461	0,5108	0,4013	0,3254	0,2701	0,2283	0,1957	0,1699	0,1490	0,1318	0,1174	0,1054	0,0951	0,0863	0,0786
165	0,6580	0,6108	0,5690	0,5319	0,4169	0,3375	0,2798	0,2363	0,2025	0,1757	0,1540	0,1362	0,1213	0,1088	0,0982	0,0891	0,0812
170	0,6866	0,6366	0,5925	0,5534	0,4327	0,3498	0,2897	0,2444	0,2094	0,1815	0,1591	0,1406	0,1253	0,1123	0,1013	0,0919	0,0838
175	0,7161	0,6631	0,6166	0,5754	0,4487	0,3621	0,2996	0,2526	0,2162	0,1874	0,1641	0,1451	0,1292	0,1158	0,1045	0,0947	0,0863
180	0,7464	0,6904	0,6413	0,5978	0,4651	0,3747	0,3096	0,2608	0,2231	0,1933	0,1693	0,1495	0,1331	0,1193	0,1076	0,0976	0,0889
185	0,7777	0,7184	0,6665	0,6208	0,4816	0,3874	0,3197	0,2691	0,2301	0,1993	0,1744	0,1540	0,1371	0,1229	0,1108	0,1004	0,0915
190	0,8100	0,7472	0,6925	0,6444	0,4985	0,4003	0,3300	0,2775	0,2371	0,2052	0,1796	0,1585	0,1411	0,1264	0,1140	0,1033	0,0941
195	0,8434	0,7769	0,7191	0,6685	0,5157	0,4133	0,3403	0,2860	0,2442	0,2113	0,1847	0,1631	0,1451	0,1300	0,1171	0,1062	0,0967
200	0,8780	0,8075	0,7465	0,6931	0,5331	0,4265	0,3508	0,2945	0,2513	0,2173	0,1900	0,1676	0,1491	0,1335	0,1203	0,1090	0,0993

I/lb E> (%)	4,80	5,00	5,50	6,00	6,50	7,00	7,50	8,00	8,50	9,00	9,50	10,00	12,50	15,00	17,50	20,00
50	0,0219	0,0202	0,0167	0,0140	0,0119	0,0103	0,0089	0,0078	0,0069	0,0062	0,0056	0,0050	0,0032	0,0022	0,0016	0,0013
55	0,0242	0,0222	0,0183	0,0154	0,0131	0,0113	0,0098	0,0086	0,0076	0,0068	0,0061	0,0055	0,0035	0,0024	0,0018	0,0014
60	0,0264	0,0243	0,0200	0,0168	0,0143	0,0123	0,0107	0,0094	0,0083	0,0074	0,0067	0,0060	0,0038	0,0027	0,0020	0,0015
65	0,0286	0,0263	0,0217	0,0182	0,0155	0,0134	0,0116	0,0102	0,0090	0,0081	0,0072	0,0065	0,0042	0,0029	0,0021	0,0016
70	0,0309	0,0284	0,0234	0,0196	0,0167	0,0144	0,0125	0,0110	0,0097	0,0087	0,0078	0,0070	0,0045	0,0031	0,0023	0,0018
75	0,0331	0,0305	0,0251	0,0211	0,0179	0,0154	0,0134	0,0118	0,0104	0,0093	0,0083	0,0075	0,0048	0,0033	0,0025	0,0019
80	0,0353	0,0325	0,0268	0,0225	0,0191	0,0165	0,0143	0,0126	0,0111	0,0099	0,0089	0,0080	0,0051	0,0036	0,0026	0,0020
85	0,0376	0,0346	0,0285	0,0239	0,0203	0,0175	0,0152	0,0134	0,0118	0,0105	0,0095	0,0085	0,0055	0,0038	0,0028	0,0021
90	0,0398	0,0367	0,0302	0,0253	0,0215	0,0185	0,0161	0,0142	0,0125	0,0112	0,0100	0,0090	0,0058	0,0040	0,0029	0,0023
95	0,0421	0,0387	0,0319	0,0267	0,0227	0,0196	0,0170	0,0150	0,0132	0,0118	0,0106	0,0095	0,0061	0,0042	0,0031	0,0024
100	0,0444	0,0408	0,0336	0,0282	0,0240	0,0206	0,0179	0,0157	0,0139	0,0124	0,0111	0,0101	0,0064	0,0045	0,0033	0,0025
105	0,0466	0,0429	0,0353	0,0296	0,0252	0,0217	0,0188	0,0165	0,0146	0,0130	0,0117	0,0106	0,0067	0,0047	0,0034	0,0026
110	0,0489	0,0450	0,0370	0,0310	0,0264	0,0227	0,0197	0,0173	0,0153	0,0137	0,0123	0,0111	0,0071	0,0049	0,0036	0,0028
115	0,0512	0,0471	0,0388	0,0325	0,0276	0,0237	0,0207	0,0181	0,0160	0,0143	0,0128	0,0116	0,0074	0,0051	0,0038	0,0029
120	0,0535	0,0492	0,0405	0,0339	0,0288	0,0248	0,0216	0,0189	0,0167	0,0149	0,0134	0,0121	0,0077	0,0053	0,0039	0,0030
125	0,0558	0,0513	0,0422	0,0353	0,0300	0,0258	0,0225	0,0197	0,0175	0,0156	0,0139	0,0126	0,0080	0,0056	0,0041	0,0031
130	0,0581	0,0534	0,0439	0,0368	0,0313	0,0269	0,0234	0,0205	0,0182	0,0162	0,0145	0,0131	0,0084	0,0058	0,0043	0,0033
135	0,0604	0,0555	0,0457	0,0382	0,0325	0,0279	0,0243	0,0213	0,0189	0,0168	0,0151	0,0136	0,0087	0,0060	0,0044	0,0034
140	0,0627	0,0576	0,0474	0,0397	0,0337	0,0290	0,0252	0,0221	0,0196	0,0174	0,0156	0,0141	0,0090	0,0062	0,0046	0,0035
145	0,0650	0,0598	0,0491	0,0411	0,0349	0,0300	0,0261	0,0229	0,0203	0,0181	0,0162	0,0146	0,0093	0,0065	0,0047	0,0036
150	0,0673	0,0619	0,0509	0,0426	0,0361	0,0311	0,0270	0,0237	0,0210	0,0187	0,0168	0,0151	0,0096	0,0067	0,0049	0,0038
155	0,0696	0,0640	0,0526	0,0440	0,0374	0,0321	0,0279	0,0245	0,0217	0,0193	0,0173	0,0156	0,0100	0,0069	0,0051	0,0039
160	0,0720	0,0661	0,0543	0,0455	0,0386	0,0332	0,0289	0,0253	0,0224	0,0200	0,0179	0,0161	0,0103	0,0071	0,0052	0,0040
165	0,0743	0,0683	0,0561	0,0469	0,0398	0,0343	0,0298	0,0261	0,0231	0,0206	0,0185	0,0166	0,0106	0,0074	0,0054	0,0041
170	0,0766	0,0704	0,0578	0,0484	0,0411	0,0353	0,0307	0,0269	0,0238	0,0212	0,0190	0,0171	0,0109	0,0076	0,0056	0,0043
175	0,0790	0,0726	0,0596	0,0498	0,0423	0,0364	0,0316	0,0277	0,0245	0,0218	0,0196	0,0177	0,0113	0,0078	0,0057	0,0044
180	0,0813	0,0747	0,0613	0,0513	0,0435	0,0374	0,0325	0,0285	0,0252	0,0225	0,0201	0,0182	0,0116	0,0080	0,0059	0,0045
185	0,0837	0,0769	0,0631	0,0528	0,0448	0,0385	0,0334	0,0293	0,0259	0,0231	0,0207	0,0187	0,0119	0,0083	0,0061	0,0046
190	0,0861	0,0790	0,0649	0,0542	0,0460	0,0395	0,0344	0,0301	0,0266	0,0237	0,0213	0,0192	0,0122	0,0085	0,0062	0,0048
195	0,0884	0,0812	0,0666	0,0557	0,0473	0,0406	0,0353	0,0309	0,0274	0,0244	0,0218	0,0197	0,0126	0,0087	0,0064	0,0049
200	0,0908	0,0834	0,0684	0,0572	0,0485	0,0417	0,0362	0,0317	0,0281	0,0250	0,0224	0,0202	0,0129	0,0089	0,0066	0,0050

hot curves:
t/T1 = f(E>, I/Ib)

The following charts give the numerical values of the hot curves.

Example of chart use
For an operation set-point E> of 115% with a time constant T1 of 15 mn, what is the operation time when hot at 2.6 Ib?

Using the hot curve chart:

■ read the value t/T1= 0.0264 at the intersection of row E> = 115 and column I/Ib = 2.6

■ calculate the operation time
t = 0.0264 x T1
i.e. t = 0.0264 x 15 x 60 = 23.7s

I/Ib E> (%)	1,00	1,05	1,10	1,15	1,20	1,25	1,30	1,35	1,40	1,45	1,50	1,55	1,60	1,65	1,70	1,75	1,80
105		0,6690	0,2719	0,1685	0,1206	0,0931	0,0752	0,0627	0,0535	0,0464	0,0408	0,0363	0,0326	0,0295	0,0268	0,0245	0,0226
110		3,7136	0,6466	0,3712	0,2578	0,1957	0,1566	0,1296	0,1100	0,0951	0,0834	0,0740	0,0662	0,0598	0,0544	0,0497	0,0457
115			1,2528	0,6257	0,4169	0,3102	0,2451	0,2013	0,1699	0,1462	0,1278	0,1131	0,1011	0,0911	0,0827	0,0755	0,0693
120			3,0445	0,9680	0,6061	0,4394	0,3423	0,2786	0,2336	0,2002	0,1744	0,1539	0,1372	0,1234	0,1118	0,1020	0,0935
125				1,4925	0,8398	0,5878	0,4499	0,3623	0,3017	0,2572	0,2231	0,1963	0,1747	0,1568	0,1419	0,1292	0,1183
130				2,6626	1,1451	0,7621	0,5705	0,4537	0,3747	0,3176	0,2744	0,2407	0,2136	0,1914	0,1728	0,1572	0,1438
135					1,5870	0,9734	0,7077	0,5543	0,4535	0,3819	0,3285	0,2871	0,2541	0,2271	0,2048	0,1860	0,1699
140					2,3979	1,2417	0,8668	0,6662	0,5390	0,4507	0,3857	0,3358	0,2963	0,2643	0,2378	0,2156	0,1967
145						1,6094	1,0561	0,7921	0,6325	0,5245	0,4463	0,3869	0,3403	0,3028	0,2719	0,2461	0,2243
150						2,1972	1,2897	0,9362	0,7357	0,6042	0,5108	0,4408	0,3864	0,3429	0,3073	0,2776	0,2526
155						3,8067	1,5950	1,1047	0,8508	0,6909	0,5798	0,4978	0,4347	0,3846	0,3439	0,3102	0,2817
160							2,0369	1,3074	0,9808	0,7857	0,6539	0,5583	0,4855	0,4282	0,3819	0,3438	0,3118
165							2,8478	1,5620	1,1304	0,8905	0,7340	0,6226	0,5390	0,4738	0,4215	0,3786	0,3427
170								1,9042	1,3063	1,0076	0,8210	0,6914	0,5955	0,5215	0,4626	0,4146	0,3747
175								2,4288	1,5198	1,1403	0,9163	0,7652	0,6554	0,5717	0,5055	0,4520	0,4077
180								3,5988	1,7918	1,2933	1,0217	0,8449	0,7191	0,6244	0,5504	0,4908	0,4418
185									2,1665	1,4739	1,1394	0,9316	0,7872	0,6802	0,5974	0,5312	0,4772
190									2,7726	1,6946	1,2730	1,0264	0,8602	0,7392	0,6466	0,5733	0,5138
195									4,5643	1,9782	1,4271	1,1312	0,9390	0,8019	0,6985	0,6173	0,5518
200										2,3755	1,6094	1,2483	1,0245	0,8688	0,7531	0,6633	0,5914

I/Ib E> (%)	1,85	1,90	1,95	2,00	2,20	2,40	2,60	2,80	3,00	3,20	3,40	3,60	3,80	4,00	4,20	4,40	4,60
105	0,0209	0,0193	0,0180	0,0168	0,0131	0,0106	0,0087	0,0073	0,0063	0,0054	0,0047	0,0042	0,0037	0,0033	0,0030	0,0027	0,0025
110	0,0422	0,0391	0,0363	0,0339	0,0264	0,0212	0,0175	0,0147	0,0126	0,0109	0,0095	0,0084	0,0075	0,0067	0,0060	0,0055	0,0050
115	0,0639	0,0592	0,0550	0,0513	0,0398	0,0320	0,0264	0,0222	0,0189	0,0164	0,0143	0,0126	0,0112	0,0101	0,0091	0,0082	0,0075
120	0,0862	0,0797	0,0740	0,0690	0,0535	0,0429	0,0353	0,0297	0,0253	0,0219	0,0191	0,0169	0,0150	0,0134	0,0121	0,0110	0,0100
125	0,1089	0,1007	0,0934	0,0870	0,0673	0,0540	0,0444	0,0372	0,0317	0,0274	0,0240	0,0211	0,0188	0,0168	0,0151	0,0137	0,0125
130	0,1322	0,1221	0,1132	0,1054	0,0813	0,0651	0,0535	0,0449	0,0382	0,0330	0,0288	0,0254	0,0226	0,0202	0,0182	0,0165	0,0150
135	0,1560	0,1440	0,1334	0,1241	0,0956	0,0764	0,0627	0,0525	0,0447	0,0386	0,0337	0,0297	0,0264	0,0236	0,0213	0,0192	0,0175
140	0,1805	0,1664	0,1540	0,1431	0,1100	0,0878	0,0720	0,0603	0,0513	0,0443	0,0386	0,0340	0,0302	0,0270	0,0243	0,0220	0,0200
145	0,2055	0,1892	0,1750	0,1625	0,1246	0,0993	0,0813	0,0681	0,0579	0,0499	0,0435	0,0384	0,0341	0,0305	0,0274	0,0248	0,0226
150	0,2312	0,2127	0,1965	0,1823	0,1395	0,1110	0,0908	0,0759	0,0645	0,0556	0,0485	0,0427	0,0379	0,0339	0,0305	0,0276	0,0251
155	0,2575	0,2366	0,2185	0,2025	0,1546	0,1228	0,1004	0,0838	0,0712	0,0614	0,0535	0,0471	0,0418	0,0374	0,0336	0,0304	0,0277
160	0,2846	0,2612	0,2409	0,2231	0,1699	0,1347	0,1100	0,0918	0,0780	0,0671	0,0585	0,0515	0,0457	0,0408	0,0367	0,0332	0,0302
165	0,3124	0,2864	0,2639	0,2442	0,1855	0,1468	0,1197	0,0999	0,0847	0,0729	0,0635	0,0559	0,0496	0,0443	0,0398	0,0360	0,0328
170	0,3410	0,3122	0,2874	0,2657	0,2012	0,1591	0,1296	0,1080	0,0916	0,0788	0,0686	0,0603	0,0535	0,0478	0,0430	0,0389	0,0353
175	0,3705	0,3388	0,3115	0,2877	0,2173	0,1715	0,1395	0,1161	0,0984	0,0847	0,0737	0,0648	0,0574	0,0513	0,0461	0,0417	0,0379
180	0,4008	0,3660	0,3361	0,3102	0,2336	0,1840	0,1495	0,1244	0,1054	0,0906	0,0788	0,0692	0,0614	0,0548	0,0493	0,0446	0,0405
185	0,4321	0,3940	0,3614	0,3331	0,2502	0,1967	0,1597	0,1327	0,1123	0,0965	0,0839	0,0737	0,0653	0,0583	0,0524	0,0474	0,0431
190	0,4644	0,4229	0,3873	0,3567	0,2671	0,2096	0,1699	0,1411	0,1193	0,1025	0,0891	0,0782	0,0693	0,0619	0,0556	0,0503	0,0457
195	0,4978	0,4525	0,4140	0,3808	0,2842	0,2226	0,1802	0,1495	0,1264	0,1085	0,0943	0,0828	0,0733	0,0654	0,0588	0,0531	0,0483
200	0,5324	0,4831	0,4413	0,4055	0,3017	0,2358	0,1907	0,1581	0,1335	0,1145	0,0995	0,0873	0,0773	0,0690	0,0620	0,0560	0,0509

I/Ib E> (%)	4,80	5,00	5,50	6,00	6,50	7,00	7,50	8,00	8,50	9,00	9,50	10,00	12,50	15,00	17,50	20,00
105	0,0023	0,0021	0,0017	0,0014	0,0012	0,0010	0,0009	0,0008	0,0007	0,0006	0,0006	0,0005	0,0003	0,0002	0,0002	0,0001
110	0,0045	0,0042	0,0034	0,0029	0,0024	0,0021	0,0018	0,0016	0,0014	0,0013	0,0011	0,0010	0,0006	0,0004	0,0003	0,0003
115	0,0068	0,0063	0,0051	0,0043	0,0036	0,0031	0,0027	0,0024	0,0021	0,0019	0,0017	0,0015	0,0010	0,0007	0,0005	0,0004
120	0,0091	0,0084	0,0069	0,0057	0,0049	0,0042	0,0036	0,0032	0,0028	0,0025	0,0022	0,0020	0,0013	0,0009	0,0007	0,0005
125	0,0114	0,0105	0,0086	0,0072	0,0061	0,0052	0,0045	0,0040	0,0035	0,0031	0,0028	0,0025	0,0016	0,0011	0,0008	0,0006
130	0,0137	0,0126	0,0103	0,0086	0,0073	0,0063	0,0054	0,0048	0,0042	0,0038	0,0034	0,0030	0,0019	0,0013	0,0010	0,0008
135	0,0160	0,0147	0,0120	0,0101	0,0085	0,0073	0,0064	0,0056	0,0049	0,0044	0,0039	0,0035	0,0023	0,0016	0,0011	0,0009
140	0,0183	0,0168	0,0138	0,0115	0,0097	0,0084	0,0073	0,0064	0,0056	0,0050	0,0045	0,0040	0,0026	0,0018	0,0013	0,0010
145	0,0206	0,0189	0,0155	0,0129	0,0110	0,0094	0,0082	0,0072	0,0063	0,0056	0,0051	0,0046	0,0029	0,0020	0,0015	0,0011
150	0,0229	0,0211	0,0172	0,0144	0,0122	0,0105	0,0091	0,0080	0,0070	0,0063	0,0056	0,0051	0,0032	0,0022	0,0016	0,0013
155	0,0253	0,0232	0,0190	0,0158	0,0134	0,0115	0,0100	0,0088	0,0077	0,0069	0,0062	0,0056	0,0035	0,0025	0,0018	0,0014
160	0,0276	0,0253	0,0207	0,0173	0,0147	0,0126	0,0109	0,0096	0,0085	0,0075	0,0067	0,0061	0,0039	0,0027	0,0020	0,0015
165	0,0299	0,0275	0,0225	0,0187	0,0159	0,0136	0,0118	0,0104	0,0092	0,0082	0,0073	0,0066	0,0042	0,0029	0,0021	0,0016
170	0,0323	0,0296	0,0242	0,0202	0,0171	0,0147	0,0128	0,0112	0,0099	0,0088	0,0079	0,0071	0,0045	0,0031	0,0023	0,0018
175	0,0346	0,0317	0,0260	0,0217	0,0183	0,0157	0,0137	0,0120	0,0106	0,0094	0,0084	0,0076	0,0048	0,0034	0,0025	0,0019
180	0,0370	0,0339	0,0277	0,0231	0,0196	0,0168	0,0146	0,0128	0,0113	0,0101	0,0090	0,0081	0,0052	0,0036	0,0026	0,0020
185	0,0393	0,0361	0,0295	0,0246	0,0208	0,0179	0,0155	0,0136	0,0120	0,0107	0,0096	0,0086	0,0055	0,0038	0,0028	0,0021
190	0,0417	0,0382	0,0313	0,0261	0,0221	0,0189	0,0164	0,0144	0,0127	0,0113	0,0101	0,0091	0,0058	0,0040	0,0030	0,0023
195	0,0441	0,0404	0,0330	0,0275	0,0233	0,0200	0,0173	0,0152	0,0134	0,0119	0,0107	0,0096	0,0061	0,0043	0,0031	0,0024
200	0,0464	0,0426	0,0348	0,0290	0,0245	0,0211	0,0183	0,0160	0,0141	0,0126	0,0113	0,0102	0,0065	0,0045	0,0033	0,0025

negative sequence unbalance protection

ANSI code 46

equipment

- single-phase current generator
- ammeters
- adapter for EA module
- chronometer
- documentation

wiring

- diagram B1 or B7
- protective relay output:
tripping: Ii>→ (10000 by default)

test

- read the section entitled **measurement and testing method**
- To check the protection, it is sufficient to inject current in a single phase.

Phase 1 or 3 should be used.

If I is the the single-phase current injected in phase 1 or 3, the negative sequence current Ii will be $I/\sqrt{3}$.

- **status** parameter setting

□ select the value of the CT primary circuits

□ set Ib

□ check the microswitches (1 A or 5 A) that correspond to the CT secondary circuits on the EM module

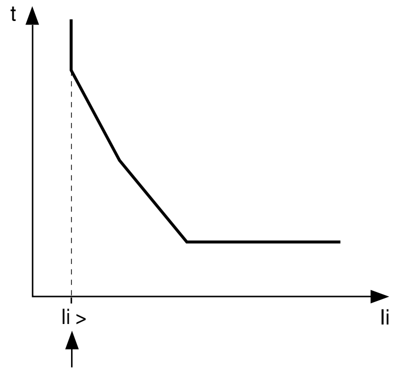
□ or check and set the microswitches on the EA module

procedure

- disable the protections that are liable to interfere with testing.

Checking of Ii> set-point

- set the set-point Ii> to the required value
- gradually inject a single-phase current I in phase 1 or 3 until the alarm message "UNBALANCE" appears
- measure the current which is present when the message appears
- use it to calculate the set-point by applying the following relation: $Ii> = I/\sqrt{3}$



Checking of tripping curve

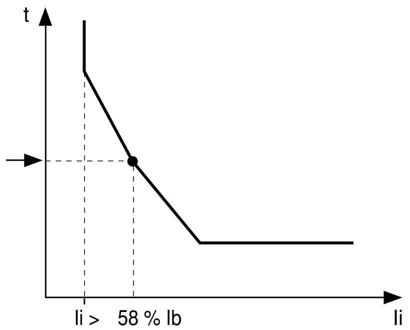
- for Ii = 58%Ib (= $100/\sqrt{3}$ %Ib)

□ inject a single-phase current equal to Ib into phase 1 or 3

□ check the negative sequence current value on the display: 58%Ib

□ measure the tripping time for this current.

3.92 s ±10% should be obtained.



Remember to reactivate the protections at the end of testing.

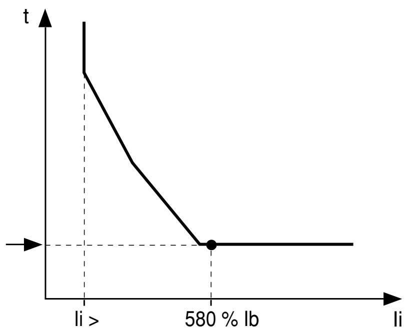
procedure (cont'd)

■ for Ii = 580%Ib

□ inject a single-phase current equal to 10Ib into phase 1 or 3

□ measure the tripping time for this current.

500 ms ± 60 ms should be obtained.



Remember to reactivate the protections at the end of testing.

excessive starting time and locked rotor protection

ANSI code 51LR

equipment

- ■ single-phase current generator
- ■ power resistor
- ■ contactor
- ■ ammeter
- ■ chronometer
- ■ adapter for EA module
- ■ documentation

wiring

■ diagram B1 or B7 or B8

■ protective relay output:
tripping: LSLR→ (10000 by default)

test

■ read the section entitled **measurement and testing method**

The protection may be tested on each phase individually with single-phase current.

■ **status** parameter setting

□ select the **In** value of the CT primary circuits

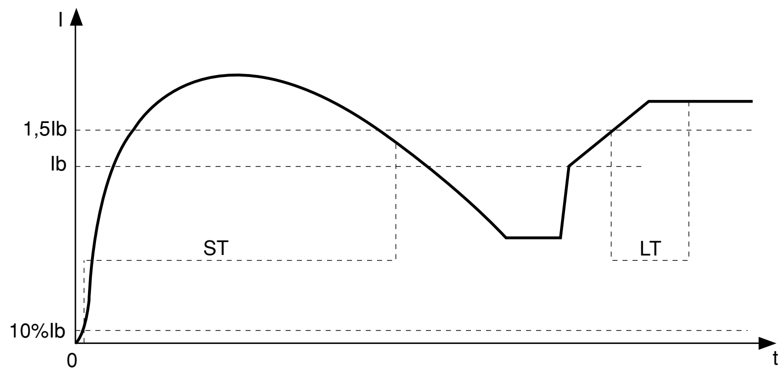
□ set the value of Ib

□ check the microswitches on the EM module

□ or check and set the microswitches on the EA module.

Remember to reactivate the protections at the end of testing.

Testing of 15Ib set-point (diagram B1 or B2 or B7)



procedure

□ disable the protections that are liable to interfere with testing

■ parameter setting

□ set **ST** to 0.5 s (minimum)

□ set **LT** to 0.5 s (minimum)

■ test

□ start up the injection unit with a current >10%Ib and then, after 1 s

□ gradually inject the current or currents until the locked rotor protective relay picks up

□ read the **i** value on the ammeter

Testing of excessive starting time ST (diagram B1 or B2 or B7)

■ parameter setting

□ set **ST** to the desired value

■ test

□ preset the injection to 1.2 times Is

□ stop the injection and reset Sepam and the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value on the chronometer

Remark:

If current injection is controlled by a static contactor, it is necessary to ensure that leakage current is less than 10% of Ib and does not interfere with testing.

Testing of locked rotor time LT (diagram B9)

■ parameter setting

□ set **ST** to 0.5 s

□ set **LT** to the desired value

■ test

□ preset the injection as follows:

- contactor closed i > 1.5Ib

- with load resistance 1.5Ib > **i** > 10%Ib

□ stop injection and reset Sepam to zero

□ start up injection with the contactor open

□ reset the chronometer to zero

□ after a first time period greater than **ST** (0.5 s), close the contactor and start up the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value on the chronometer

starts per hour protection

ANSI code 66

equipment

■ single-phase or three-phase current generator

■ ammeter

■ adapter for EA module

■ chronometer

■ calculator

■ documentation

wiring

■ diagram B1 or B2 or B7

■ start inhibition relay output:

INHIB→ (10000 by default)

test

■ read the section entitled **measurement and testing method**

■ **status** parameter setting

□ select the value of the CT primary circuits

□ check the microswitches (1 A or 5 A) which correspond to the CT secondary circuits

□ or check and set the microswitches on the EA module

Clearing of recorded starts
2 situations may occur

■ the starts per hour function is deactivated (no start inhibition in progress), in which case the user simply switches off the power supply

■ the starts per hour function is activated (start inhibition in progress), in which case there are 2 possible solutions:

□ wait until the end of the inhibited start period and switch off the auxiliary power supply

□ disable the protection by setting N1 to 999 and switch off the power supply

procedure

■ Set **protection** parameters

□ set: N1 = total permissible starts per hour

□ set: N2 = number of permissible consecutive starts

Checking of N1

■ clear the recorded starts using one of the procedures described above

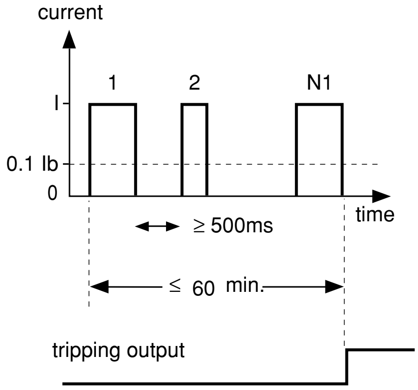
■ disable the consecutive starts function by setting N2 to a greater value than N1

■ simulate N1 starts by injecting N1 times, in less than an hour, a current greater than 10% of Ib. Wait at least 500 ms between current injections in order for the following start to be processed

■ during these operations, observe the decrease by decrements of the number N of permissible starts, which is displayed by pressing the **meter** key

■ when the N1st injection is made, the number **N** is replaced by the waiting period before another start can be made **Tsi**

■ when the current picks up after the N1st injection, the output relays are activated and a **START INHIBIT.** message is displayed.



Remember to reactivate the protections at the end of testing.

ANSI code 66

procedure (cont'd)

Checking of N2

■ clear the recorded starts again using one of the procedures described above

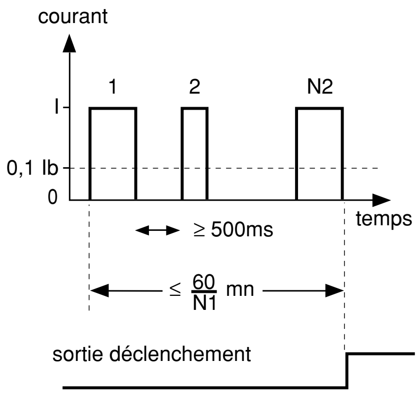
■ set N1 and N2 to the final values

■ simulate N2 starts by injecting N2 times, in less than 60/N1 minutes, a current greater than 10% of Ib. Wait at least 500 ms between current injections in order for the following start to be processed

■ during these operations, observe the decrease by decrements of the number N of permissible starts, which is displayed by pressing the **meter** key

■ when the N2nd injection is made, the number **N** is replaced by the waiting period before another start can be made **Tsi**

■ when the current picks up after the N2nd injection, the output relays are activated and a **START INHIBIT.** message is displayed.



Remember to reactivate the protections at the end of testing.

phase undercurrent protection

ANSI code 37

equipment

- single-phase current generator
- power resistor
- contactor
- ammeter
- chronometer
- adapter for EA module
- documentation

wiring

- diagram B1 or B7 or B9
- protective relay output:

tripping: I<→ (10000 by default)

test

- read the section on **measurement and testing method**

Undercurrent protection is single-phase and controls phase I1.

- **status** parameter setting

□ select the value of the CT primary circuits

□ set the value of Ib

□ check the microswitches (1 A or 5 A) which correspond to the CT secondary circuits

□ or check and set the microswitches on the EA module.

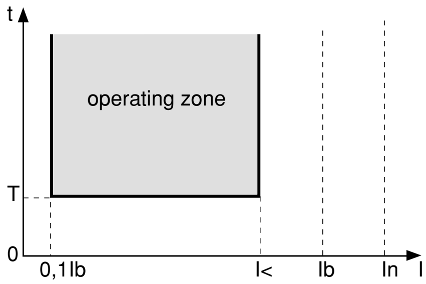
procedure

- **protection** parameter setting:

□ set **I<** as a % of Ib to the desired value

□ set **T** to the desired value

Testing of set-point



- test

□ preset the current to **i** greater than I<

□ inject the current i

□ gradually reduce the current until the **UNDERCURRENT** message appears

□ read the **i** value on the ammeter

Testing of time delay

- test

□ first method (diagram B1 or B7)

- preset **i** below set-point I> (0.1Ib < **i** < I<)
- cut off current completely (be careful of injection unit leakage current)
- start up injection and the chronometer at the same time
- Sepam's output relay stops the chronometer after **t<**
- read the **t** value on the chronometer

□ second method using a resistor (B9 diagram)

- present current injection **i** to I1 as follows:

with load resistance, i > 0.1Ib

contactor closed, i less than I<

- inject current with the contactor closed
- cut off the contactor power supply and start up the chronometer at the same time
- Sepam's output relay stops the chronometer after **t<**
- read the **t** value on the chronometer

Remember to reactivate the protections at the end of testing.

remanent undervoltage protection

ANSI code 27

equipment

■ single-phase voltage generator

■ voltmeters

■ chronometer

■ documentation

wiring

■ B3 or B4 diagram

■ protective relay output:

tripping: Ur<→ (10000 by default)

test

This function is single-phase and is only effective on U21.

■ read the section entitled **measurement and testing method**

■ **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ set **Uns** VT secondary circuit phase-to-phase voltage

procedure

■ disable the non-tested protections that are liable to interfere with testing (other undervoltage protections).

Checking of set-point

■ parameter setting

□ set set-point Ur < to the desired value

■ test

□ gradually reduce U21 voltage until the relay linked with the protection picks up

□ read the value on the voltmeter

□ increase the voltage to Uns

□ press **reset** on Sepam to reset the output relay

Checking of time delay

■ test

□ wire the chronometer so that it starts when voltage injection stops and is stopped by the output relay linked with the protection

□ set the chronometer to zero

□ cut off the voltage and start the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value displayed on the chronometer

Remember to reactivate the protections at the end of testing.

positive sequence undervoltage protection

ANSI code 27D

equipment

■ three-phase voltage generator

■ voltmeters

■ chronometer

■ documentation

wiring

■ diagram B4

■ protective relay outputs:

tripping set-point 1: Vd<→ (10000 by default)

tripping set-point 2: Vd<<→ (00010 by default)

test

■ read the section entitled **measurement and testing method**

■ **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ set **Uns** VT secondary circuit phase-to-phase voltage

□ set the "VTs" paramter to U21 U32

procedure

Checking of set-point

■ parameter setting

□ set the set-point to be tested (Vd< or Vd<<) to the desired value (in kV)

□ set the corresponding time delay (tvd< or tvd<<) to 100 ms

□ disable the other set-point as well as the protections that are liable to interfere with testing (other undervoltage protections)

■ test

□ inject the 3 rated phase voltages **Vns**

In balanced networks:
Vd = Vn = Un/1.732

□ gradually reduce the 3 voltages at the same time until the relay linked wiht the protection picks up

□ the positive sequence voltage that is simulated corresponds to the common value of the three phase voltages. Read the value on the voltmeter

□ read the **Vd** value on the display (**meter** loop, *other data* page)

□ increase the voltages to Vns

□ press **reset** on Sepam to erase the message and reset the output relay

Checking of time delay

■ parameter setting

□ set the time delay (tvd< or tvd<<) to the desired value

■ test

□ wire the chronometer so that it starts when voltage injection stops and is stopped by the output relay linked with the protection

□ set the chronometer to zero

□ cut off the voltage or voltages and start the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value displayed on the chronometer

Remember to reactivate the protections at the end of testing.

phase-to-phase undervoltage protection

ANSI code 27

equipment

- single-phase or three-phase voltage generator
- voltmeters
- chronometer
- calculator
- documentation

wiring

- diagram B3 or B4
- protective relay outputs:

tripping set-point 1: U<→ (10000 by default)
tripping set-point 2: U<<→ (00010 by default)

test

- read the section entitled **measurement and testing method**

When the protection is used in a single-phase system (VTs parameter = U21), the tests may be carried out using a single-phase injection unit (diagram B3)

- **status** parameter setting
  - select **Fn** network frequency (50 or 60 Hz)
  - set **Unp** network phase-to-phase voltage
  - set **Uns** VT secondary circuit phase-to-phase voltage
  - set "VTs", the parameter which defines the voltages measured by the VTs (U21 or U21U32)

procedure

- disable the non-tested protections that are liable to interfere with testing (other undervoltage protections)

Checking of set-point

- parameter setting
  - set the set-point to be tested (U< or U<<) to the desired value. Disable the other set-point (999 kV)
  - set the corresponding time delay (tu< or tu<<) to 100 ms
- test
  - gradually reduce U21 voltage (or U21 and U32 voltages) until the output relay linked with the set-point being tested picks up
  - read the value on the voltmeter
  - increase the voltage to Uns
  - press **reset** on Sepam to erase the message and reset the output relay

Checking of time delay

- parameter setting
  - set the time delay (tu< or tu<<) to the desired value
- test
  - wire the chronometer so that it starts when voltage injection stops and is stopped by the output relay linked with the protection
  - set the chronometer to zero
  - cut off the voltage or voltages and start the chronometer at the same time
  - Sepam's output relay stops the chronometer
  - read the **t** value displayed on the chronometer

Use the same procedure to check the other protection set-point

Remember to reactivate the protections at the end of testing.

phase-to-phase overvoltage protection

ANSI code 59

equipment

■ single-phase or three-phase voltage generator

■ voltmeters

■ chronometer

■ calculator

■ documentation

wiring

■ diagram B3 or B4

■ protective relay outputs:

set-point 1: U>→

set-point 2: U>>→

test

■ read the section entitled **measurement and testing method**

■ **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ set **Uns** VT secondary circuit phase-to-phase voltage

□ set "VTs", the parameter which defines the voltages measured by the VTs (U21 or U21U32)

procedure

■ disable the non-tested protections that are liable to interfere with testing (other overvoltage protections).

Checking of set-point

■ parameter setting

□ set the set-point to be tested (U> or U>>) to the desired value. Disable the other set-point (999 kV)

□ set the corresponding time delay (tu> or tu>>) to 100 ms

■ test

□ gradually increase U21 voltage until the output relay linked with the set-point being tested picks up

□ read the value on the voltmeter

□ stop injection

□ press **reset** on Sepam to erase the message and reset the output relay (no message or latching for set-point 1)

Checking of time delay

■ parameter setting

□ set the time delay (tu> or tu>>) to the desired value

■ test

□ wire the chronometer so that it starts when voltage injection stops and is stopped by the output relay linked with the protection

□ set the chronometer to zero

□ prepare the injection with 1.2 times the set-point value

□ start injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value displayed on the chronometer

Use the same procedure to check the other protection set-point

Remember to reactivate the protections at the end of testing.

neutral voltage displacement protection

ANSI code 59N

equipment

- single-phase and three-phase voltage generators
- voltmeters
- chronometer
- calculator
- documentation

wiring

- diagram B4 or B7
- tripping relay outputs

set-point 1: Vo>→ (00100 by default)

set-point 2: Vo>>→ (10000 by default)

test

- read the section entitled **measurement and testing method**
- **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ select "VTs", the parameter which defines the voltages measured by the VTs (U21 or U21U32) Measurement by the sum of Vo voltages can only be used with 3 VTs (VTs = U21U32)

□ set **Uns** VT secondary circuit phase-to-phase voltage

□ select **Vnso** the VT secondary circuit value which enables Vo to be measured (Uns/1.732 or Uns/3 or sum of 3 Vs)

□ check the microswitches on the ET module

Microswitch setting determines the Vo measurement method, i.e.:

- no Vo measurement

- measurement by open delta star VT of secondary value Uns/1.732 or Uns/3 (A1-A2 inputs)

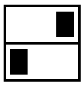
- measurement by the sum of the 3 voltages (A1-A6 connection)

Remember to reactivate the protections at the end of testing.

procedure

Testing by injection with sum of the 3 voltages (diagram B4)
A single-phase voltage generator may be used for the test provided the 2 voltage inputs not being used are short-circuited with terminal A2.

- cut off Sepam's auxiliary power supply to set the microswitches (SW1).


Sum of
3 VTs

- **status** parameter setting

□ select **VTs** = **U21U32**

□ select **Vnso** = **3V**

Testing of set-point

- **protection** parameter setting

□ set the set-point to be tested (Vo> or Vo>>) to the desired value. Disable the other set-point

□ set the corresponding time delay
(tvo> or tvo>>) to 100 ms

- test

□ gradually increase one of the voltages (leaving the other 2 voltages at zero) until the output relay picks up

□ read the voltage value on the voltmeter

The value **u** should be:

$$\text{injected voltage } \mathbf{u} = \frac{\text{set - point x Uns}}{\text{Unp}}$$

□ stop injection

□ press **reset** on Sepam to erase the messages and reset the output relay

Testing of time delay

- parameter setting

□ set the time delay to the desired value

- test

□ prepare the injection with 1.2 times the value of **Vso** (see above)

□ set the chronometer to zero

□ start injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the value measured by the chronometer

example: sum of VTs

- **status** parameter setting

□ Unp = 20 kV

□ Uns = 100 V

□ VT's = U21U32

□ Vnso = 3 V

- **protection** parameter setting

□ Vo > = 11.5 kV

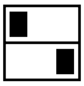
□ tvo > = 500 ms

For an injection of u > 57.7 V, in accordance with diagram B4, into one of the phase voltage inputs (the others = 0), the protection will trip after a period T = 0.5 s.

remark: $57.7 = \frac{11.5 \times 100}{20}$

neutral voltage displacement protection

Testing by injection into input A1-A2 (diagram B7) external VTs
Cut off Sepam's auxiliary power supply to set the microswitches (SW1)


A1-A2
input

■ **status** parameter setting

□ select **Vnso** = **Uns**/ $\sqrt{3}$ or **= Uns/3**

These values correspond to the value of the Vo measurement VT secondary circuits

Testing of set-point
■ **protection** parameter setting

□ set the set-point to be tested (Vo> or Vo>>) to the desired value. Disable the other set-point

□ set the corresponding time delay (tvo> or tvo>>) to 100 ms

■ test

□ gradually inject Vo voltage until the output relay picks up

□ read the voltage value on the voltmeter. The value **u** should be:

Case 1: Vnso = Uns/$\sqrt{3}$

injected voltage $\mathbf{u} = \dfrac{\text{set - point x Uns}}{\text{Unp}}$

Case 2 : Vnso = Uns/3

injected voltage $\mathbf{u} = \dfrac{\text{set - point x Uns}}{\text{Unp x } \sqrt{3}}$

□ stop injection

□ press **reset** on Sepam to erase the messages and reset the output relay

Testing of time delay
■ parameter setting

□ set the time delay to the desired value

■ test

□ prepare the injection with 1.2 times the set-point value (see above)

□ set the chronometer to zero

□ start injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value measured by the chronometer

Example: external VT
■ **status** parameter setting

□ Unp = 20 kV

□ Uns = 100 V

□ Vo> = 11.5 kV

□ tvo> = 0,5 s

Vnso = Uns/$\sqrt{3}$ for injection of u > 57.7 V in accordance with diagram B7, the protection will trip after a period t=0.5 s.

Vnso = Uns/3 for an injection of
u > 33.3V in accordance with diagram B7, the protection will trip after a period of t = 0.5 s.

Remember to reactivate the protections at the end of testing.

underfrequency protection

ANSI code 81

equipment

■ single-phase voltage generator with frequency variator

■ voltmeter

■ chronometer

■ documentation

wiring

■ diagram B3

■ protective relay outputs:

tripping set-point 1: F<➞ (00010 by default)

tripping set-point 2: F<<➞ (10000 by default)

test

■ read the section entitled **measurement and testing method**

The underfrequency protection operates with positive sequence voltage. This entails measurement by Sepam 1000 of U21 and U32.
However, to simplify arrangements, tests may be performed using a single-phase injection unit on the U21 voltage input.

■ **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ set **Uns** VT secondary circuit phase-to-phase voltage

□ set "VTs", the parameter which defines the voltages measured by the VTs (U21 or U21U32)

procedure

Testing of set-point

■ parameter setting

□ set the set-point to be tested (F< or F<<) to the desired value. Disable the other set-point (999 Hz)

□ set the corresponding time delay (tf< or tf<<) to 100 ms

■ test

□ inject a voltage of at least 100 V and frequency **Fn** into U21

□ gradually reduce the frequency injected into U21 until the Sepam relay linked to the protection picks up

□ read the value on the frequency indicator

□ increase the frequency to Fn

□ press **reset** on Sepam to erase the message and reset the output relay.

Testing of time delay

■ parameter setting

□ set the time delay to the desired value

■ test

□ preset the voltage to about 100 V and the frequency below the set point

□ stop injection

□ set the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value displayed by the chronometer

Remember to reactivate the protections at the end of testing.

overfrequency protection

ANSI code 81

equipment

■ single-phase voltage generator with frequency variator

■ voltmeter

■ chronometer

■ documentation

wiring

■ diagram B3

■ protective relay output:

tripping set-point 1: F>→ (10000 by default)

test

■ read the section entitled **measurement and testing method**

The overfrequency protection operates with positive sequence voltage. This entails measurement by Sepam 1000 of U21 and U32.
However, to simplify arrangements, tests may be performed using a single-phase injection unit on the U21 voltage input.

■ **status** parameter setting

□ select **Fn** network frequency (50 or 60 Hz)

□ set **Unp** network phase-to-phase voltage

□ set **Uns** VT secondary circuit phase-to-phase voltage

□ set "VTs", the parameter which defines the voltages measured by the VTs (U21 or U21U32)

procedure

Testing of set-point

■ parameter setting

□ set the F> set-point to the desired value.
□ set the tf> time delay to 100 ms

■ test

□ inject a voltage of at least 100 V and frequency **Fn** into U21

□ gradually increase the frequency injected into U21 until the Sepam relay linked to the protection picks up

□ read the value on the frequency indicator

□ decrease the frequency to Fn

□ press **reset** on Sepam to erase the message and reset the output relay.

Testing of time delay

■ parameter setting

□ set tf> to the desired value

■ test

□ preset the voltage to about 100 V and the frequency above the set point

□ stop injection

□ set the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's output relay stops the chronometer

□ read the **t** value displayed by the chronometer

Remember to reactivate the protections at the end of testing.

measurement and testing equipment required according to the type of test

The injection apparatus should transmit a pure sine wave signal (with no harmonics (1)).

Measuring instruments
The instruments should have accuracy and tolerance characteristics which are at least equivalent to those of Sepam 1000 (minimum class 1).

Current generator
- single-phase or three-phase
- dynamic range: 0 to 100 A rms
- % harmonics of level (≥ 3) < 7%
- synchronous ON/OFF contacts

Voltage generator
- single-phase or three-phase
- dynamic range: 0 to 220 V rms
- % harmonics of level (≥ 3) < 7%
- synchronous ON/OFF contacts

Frequency generator (2)
- dynamic range: 0 to 100 V rms, sine wave
- frequency range: 45 Hz to 65 Hz

Contactor or relay (k)
- minimum breaking capacity 10 A AC
- coil: supply voltage (according to the auxiliary source available)
- used to shunt injection current limiting

Ammeter
- 0 to 10 A rms

Clamp-on probe
- 100 A (measurement for 20 In) identified as P1 and P2, S1 and S2

TSM2003 adapter
- 5 A / 40 mV (for CSP type current sensor)

Voltmeter
- 0 to 220 V rms (AC and DC)
- 20 Mohms/volt

Chronometer
- 0 to 2h, accuracy 0.1 s
- synchronous and manual ON/OFF contacts (for very long time periods)

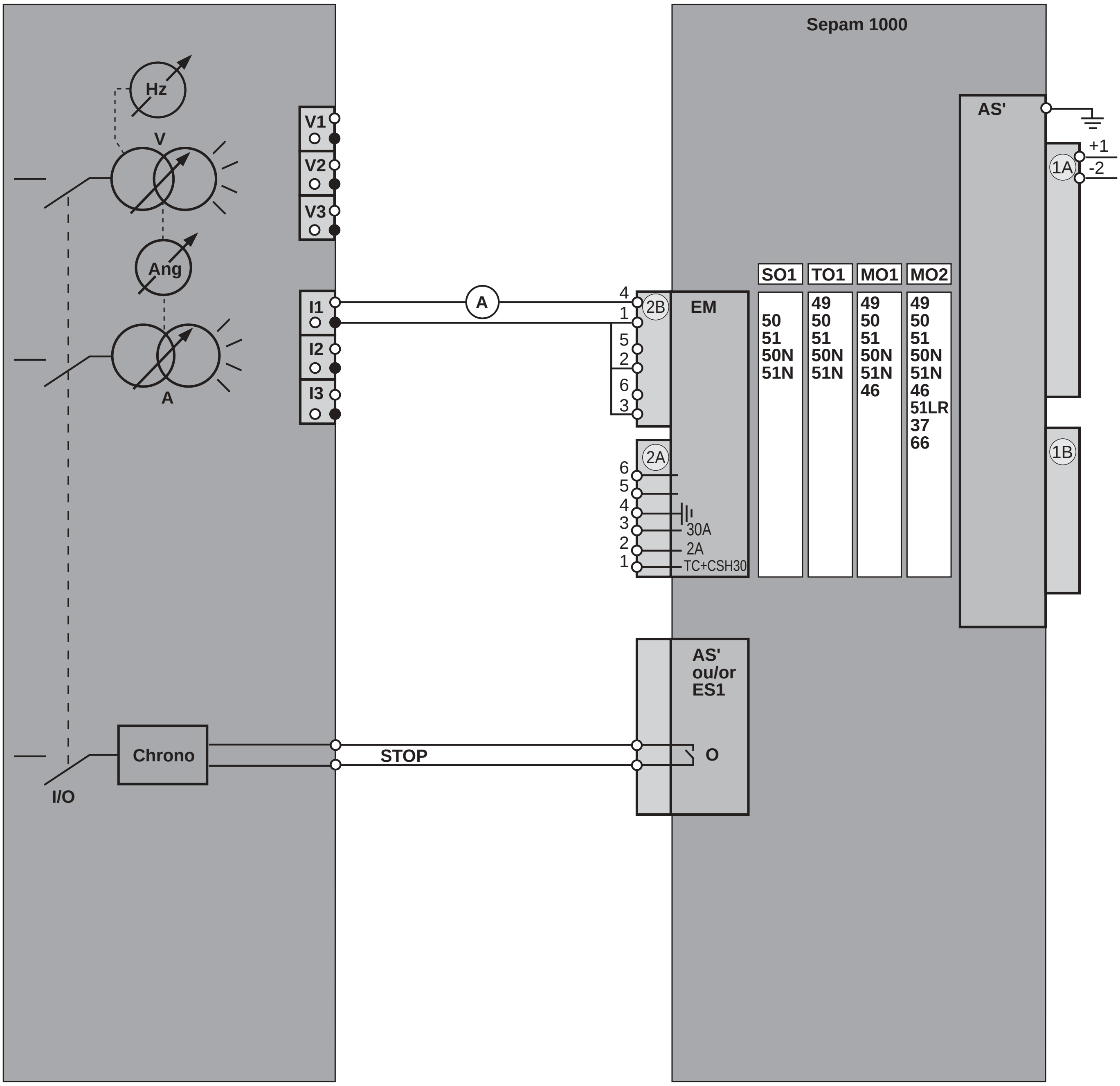
Power resistor
- 1 ohm ≥ 25W (simulation of undercurrent)

Scientific calculator
(Log, square root, Cos, Sin)

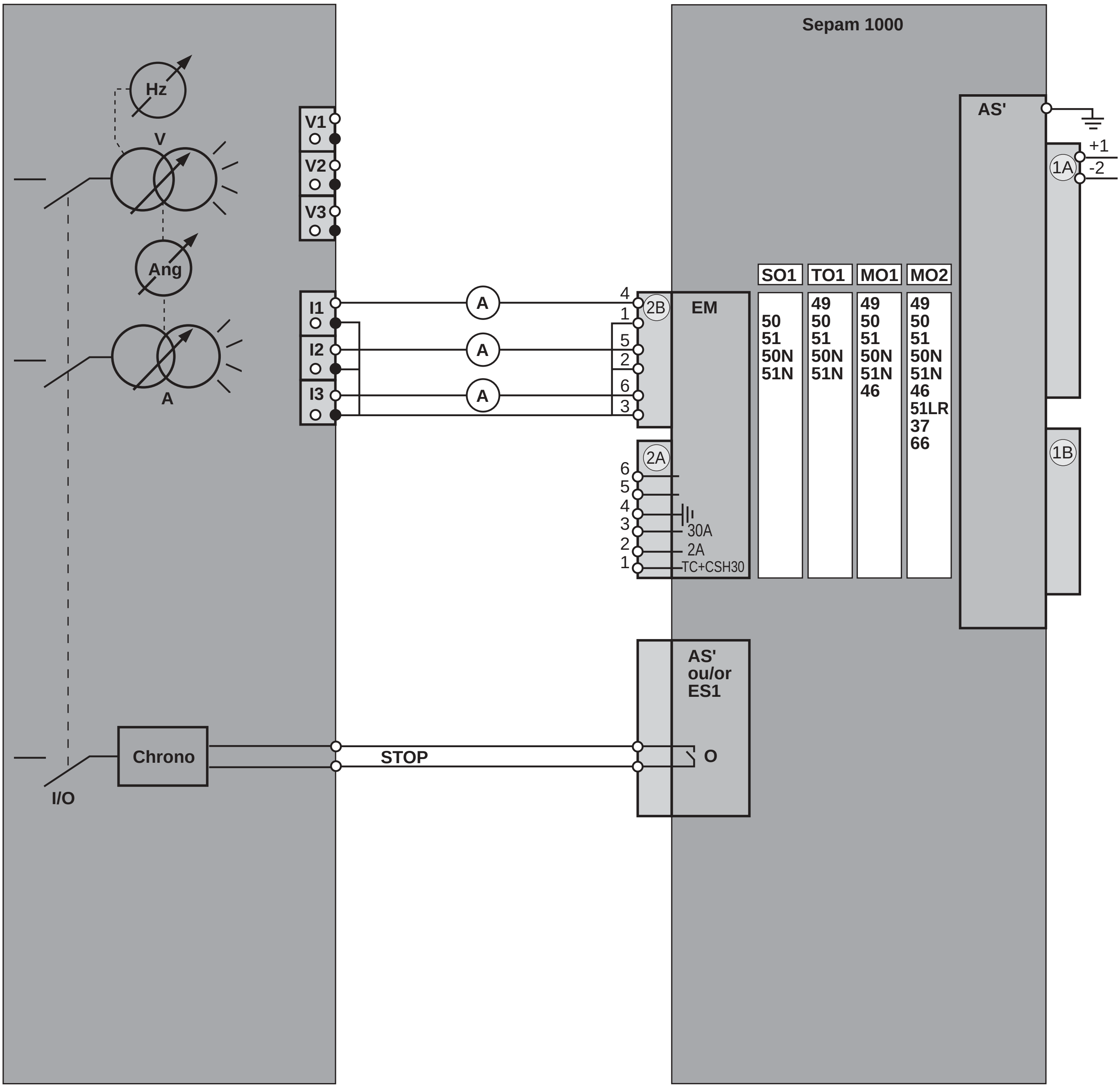
(1) in order to validate the tests, it is recommended to use an oscilloscope to verify the shape of the injection unit signals and to use a spectral analyzer to verify the amplitude of level 3, 5 and 7 harmonics.
(2) these instruments are very often linked to the voltage generator and include their own measurement indicators.

appendix

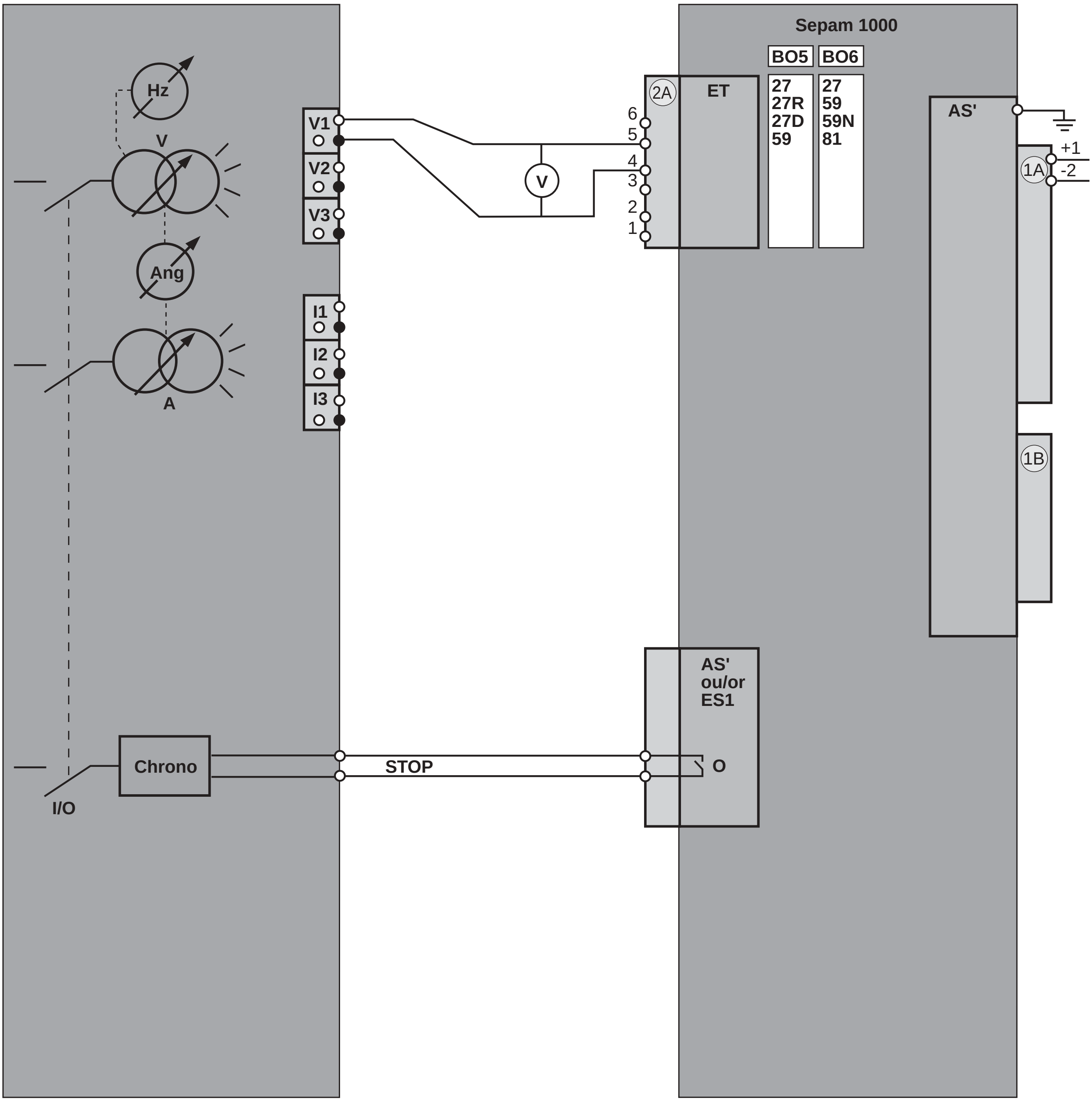
B1: single-phase current injection (phase / neutral)



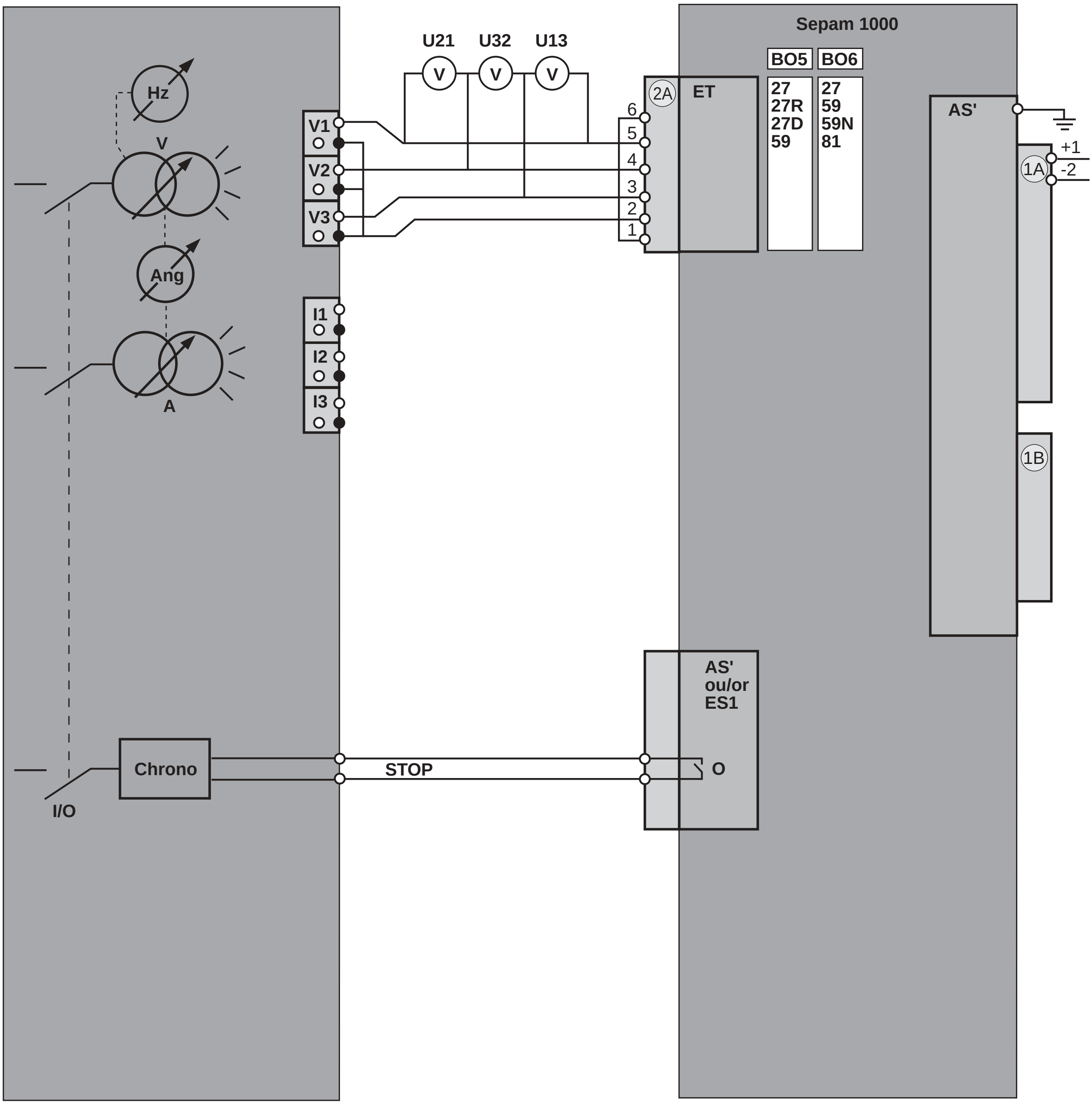
B2: three-phase current injection



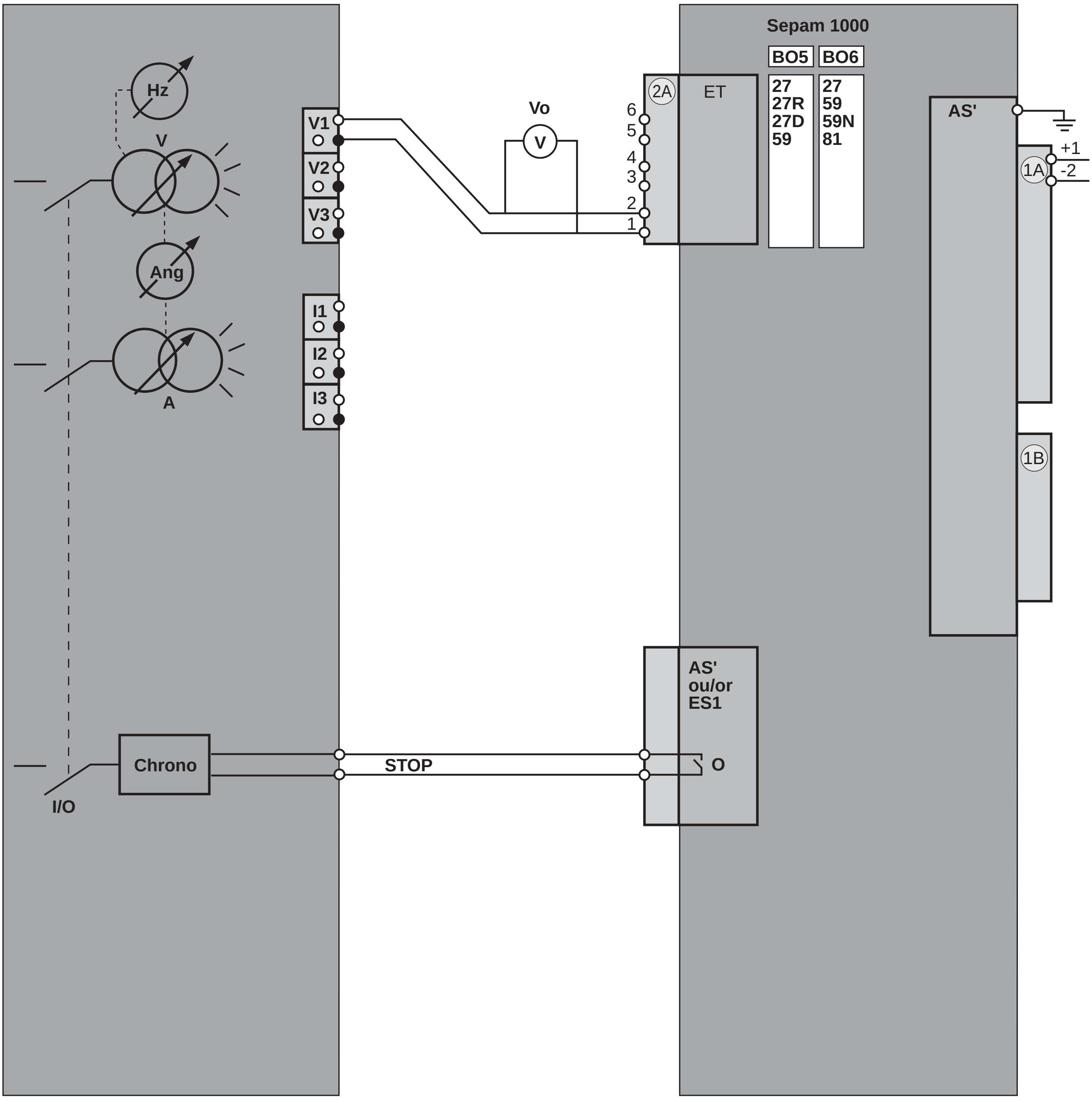
B3: single-phase voltage injection



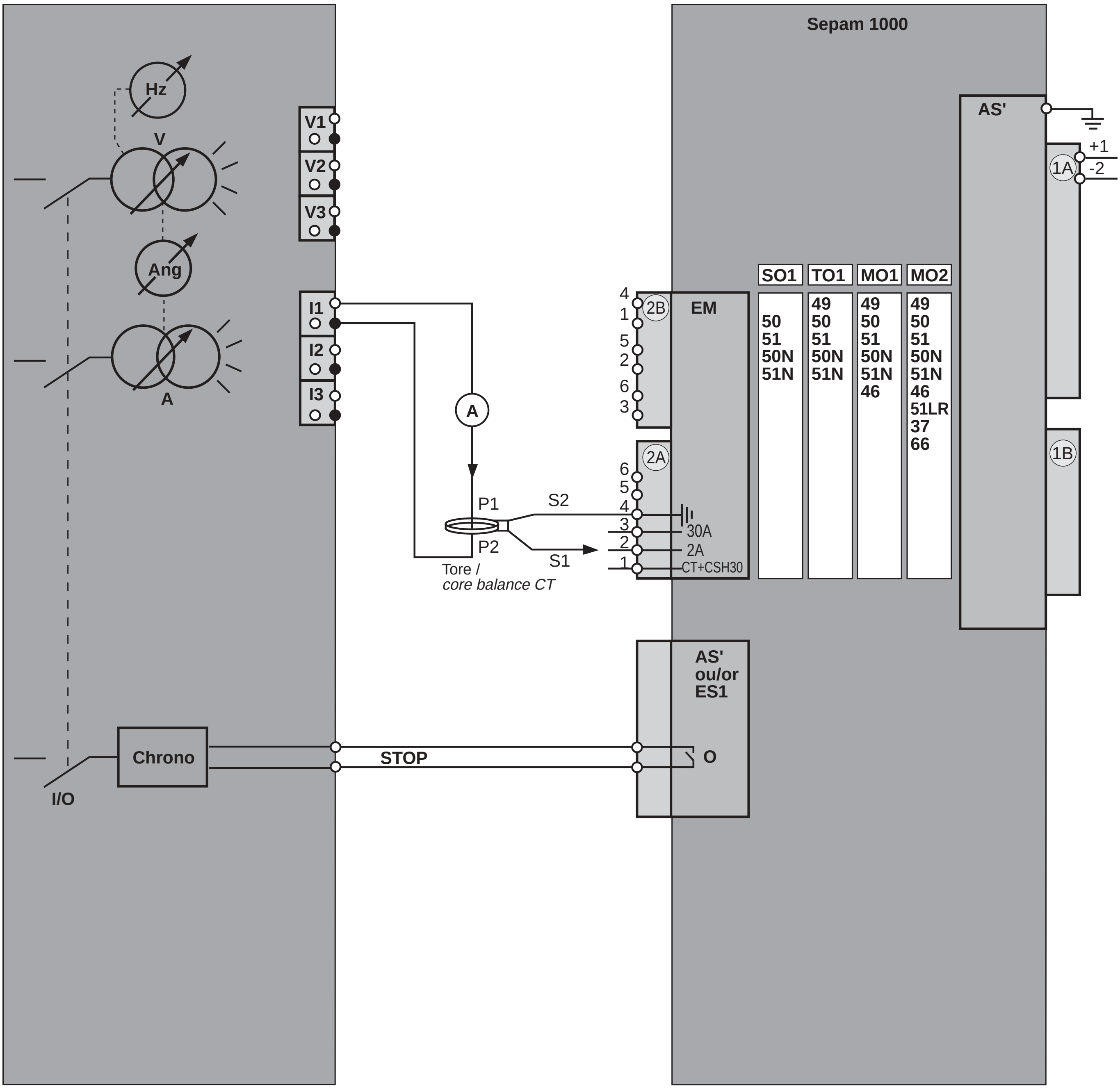
B4: three-phase voltage injection



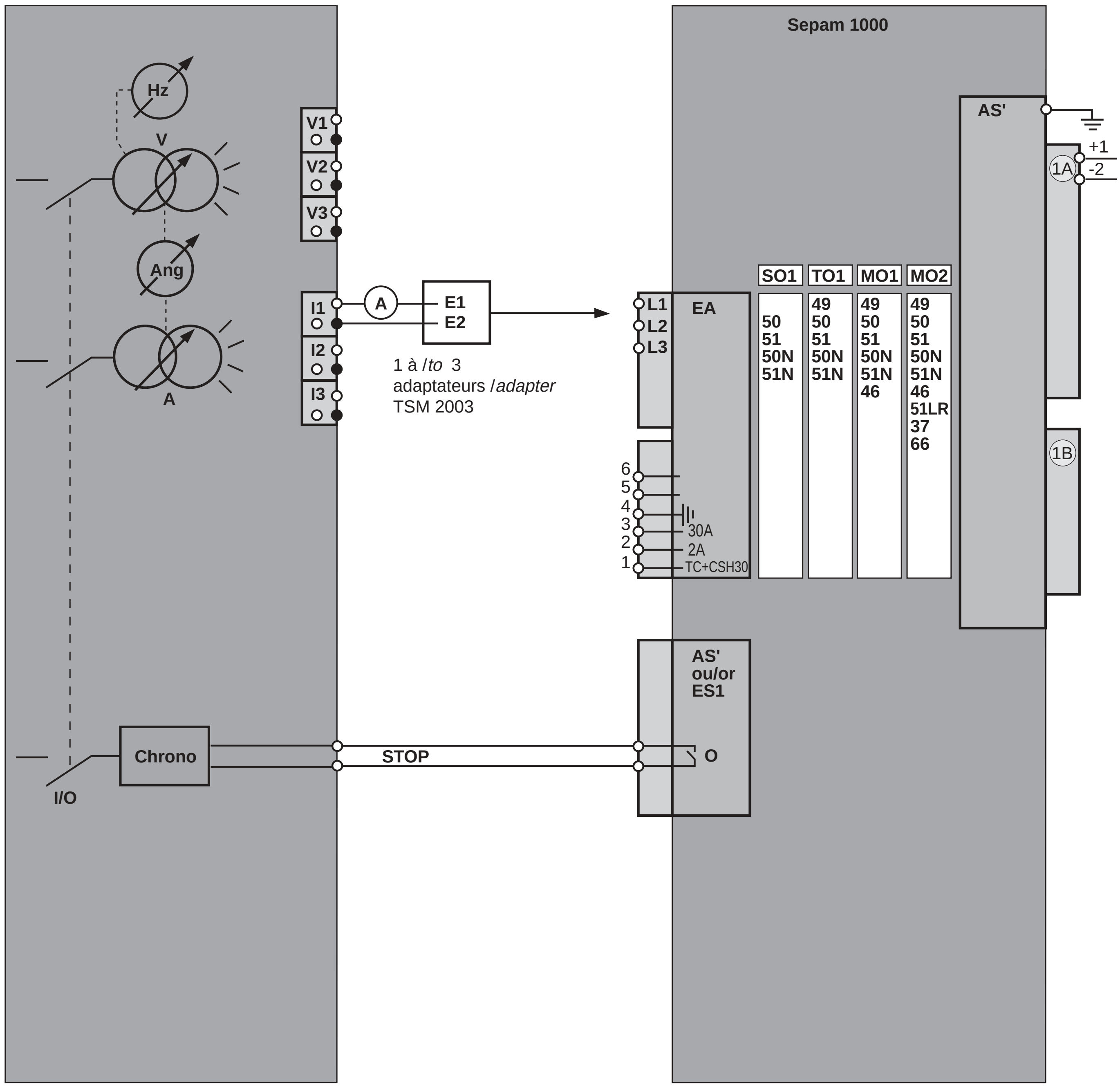
B5: single-phase residual voltage injection



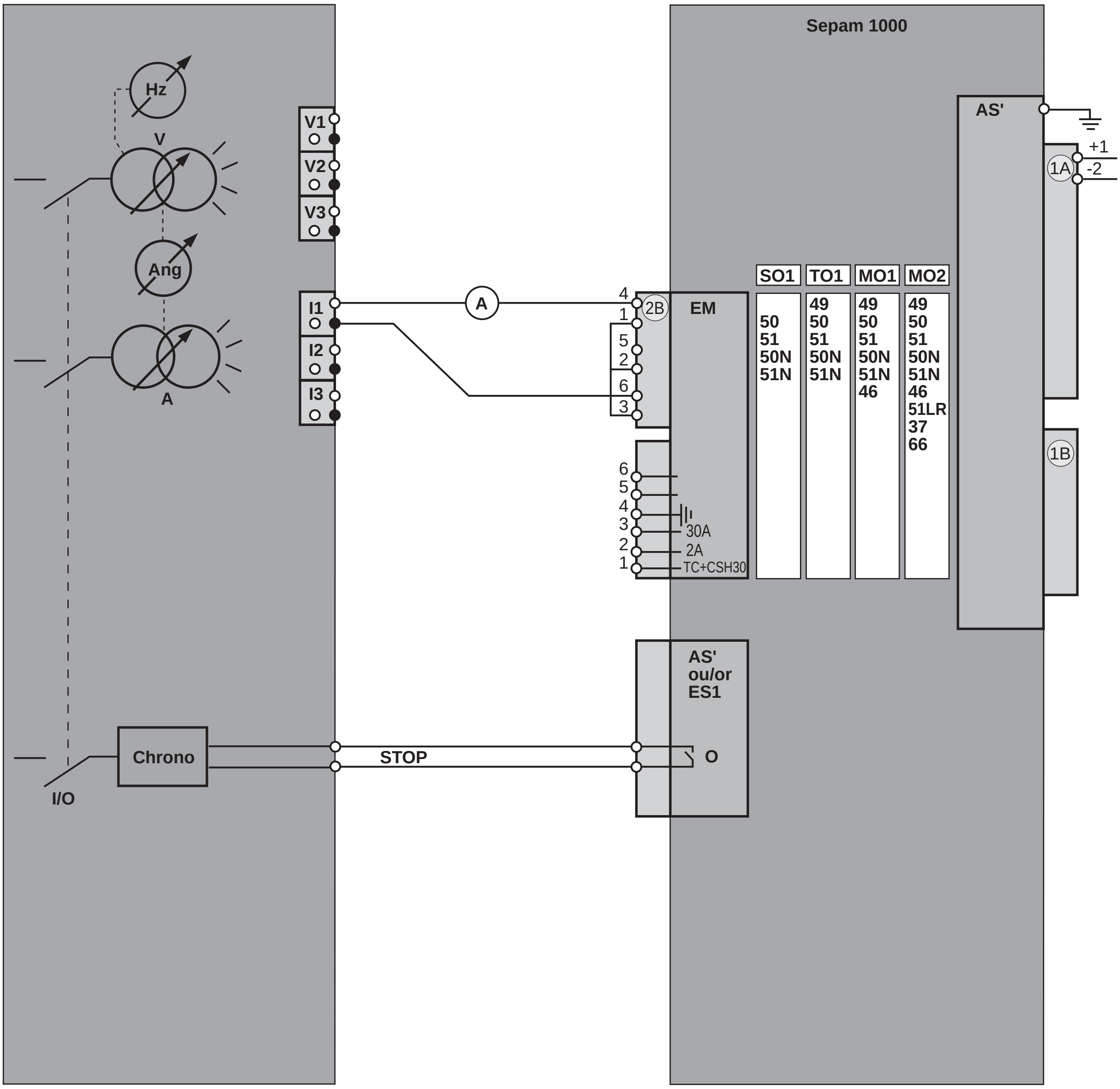
B6: current injection with core balance CT (residual current)



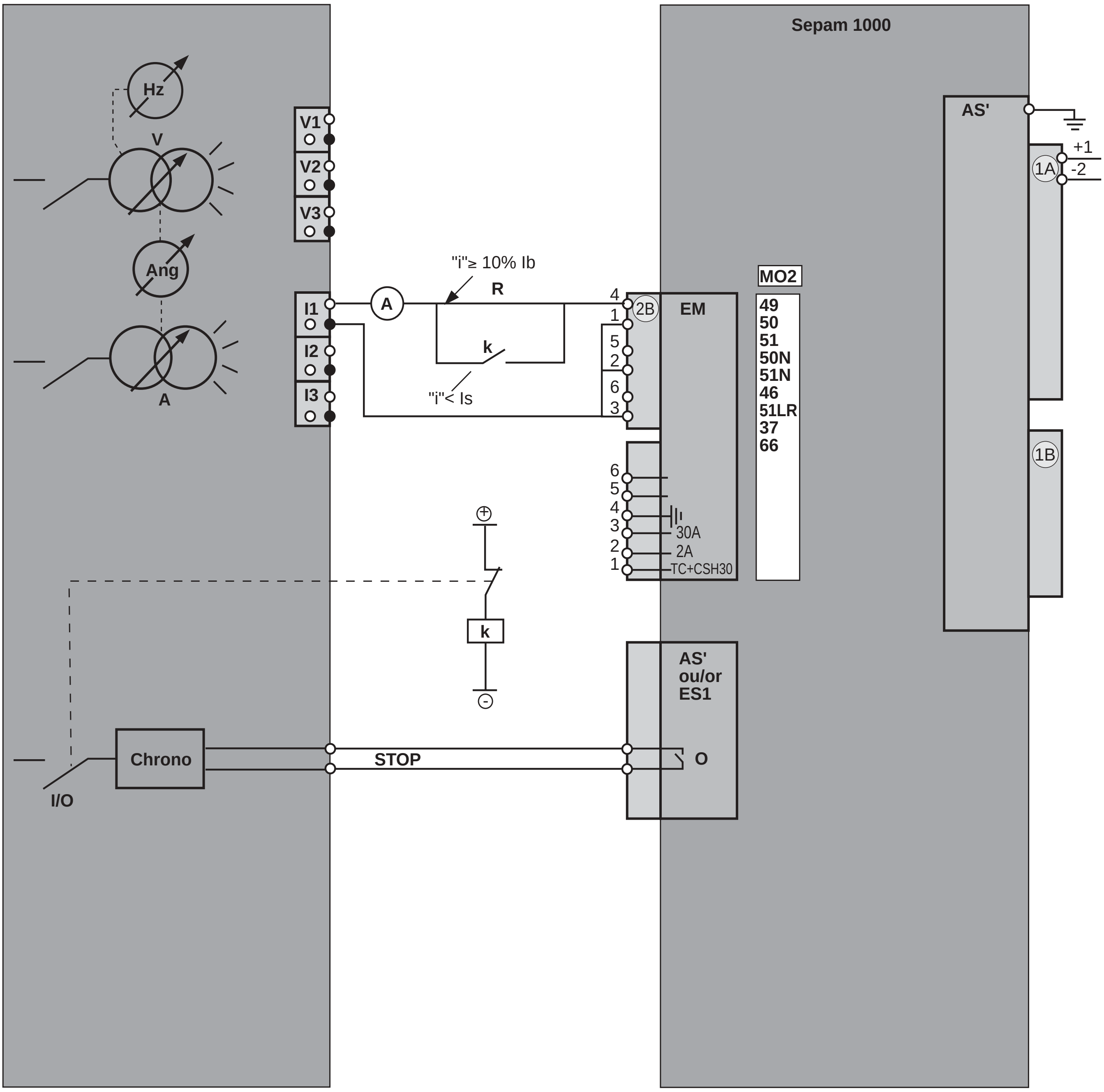
B7: current injection with CSA adapter



B8: single-phase injection into 2 current inputs



B9: undercurrent and locked rotor test



Sepam 1000 test sheet

Site : .... Switchboard : .... Cubicle :	Type of Sepam 1000 |_|_|_| serial number |_|_|_|_|_|_|_|

Commissioning tests

Prior to commissioning, check current and voltage transformer wiring, and phase rotation direction.

Set status parameters and protections according to the **setting record sheet**.

type of test		diag.	result	display	
Sepam connected to current transformers S01, T01, M01, M02					
Current measurement test:					
rated current secondary injection	I1 = 1 or 5 A I2 = 1 or 5 A I3 = 1 or 5 A	B2	primary rated current	I1 = ... I2 = ... I3 = ...	☐
Earth fault protection test					
Σ3CT 3-phase secondary injection in 1 phase	rated current (1 or 5 A) tripping current	B2	no tripping tripping at set-point		☐ ☐
CSH primary injection	tripping current	B6	tripping at set-point	I = Iso or Io>> (according to set-point)	☐
CT secondary injection	tripping current	B6	tripping at set-point		☐
Sepam connected to voltage transformers B05, B06					
Voltage measurement test:					
rated voltage secondary injection Uns = 100 or 110 or 115 or 120 V	U12 = Uns U23 = Uns U31 = Uns	B4	rated voltage primary	U12 = ... U21 = ... U31 = ...	☐
Neutral voltage displacement protection test					
broken delta voltage transformer, single-phase secondary injection	tripping voltage	B5	tripping at set-point		☐
star voltage transformer 3-phase secondary injection	tripping voltage	B4	tripping at set-point		☐
logic input / output wiring					
checkwiring of logic inputs and outpus					☐
circuit breaker / contactor program logic					
test = TRIP AUX1			tripping according to wiring		☐ ☐
AUX2 AUX3 AUX4			according to wiring according to wiring according to wiring		☐ ☐ ☐
pilot wire test					
AUX2 test			(message) INPUT=1 (on upstream Sepam)		☐

Tests performed on: |__|__|__| **by:** ________________	**Signature**	**Signature**
Comments: ________________		

Sepam 1000 setting record sheet

Site :	Type of Sepam 1000 ⌊_⌊_⌊_⌋
Switchboard :	
Cubicle :	serial number ⌊_⌊_⌊_⌊_⌊_⌊_⌊_⌋
....	

General parameters in status loop

menu	name	function		
device	Fn	network frequency	☐ 50 Hz ☐ 60 Hz	☐
	In	CT rating (amps)	⌊_⌊_⌊_⌊_⌊_⌋	
	Ib	basis current (amps)	⌊_⌊_⌊_⌊_⌊_⌋	☐
	Ino	residual current measurement	☐ ∑3Iph ☐ tore 2 A ☐ tore 30 A ☐ TC ⌊_⌊_⌊_⌊_⌊_⌋	☐ ☐ ☐
	VTs	voltage measured by VTs	☐ U21 ☐ U21-U32	
	Unp	rated VT primary voltage	⌊_⌊_⌊_⌊_⌊_⌋ ☐ volts ☐ kilovolts	☐
	Uns	rated VT secondary voltage	☐ 100 V ☐ 110 V ☐ 115 V ☐ 120 V	☐
	Vnso	type of residual voltage measurement	☐ ∑3V ☐ Uns/$\sqrt{3}$ ☐ Uns/3	☐
Microswitch settings		logic input	SW1 (2 × 2 boxes)	☐
		voltage module	SW1 (2 × 2 boxes)	☐
		current module	CT (EM): SW2 (6 × 2 boxes); SW1 (2 × 2 boxes) CSP (EA): SW2 (3 × 6 × 2 boxes); SW1 (2 × 2 boxes)	

tick the box to indicate switch position
e.g. switch set to right

☐ ☒

Sepam 1000 logic parameters sheet

Sepam program logic parameters (status loop, *Input/Ouput* page)

Relay output addressing matrix

S01 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
I>→						☐
I>>→						☐
Io>→						☐
Io>>→						☐
START→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

T01 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
I>→						☐
I>>→						☐
Io>→						☐
Io>>→						☐
E>→						☐
ALARM→						☐
START→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

M01 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
I>>→						☐
Io>>→						☐
Ii>→						☐
E>→						☐
ALARM→						☐
START→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

M02 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
I>>→						☐
Io>>→						☐
Ii>→						☐
E>→						☐
ALARM→						☐
LSLR→						☐
INHIB→						☐
I<→						☐
START→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

B05 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
U>→						☐
U>>→						☐
U<→						☐
U<<→						☐
Vd<→						☐
Vd<<→						☐
Ur<→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

B06 type ☐

relay outputs	TRIP	AUX1	AUX2	AUX3	AUX4	
U>>→						☐
U<→						☐
Vo>→						☐
Vo>>→						☐
F>→						☐
F<→						☐
F<<→						☐
WDG→						☐

output relay: TRIP AUX1 AUX2 AUX3 AUX4

Latching	:	**LATCH**	=		☐
Program logic	:	**PS**	=		☐
Input	:	**INP1**	=		☐

Sepam 1000 logic parameters sheet

Sepam 1000 type	S01 ☐	T01 ☐	M01 ☐	M02 ☐	B05 ☐	B06 ☐

type	function	ANSI	name	setting			
S01 T01 M01 M02	overcurrent	50 / 51		curve	set-point	time delay	
			low set	CURVE = ☐	Is= ☐	t> = ☐	t>Is (1) ☐
			high set	DT	I>>= ☐	t>> = ☐	t>>Is (1) ☐
	earth fault	50N 51N		curve	set-point	time delay	
			low set	CURVEo = ☐	Iso = ☐	to> = ☐	to>Is (1) ☐
			high set	DT	Io>> = ☐	to>> = ☐	to>>Is (1) ☐
T01 M01 M02	thermal overload	49		T1	T2 (M01/M02)	E<	E>
			E>	T1 = ☐	T2 = ☐	☐	☐
M02	neg. sequence unbalance	46		set-point			
			Ii>	Ii> = ☐			
	locked rotor / exc. start. time	51LR		set-point	ST	LT	
			LSLR	1.5 Ib	ST = ☐	LT = ☐	
	undercurrent	37		set-point	time delay		
			I<	I< = ☐	t< = ☐		
	number of starts	66		N1 (per hour)	N2 (consecutive)		
			INHIB	☐	☐		
B05 B06	undercurrent	27		set-point	time delay		
			set-point 1	U< = ☐	tu< = ☐		
			set-p 2 (B05)	U<< = ☐	tu<< = ☐		
	overcurrent	59		set-point	time delay		
			set-point 1	U> = ☐	tu> = ☐		
			set-p 2 (B05)	U>> = ☐	tu>> = ☐		
B05	remanent undervoltage	27R		set-point	time delay		
			Ur<	Ur< ☐	100 ms		
	positive sequence undervoltage	27D		set-point	time delay		
			set-point 1	Vd< = ☐	tvd< = ☐		
			set-point 2	Vd<< = ☐	tvd<< = ☐		
B06	neutral voltage displacement	59N		set-point	time delay		
			set-point 1	Vo> = ☐	tvo> = ☐		
			set-point 2	Vo>> = ☐	tvo>> = ☐		
	underfrequency	81		set-point	time delay		
			set-point 1	F< = ☐	tf< = ☐		
			set-point 2	F<< = ☐	tf<< = ☐		
	overfrequency	81		set-point	time delay		
			F>	F> = ☐	tF> = ☐		

(1) SO1 and TO1 versions with logic discrimination

☐ tick the box after the setting has been made

Settings made on: by:	Signature	Signature
Comments:		

notes

notes

notes

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