Protection
and control

Sepam range
Sepam 2000
Testing

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Modicon
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Sepam 2000 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 2000 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 sensor connections,
- switchgear control and annunciation connections.

The chapter entitled **commissioning tests** describes the simple, exhaustive method that is applied for checking.

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

Protection function tests

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Introduction

This chapter describes the procedures used to test the protection functions that are available in the Sepam 2000 range.

The tests call for:

■ knowledge of how to use Sepam 2000

■ a set of testing equipment

■ a TSM 2001 pocket terminal or a PC microcomputer which includes the SFT 2801 PC software package

■ documentation

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

In the rest of the document, "pocket terminal" refers to:

■ the TSM 2001 pocket terminal,
■ a computer which includes the SFT 2801 PC software package.

Measurement and testing method

General information

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

Most of the tests may be performed using a **Single-Phase** injection unit, with the exception of phase rotation checking.

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 and phase rotation,

■ directional overcurrent.

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:

□ auxiliary voltages of Sepam and ESB, ESTOR modules,

□ coherency between the cartridge and Sepam labels (model, type),

□ module insertion and presence of DPC straps,

□ setting of microswitches on the ECM, 3U/Vo and ECA modules,

□ connection of the core balance CT (P1-P2 and S1-S2 directions),

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

□ wiring and polarization of the required inputs and ouputs.

■ after energizing

□ set the parameters under the **status** heading,

□ set [1] the time delays required by the automation systems (T1, T2 etc…), the parameters values (KPxx),

□ in the case of customized program logic: check that the protection contacts (FXXX/X) to be tested, as well as the output relays associated with the protections, are being used.

■ 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.

Please note:
Remember to re-activate 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 1.5% of CT In (150 mA or 750 mA) [2],

- maximum 3 times steady state In (3 A or 15 A) [2], 24 times In for 3 s (24 A or 120 A) [2],

- 50 Hz (±10%);

□ voltage:

- minimum 1.5% of Un (0.86% of Vn) i.e. 1.5 V for 100 V [3],

- maximum 150% of Un,

- 50 Hz (±10%).

Remarks:
In order to simplify the presentation of examples, injection current values are given in **primary** amperes (like Sepam 2000 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 broken should be less than 5% of Ib.

[1] in the case of **standard** logic, refer to the **control and monitoring function** manuals
[2] to the position corresponding to 1 or 5 A according to the microswitch setting
[3] according to SM2001 pocket terminal setting of the value (Uns) of the VT secondary circuit
Un : phase-to-phase voltage
Vn : phase voltage
In : rated current on CT primary
Ib : exact load current (manufacturer data)

Phase overcurrent protection

ANSI Code	50-51	
function n°	F01X for phase I overcurrent protection	$1 \leq X \leq 6$
	F02Y for phase I' overcurrent protection	$1 \leq Y \leq 2$

Equipment

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

Injection unit wiring

■ diagram B1 or B2 or B8
■ protection relays:
F011/1, F011/2 F021/1, F021/2
F012/1, F012/2 F022/1, F022/2
F013/1, F013/2
F014/1, F014/2
F015/1, F015/2
F016/1, F016/2

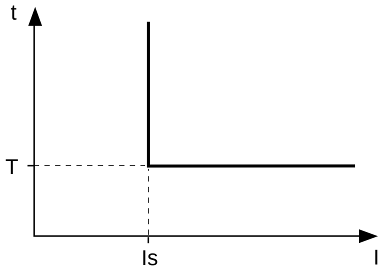
Test

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

Procedure

■ **protection** parameter setting**: O/C X** or **frame leak**
□ select the curve
□ set **Is** to the desired value
□ set **T** to the desired value
□ disable the following protections [(2)]: unbalance; the other O/C protections, E/F (if CT sum is used)

Checking of definite time Is set point



■ **protection** parameter setting
□ select the **definite** curve
□ set **T** to 0.05 s (for immediate pick-up of the output relay)
■ test
□ gradually inject the current or currents until the output relay linked to the protection in program logic picks up
□ read the **Is** current value on the ammeter
□ check the **meter** and the **I TRIP** [(1)] values on the display unit or pocket terminal
□ stop the injection
□ press **reset** [(1)] on the Sepam to erase the messages and reset the output relay

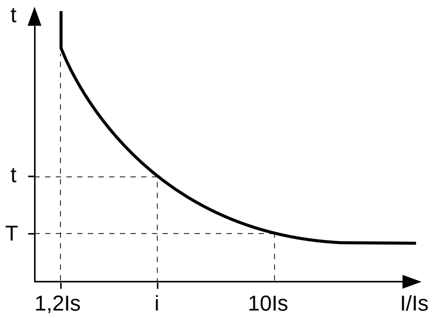
Checking of the definite time set point and time delay
■ **protection** parameter setting: **O/C X**
□ set **T** to the desired value
□ prepare the injection with twice the value of **Is**
□ set the chronometer to zero

■ test
□ start up injection and the chronometer at the same time
□ Sepam's output relay stops the chronometer
□ read the value **T** measured by the chronometer

[(1)] this function may only be activated if your program logic has been customized.
[(2)] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Checking of IDMT set point and time delay

The set point and time delay are interrelated. They correspond to curve coordinates (see appendices).



a time t corresponds to an injected value i.

■ **protection** parameter setting: **O/C X**
□ select the **standard inverse (SIT), very inverse (VIT)**, **extremely inverse (EIT)** or **ultra inverse (UIT)** curve
□ set **Is** (asymptote: for an injection i = Is, so t = infinity)
□ set **T** (corresponding to 10 Is: for an injection i = 10 Is, so t = T)
□ identify on the curve the different coordinates of the points that you will be testing (i and t)
■ test the different points on the curve
□ preset the injection i (to a value > 1.2 Is) and make a note of the value
□ stop the injection and reset the chronometer to zero
□ press **reset** if required (1)
□ start up injection and the chronometer at the same time
□ check the injection value on the ammeter (stability)
□ Sepam's 2000 output relay stops the chronometer
□ read the **t** value measured by the chronometer
□ compare with the value given in the curve
□ check the **meter** and the **I TRIP** (1) values on the display unit or pocket terminal
□ stop the injection
□ press **reset** (1) on Sepam 2000 to erase the messages and reset the output relay

Example

Status	In = 400 A
settings	very inverse curve
	Is = 200 A
	T = 0.5 s
injection	i = 300 A (0.75 or 3.75 A)

In the **very inverse** column of the chart which gives K for I/Is, read the value K = 18 which corresponds to I/Is = 1.5 (= 300/200) for an injection **i** = 300 A, the relay will pick up after a time period **t** = 18 x 0.5 s = 9 s (t = K x T) (Ib is not used in the O/C protections)

(1) this function may only be activated if your program logic has been customized.
X = number of the protective relay.

Phase overcurrent protection (cont'd)

K factor chart

I/Is	inverse (SIT)	very inv. (VIT)	ext. inv. (EIT)	ultra inv. (UIT)
1.2	12.90	45.00	225.00	545.51
1.3	8.96	30.00	143.48	339.84
1.4	6.98	22.50	103.13	238.80
1.5	5.79	18.00	79.20	179.42
1.6	4.99	15.00	63.46	140.74
1.7	4.42	12.86	52.38	113.80
1.8	3.99	11.25	44.20	94.12
1.9	3.65	10.00	37.93	79.22
2.0	3.38	9.00	33.00	67.64
2.1	3.15	8.18	29.03	58.43
2.2	2.97	7.50	25.78	50.98
2.3	2.81	6.92	23.08	44.85
2.4	2.67	6.43	20.80	39.76
2.5	2.55	6.00	18.86	35.46
2.6	2.44	5.63	17.19	31.82
2.7	2.35	5.29	15.74	28.69
2.8	2.27	5.00	14.47	25.99
2.9	2.19	4.74	13.36	23.65
3.0	2.12	4.50	12.38	21.59
3.1	2.06	4.29	11.50	19.79
3.2	2.00	4.09	10.71	18.19
3.3	1.95	3.91	10.01	16.77
3.4	1.90	3.75	9.38	15.51
3.5	1.86	3.60	8.80	14.37
3.6	1.82	3.46	8.28	13.35
3.7	1.78	3.33	7.80	12.43
3.8	1.74	3.21	7.37	11.60
3.9	1.71	3.10	6.97	10.85
4.0	1.68	3.00	6.60	10.16
4.1	1.65	2.90	6.26	9.53
4.2	1.62	2.81	5.95	8.96
4.3	1.59	2.73	5.66	8.44
4.4	1.57	2.65	5.39	7.95
4.5	1.54	2.57	5.14	7.51
4.6	1.52	2.50	4.91	7.10
4.7	1.50	2.43	4.69	6.72
4.8	1.48	2.37	4.49	6.37
4.9	1.46	2.31	4.30	6.04
5.0	1.44	2.25	4.13	5.74
5.1	1.42	2.20	3.96	5.46
5.2	1.41	2.14	3.80	5.19
5.3	1.39	2.09	3.65	4.95
5.4	1.37	2.05	3.52	4.72
5.5	1.36	2.00	3.38	4.50
5.6	1.34	1.96	3.26	4.30
5.7	1.33	1.91	3.14	4.11
5.8	1.32	1.88	3.03	3.94
5.9	1.30	1.84	2.93	3.77
6.0	1.29	1.80	2.83	3.61
6.1	1.28	1.76	2.73	3.47
6.2	1.27	1.73	2.64	3.33
6.3	1.26	1.70	2.56	3.19
6.4	1.25	1.67	2.48	3.07
6.5	1.24	1.64	2.40	2.95

I/Is	inverse (SIT)	very inv. (VIT)	ext. inv. (EIT)	ultra inv. (UIT)
6.6	1.23	1.61	2.33	2.84
6.7	1.22	1.58	2.26	2.73
6.8	1.21	1.55	2.19	2.63
6.9	1.20	1.53	2.12	2.54
7.0	1.19	1.50	2.06	2.45
7.1	1.18	1.48	2.00	2.36
7.2	1.17	1.45	1.95	2.28
7.3	1.16	1.43	1.89	2.20
7.4	1.15	1.41	1.84	2.13
7.5	1.15	1.38	1.79	2.06
7.6	1.14	1.36	1.74	1.99
7.7	1.13	1.34	1.70	1.93
7.8	1.12	1.32	1.65	1.86
7.9	1.12	1.30	1.61	1.81
8.0	1.11	1.29	1.57	1.75
8.1	1.10	1.27	1.53	1.70
8.2	1.10	1.25	1.49	1.64
8.3	1.09	1.23	1.46	1.60
8.4	1.08	1.22	1.42	1.55
8.5	1.08	1.20	1.39	1.50
8.6	1.07	1.18	1.36	1.46
8.7	1.07	1.17	1.33	1.42
8.8	1.06	1.15	1.30	1.38
8.9	1.05	1.14	1.27	1.34
9.0	1.05	1.13	1.24	1.30
9.1	1.04	1.11	1.21	1.27
9.2	1.04	1.10	1.18	1.23
9.3	1.03	1.08	1.16	1.20
9.4	1.03	1.07	1.13	1.17
9.5	1.02	1.06	1.11	1.14
9.6	1.02	1.05	1.09	1.11
9.7	1.01	1.03	1.06	1.08
9.8	1.01	1.02	1.04	1.05
9.9	1.00	1.01	1.02	1.02
10.0	1.00	1.00	1.00	1.00
10.5	0.98	0.95	0.91	0.88
11.0	0.96	0.90	0.83	0.79
11.5	0.94	0.86	0.75	0.70
12.0	0.92	0.82	0.69	0.63
12.5	0.91	0.78	0.64	0.57
13.0	0.90	0.75	0.59	0.52
13.5	0.88	0.72	0.55	0.47
14.0	0.87	0.69	0.51	0.43
14.5	0.86	0.67	0.47	0.39
15.0	0.85	0.64	0.44	0.36
15.5	0.84	0.62	0.41	0.43
16.0	0.83	0.60	0.39	0.31
16.5	0.82	0.58	0.36	0.29
17.0	0.81	0.56	0.34	0.26
17.5	0.80	0.55	0.32	0.25
18.0	0.79	0.53	0.31	0.23
18.5	0.78	0.51	0.29	0.21
19.0	0.78	0.50	0.28	0.20
19.5	0.77	0.49	0.26	0.19
20.0	0.76	0.47	0.25	0.18

Voltage restrained overcurrent protection

ANSI code	50V-51V
function n°	F19X for voltage-restrained overcurrent protection $1 \le X \le 2$ F20Y for voltage-restrained overcurrent protection $1 \le Y \le 2$

Equipment

■ single-phase and three-phase current and voltage generators
■ phase shifter with angle indicator
■ ammeters
■ voltmeter
■ chronometer
■ calculator
■ adapter for ECA module
■ documentation

Wiring

■ B5 or B6 diagram
■ protective relay:
F191/1, F191/2
F202/1, F202/2

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.

The set point is adjusted in accordance with the lowest phase-to-phase voltage measured.

■ checking of the set points for this protection, at rated voltage **Uns**, is the same as for the phase overcurrent protection test

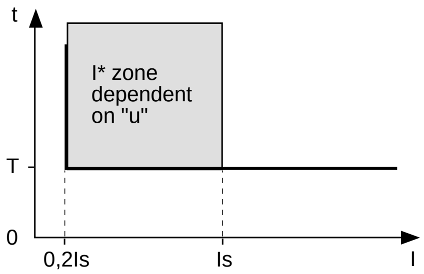
■ for voltage **lower** than **Uns**, an adjustment factor is used which, when multiplied by the **Is** set point, gives the new protection activation set point **I*.**
Set point to be tested **I*** = K.Is
or with K = 1/3 x (4u / Uns - 0.2)

■ **status** parameter setting: enter all data items
□ **Fn** network frequency
□ **Unp** network phase-to-phase voltage
□ **Uns** phase-to-phase voltage of the VT secondary circuits
□ **number** of VTs connected
(1 VT for single-phase testing)
□ select **In** the CT primary value
□ check and set the microswitches on the **3U/Vo**, **ECM** and **ECA** modules

Procedure

■ **protection** parameter setting: **V Rest O/C** (refer to the section entitled **phase overcurrent**)

□ select the **curve** (definite or IDMT)
□ set **Is** to the desired value
□ set **T** to the desired value (10Is IDMT)
□ disable the **unbalance** protections;
O/C X; **U U/V X**; **U U/V**; **U/C**; **E/F X** (when the sum of 3 CTs is used)



Testing of definite time set points

■ parameter setting

□ set **Is** to the desired value
□ set **T** to 0.05 s

■ test

□ inject "**u**" = Uns (into U21 for single-phase injection)
□ lower one of the voltages and calculate the ratio **u**/Uns
□ gradually increase the current or currents until the protective relay picks up
□ read the value **I*** on the ammeter

Testing of definite time delay
■ parameter setting

□ inject **"u"** = Uns (into U21 for single-phase injection)
□ set **i** higher than Is
□ set **T** to the desired value

■ test

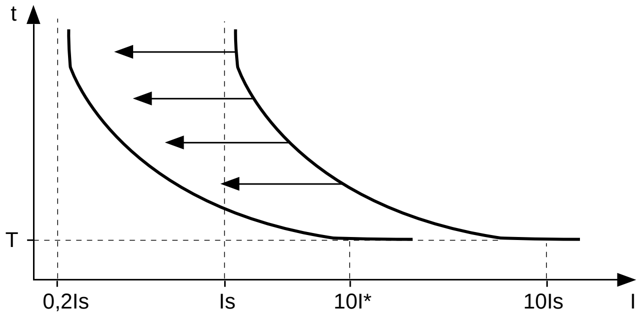
□ set the chronometer to zero
□ start up the chronometer and injection at the same time
□ the Sepam 2000 relay stops the chronometer
□ read the value **T** measured by the chronometer

Chart giving the Is set point adjustment factor as a function of the change of voltage.

u/Uns	K	u/Uns	K	u/Uns	K	u/Uns	K
< 0.2	0.2	0.36	0.413	0.54	0.653	0.72	0.893
0.2	0.2	0.38	0.44	0.56	0.68	0.74	0.92
0.22	0.227	0.4	0.467	0.58	0.707	0.76	0.947
0.24	0.253	0.42	0.493	0.6	0.733	0.78	0.973
0.26	0.28	0.44	0.52	0.62	0.76	0.8	1
0.28	0.306	0.46	0.547	0.64	0.787	> 0.8	1
0.3	0.333	0.48	0.573	0.66	0.813		
0.32	0.36	0.5	0.6	0.68	0.84		
0.34	0.387	0.52	0.627	0.7	0.867		

(1) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Testing of IDMT set points
For injection voltage **u = Uns**, testing of the **O/C V REST** protection is the same as IDMT phase **overcurrent** testing.



■ **protection** parameter setting**: V Rest O/C**

□ select the **standard inverse, very inverse**, **extremely inverse** or **ultra inverse** curve
□ set **Is** (asymptote: for an injection i = Is, so t = infinity)
□ set **T** (corresponding to 10Is: for an injection i = 10Is, so t = T)
□ identify on the curve the different coordinates of the points that you will be testing (i and t)

■ test the different points on the curve

□ set and inject voltage **u** and calculate **u/Uns**
□ preset the injection **i** = **I*** = **Is.u/Uns**
□ stop the injection and reset the chronometer to zero
□ press **reset** if required [(1)]
□ start up injection and the chronometer at the same time
□ check the injection value on the ammeter (stability)
□ Sepam's 2000 output relay stops the chronometer
□ read the value **t** measured by the chronometer
□ compare with the value given in the curve and the chart corresponding to **I***
□ check the **meter** and the **I TRIP** value on the display unit or pocket terminal [(1)]
□ stop the injection
□ press **reset** [(1)] on Sepam 2000 to erase the messages and reset the output relay

Example

Status	In = 1000 A
	Uns = 100 V
settings	very inverse curve
	Is = 200 A
	T = 0.5 s

for **u** = 44 V

$$\frac{U}{Uns} = \frac{44}{100} = 0{,}44 : k = 0{,}52$$

the new value of **I*** will therefore be 200 x 0.52 = 104 A

Injection **i** = 200 A
In the **very inverse** column of the chart which gives K for **i/I***, read the value K = 10 which corresponds to
i/I* = 1.9 (= 200 / (200.u/Uns)).
for an injection **i** = 200 A the relay will pick up after a period of time
t = 10 x 0.5 s = 5 s (t = K x T)

(1) this function may only be activated if your program logic has been customized.

Earth fault protection

ANSI code	50N-51N or 50G-51G	
function n°	F06X, F08X for earth fault protection Io	1 ≤ X ≤ 4
	F07Y, F09Y for additional earth fault protection Io'	1 ≤ Y ≤ 2

Equipment

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

Wiring

■ diagram B1, B7 or B8
■ protective relays:
F061/1, F061/2, F071/1, F071/2
F062/1, F062/2, F072/1, F072/2
F063/1, F063/2,
F064/1, F064/2,
F081/1, F081/2, F091/1, F091/2
F082/1, F082/2, F092/1, F092/2
F083/1, F083/2,
F084/1, F084/2.

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 ECM and ECA modules
□ check the connection of the interposing ring CT to the connector.

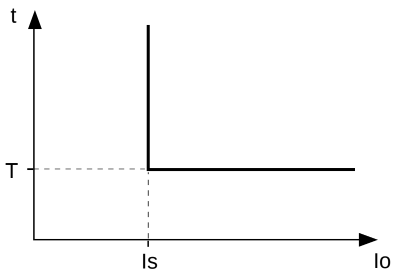
[1] this function may only be activated if your program logic has been customized.
[2] remember to reactivate the protections at the end of testing.
[3] for F08X and F09Y protections only. Restaint available as of version 9940 SFT 2800.
X = number of the protective relay.

Procedure

■ **protection** parameter setting**: E/F X**

□ select the **definite** curve
□ set **Iso** to the desired value
□ set **T** to the desired value
□ disable the **Unbalance** protections [2];
O/C X, (for sum of CTs); the other earth fault set points Io

Checking of definite time Iso set point



The direction of current injection is irrelevant for this protection.

■ parameter setting

□ set **T** to 0.05 s

■ test

□ gradually inject the real current until the output relay linked with the protection in program logic picks up
□ read the **Iso** current value on the ammeter
□ check the **meter** and **I TRIP0** [1] values on the display unit or pocket terminal
□ stop the injection
□ press **reset** [1] on the Sepam 2000 to erase the messages and reset the output relay

Checking of harmonic 2 restraint [3]
■ parameter setting

□ set H2 Rest = yes

■ testing

□ inject a real current I_A until the output relay linked to the protection in the program logic picks up
□ inject a harmonic 2 current (frequency 100 Hz or 120 Hz according to the network frequency) with a value greater than 0.2 I_A into another phase
□ the output relay should drop out
□ stop the injection
□ preset reset **[1]** on Sepam 2000 to erase the messages

Checking of the definite time delay T
■ **protection** parameter setting: **E/F X**

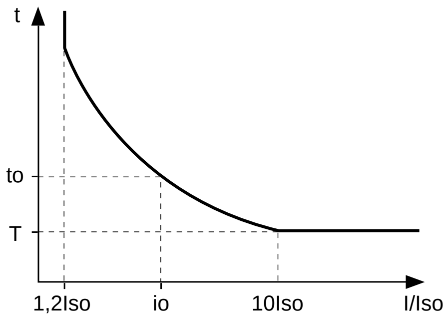
□ set **T** to the desired value
□ prepare the injection with twice the value of **Iso**
□ set the chronometer to zero

■ test

□ start up injection and the chronometer at the same time
□ Sepam's output relay stops the chronometer
□ read the **T** value measured by the chronometer.

Earth fault protection (cont'd)

Checking of IDMT set points and time delay
The set point and time delay are IDMT and correspond to the curve and chart coordinates (see **protection function** sheets in appendix).
The protection testing is the same as the IDMT phase overcurrent test.



a time to corresponds to an injected value io.

■ **protection** parameter setting**: E/F X**

□ select the **standard inverse, very inverse** or **extremely inverse** or **ultra inverse** curve
□ set **Iso**
(asymptote: for an injection io = Is, to = infinity)
□ set **T** (corresponding to 10 Iso: for an injection io = 10 Iso, to = T)
□ identify on the curve the different coordinates of the points that you will be testing (io and to)

■ test the different points on the curve

□ preset the injection i and make a note of the value
□ stop the injection and reset the chronometer to zero
□ press **reset** if required (1)
□ start up injection and the chronometer at the same time
□ check the injection value on the ammeter (stability)
□ Sepam's 2000 output relay stops the chronometer
□ read the **t** value measured by the chronometer
□ compare with the value given in the curve and calculate using the charts
□ check the **meter** and **I TRIP0** (1) values on the pocket terminal
□ stop the injection
□ press **reset** (1) on Sepam 2000 to erase the messages and reset the output relay.

(1) this function may only be activated if your program logic has been customized.
X = number of the protective relay.

Example 1
In = 400 A

Status	measurement by 2 A CT (connection of A4 and A2)
Settings	definite
	Iso = 1 A
	T = 0.5 s
Injection	i = 2 A

For an injection **io** = 2 A, the output relay picks up after time **t** = 0.5 s.
Sepam measures Io = 2 A and I TRIP0 = 2 A

Example 2
In = 400 A

Status measurement by 30 A CT (connection of A4 and A3)

The 30 A CT test is the equivalent of the 2 A CT test; measurement range is different.

Settings	standard inverse curve
	Iso = 10 A
	T = 0.5 s
Injection	i = 100 A

In the **standard inverse** column of the chart which gives K for I/Is, read the value K = 1 that corresponds to I/Is = 10 = (100A/10A)
For an injection **io** = 100 A, the output relay picks up after time t = 1 x 0.5 s = 0.5 s (t=K x T).
Sepam measures Io = 100 A and ITRIP0 = 100 A.

Example 3
In = 400 A

Status measurement by core balance CT (connection of A4 and A1)

■ select for the Io sensor the value of the CT primary circuit.
In the example: In = 400 A

■ check that number of times the wire enters the CHS30 interposing ring CT is in accordance with the value of the CT secondary circuit

(5 times for 1 A or once for 5 A)

Settings	**extremely inverse** curve
	Iso = 20 A (minimum = 5% x 400 A)
	T = 0.3 s
Injection	io = 100 A

In the **extremement inverse** column of the chart which gives K for I/Is, read the value K = 4.125 that corresponds to I/Is = 5 = (100A/20A)
For an injection io = 100 A, the output relay picks up after time **t** = 4.13 x 0.3 ≈ 1.24 s (t = K x T).
Sepam measures Io = 100 A and ITRIP0 = 100 A.

Example 4
In = 200/5 A

Status	measurement by sum of CTs
Settings	**standard inverse** curve
	Iso = 20 A
	T = 4 s
Injection	io = 400 A (10 A secondary)

In the **standard inverse** column of the chart that gives K for I/Is, read the value K = 0.763 that corresponds to I/Is = 20 = (400A/20A)
For an injection io = 400 A, the output relay picks up after time t = 0.76 x 4 ≈ 3.04 s (t=K x T).
Sepam measures Io = 400 A and ITRIP0 = 400 A.

Please note:
In order to reduce the injection unit current Ii, it is possible insert the wire through the CT several times.
The Sepam 2000 measurement will be equal to: Ii multiply by the number of turns in CT.

Percentage-based single-phase overcurrent protection

ANSI code	50-51	
function n°	F03X for the phase overcurrent I1 protection	$1 \le X \le 2$
	F04X for the phase overcurrent I2 protection	
	F05X for the phase overcurrent I3 protection	
	F11Y for the phase overcurrent I1' protection	$1 \le Y \le 2$
	F12Y for the phase overcurrent I2' protection	
	F13Y for the phase overcurrent I3' protection	

Equipment

■ single-phase current generator

■ ammeters

■ chronometer

■ documentation

Wiring

■ B1 diagram

■ protective relays:

F031/1, F031/2,

F041/1, F041/2,

F051/1, F051/2,

F111/1, F111/2,

F121/1, F121/2,

F131/1, F131/2.

Test

■ read the section entitled measurement and testing method

■ **status** parameter setting

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

Please note:
the choice of the CT primary value has no effect.

Procedure

■ **protection parameter setting**: **Iph O/C X** with ph = 1.2 or 3

□ set **Is** to the desired value

□ set **T** to the desired value

□ disable the set points of the following protections [(2)] :

- unbalance, O/C, E/F (if 3 CT sum is used)
- the other Iph O/C protections

Checking of the set point

■ parameter setting

□ set **T** to 0.05 s

■ test

□ gradually inject a current until the output relay linked to to the protection in the program logic picks up

□ read the Is value of the current on the ammeter

□ stop the injection

□ press **reset** [(1)] on Sepam 2000 to erase the messages and de-activate the outputs.

Checking of the time delay

■ parameter setting

□ set **T** to the desired value

□ preset the injection to twice the value of **Is**

□ set the chronometer to zero

■ test

□ start up the chronometer and the injection at the same time

□ the Sepam 2000 output relay stops the chronometer

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

[(1)] this function may only be activated if your program logic has been customized.
[(2)] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Directional overcurrent protection

ANSI code	67	
function n°	F51X for 2-phase directional overcurrent (I1, I3) F52X for 3-phase directional overcurrent (I1, I2, I3)	$1 \leq X \leq 2$

In order to use this function, it is necessary to be familiar with the overcurrent and overvoltage protection function procedures and settings (refer to appropriate sections).

Equipment

■ single-phase and three-phase current and voltage generators
■ phase shifter with angle indicator
■ ammeters
■ voltmeter
■ chronometer
■ calculator
■ adaptater for ECA module
■ documentation

Wiring

■ diagrams B5 or B6

■ protective relays:

F511/1, F511/2 for normal zone of set point 1
F511/3, F511/4 for inverse zone of set point 1
F512/1, F512/2 for normal zone of set point 2 [2]
F512/3, F512/4 for inverse zone of set point 2 [2]
F521/1, F521/2 for normal zone of set point 1
F521/3, F521/4 for inverse zone of set point 1
F522/1, F522/2 for normal zone of set point 2 [2]
F522/3, F522/4 for inverse zone of set point 2 [2]

Test

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

■ **status** parameter setting

□ select **Fn** network frequency

□ set **Unp** the VT secondary circuit phase-to-phase voltage

□ set Uns, the VT secondary phase-to-phase voltage

□ set the number of wired VTs to 3U

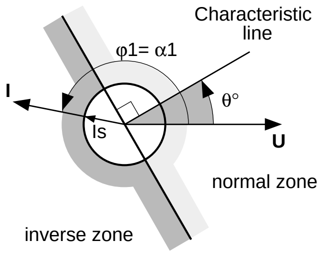
□ select the value of the CT primary circuits

□ check the microswitches on the **3U/Vo**, **ECM** or **ECA** modules.

[1] this function may only be activated if your program logic has been customized.
[2] only one relay is used in standard applications.
[3] remember to reactivate the protections at the end of testing.
[4] input value not taken into account by the F51X function
X = number of the protective relay.

Procedure

This protection checks the direction of currents I1, I2 [4] and I3 in comparison with voltages U32, U13 [4] and U21 respectively, so that testing can be carried out using single-phase current and voltage, changing only one current and the shift with respect to its voltage each time.

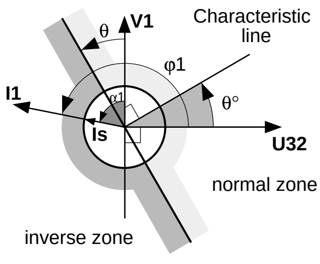


■ **protection** parameter setting**:**
Dir O/C X

□ select the **curve**

□ set **Is** to the desired value
□ set **T** to the desired value (see curves in appendix)
□ select **angle** θ (characteristic angle)
□ disable the following protections [3] O/C X; Under/C X; U/V X ; Unbalance; E/F (for sum of CTs) ; N Vol Disp (for sum of VTs)
□ inject the voltage or voltages and the current or currents in accordance with diagram B5 or B6
□ select the appropriate phase shift in accordance with the protection activation zone, given:
$\varphi 1 = \alpha 1$ or $\varphi 2 = \alpha 2$ or $\varphi 3 = \alpha 3$ (single phase)
$\varphi 1 = \alpha 1 + 90°$ or $\varphi 2 = \alpha 2 + 90°$ or $\varphi 3 = \alpha 3 + 90°$ (three phase) or $\varphi 1$, $\varphi 2$ and $\varphi 3$ being the angles read on the pocket terminal
($\pm$) $\alpha 1$, $\alpha 2$ et $\alpha 3$ being the phase shift angles of the injection unit.

Example of test on U32 and I1 using single-phase current and voltage (see diagram B5)



$\varphi 1 = 90° + (\alpha 1)$

□ connect voltage **U32**: 0 to input **U3** (terminal A3) and **V** to input **U2** (terminal A4)
□ connect current **I1**: 0 to input N (terminal B1) and **I** to input I1 (terminal B4)
■ **testing of Is set point for θ = 30° and definite time**
□ inject phase-to-phase voltage **Uns**
□ set **T** to 0.05 s
□ inject current so that the phase shift angle $\varphi 1$ can be set to 30° and 210°
□ check $\varphi 1$ on the pocket terminal
□ stop current injection and reset Sepam 2000 to zero [1]
□ gradually increase the current until the protection output relay picks up:

F511/1 or F511/2 for $\varphi 1$ = 30°

F511/3 or F511/4 for $\varphi 1$ = 210°
□ read **Is** on the ammeter.

■ **testing of T**

Once the protection activation zone has been determined, the **T** tests are the same as the **definite time and IDMT curve** phase overcurrent protection tests (see section on phase overcurrent).

■ **testing of protective relay normal and inverse zones**

The zone limits are: φ = 90° + θ to φ = 270° + θ

□ inject **phase-to-phase voltage Uns**

□ set **T** to 0.05 s

□ select θ according to the different examples given below

□ preset the current to twice **Is** and the phase shift according to the chart

□ stop current injection and reset Sepam 2000 (1)

□ inject the current with a phase shift that is outside the zone concerned by the protective relay to be tested

□ vary the phase shift angle a of the injection unit so as to determine the angle limits of the activation zone

□ reset to zero when leaving the zone each time the output relay (1) is activated.

■ **three-phase testing**

These tests are performed using the same procedures as those described previously.
□ connect the voltages (N, V1, V2, V3) and currents according to diagram B6
□ inject the voltages and currents
□ the change in the injection box phase difference angle is determined by the protection activation zone (see chart).

characteristic angle	**normal zone F51X/1 and F51X/2 F52X/1 and F52X/2**	**inverse zone F51X/3 and F51X/4 F52X/3 and F52X/4**
	φ1 or φ2 or φ3	φ1 or φ2 or φ3
θ = 30°	300° … (0°) … to … 120°	120° … (180°) … to … 300°
θ = 45°	315° … (0°) … to … 135°	135° … (180°) … to … 315°
θ = 60°	330° … (0°) … to … 150°	150° … (180°) … to … 330°

Remark
As a rule, the angle indicated by the injection unit is the phase shift between phase voltage and current.

Example

injection unit	**pocket terminal**
α	φ
+ 180°	180°
+ 90°	270°
0°	0° ou 360°
- 90°	90°
- 180°	180°

The voltage is created electronically and is shifted with respect to the current that serves as the reference for phase shift measurement.

(1) this function may only be activated if your program logic has been customized.
X = number of the protective relay.

Directional earth fault protection

ANSI code	67N	
function n°	F50X	1 ≤ X ≤ 2

In order to use this function, it is necessary to be familiar with the overcurrent and residual voltage protection function procedures and settings (refer to appropriate sections).

Equipment

■ single-phase current and voltage generators

■ phase shifter with angle indicator

■ ammeters

■ voltmeter

■ chronometer

■ calculator

■ adapter for ECA module

■ documentation

Wiring

■ B5 or B6 or B7 diagram

■ protective relays:

F501/1, F501/2 for normal zone of set point 1
F501/3, F501/4 for inverse zone of set point 1
F502/1, F502/2 for normal zone of set point 2 (2)
F502/3, F502/4 for inverse zone of set point 2 (2)

Test

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

■ **status** parameter setting

□ select **Fn** network frequency

□ set **Unp** phase-to-phase voltage

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

□ select Vo measurement method

□ select CT primary value

□ select Io measurement method

□ check microswitches on the **3U/Vo**, **ECM** or **ECA** modules.

Procedure

■ **protection** parameter setting**: Dir. E/F**

□ set **Iso** to the desired value

□ set **T** to the desired value

□ select **angle θo** (characteristic angle)

□ disable the following protections (3):

- related to Vo if measurement is by the sum of the 3 VTs: **U O/V; U O/V X; U U/V; U U/V X**

- related to Io if measurement is by the sum of the 3 CTs: all **O/C**, **E/F** and **Unbalance** set points

□ inject voltage which corresponds to Vo > 2.6 % of Unp

Checking of set point with θo = 0°

■ parameter setting

□ set **T** to 0.05 s

□ select θ**o** = 0°

■ test (see figure 1)

□ gradually inject current **i** with a phase shift of 180° with respect to Vo until the output relay linked with the normal protection zone in program logic picks up

□ read the current value on the ammeter

□ stop current injection

□ press **reset** (1) on Sepam 2000 to erase the messages and reset the output relay.

Checking of time delay T

■ parameter setting

□ set **T** to the desired value

■ test (see figure 1)

□ preset the current injection to 1.2 times the Iso value and the 180° phase shift with respect to Vo

□ set the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's 2000 output relay stops the chronometer

□ read the value measured by the chronometer

Checking of the protection range using a phase shifter

■ parameter setting

□ set **T** to the minimum (0.05 s)

□ set **Iso**

■ test (see figures 2, 3 and 4)

□ set the injection current **i** to a value that is clearly greater than Iso so that its projection **Ipo** will be greater than **Iso**

□ the angle limits of the **normal** and **inverse** ranges will be:

- normal zone

[φo] = 180° + θo ±ω

- inverse zone

[φo] = 360° + θo ±ω
with cosω = Iso/**i**

θo = angle of the line formed by the projection of **i** with respect to Vo (set via the pocket terminal).

(1) this function may only be activated if your program logic has been customized
(2) only one relay is used in standard applications
(3) remember to reactivate the protections at the end of the test.
X = number of the protective relay.

example

■ angle θo = 0° (see figure 2 graph)

settings Iso = 2 A

T = 0.05 s

for injection **i** = 5 A, the protection is activated:

cosω = 2/5 = 0.4 hence ω = 66.4°

□ in normal zone 180° + 0° ±ω i.e. [φo] equal to 113.6° to 246.4°.

□ in inverse zone 360° + 0° ±66.4° i.e. [φo] equal to 293.6° to 66.4° (426.4).

■ angle θo = 0° (see figure 2 graph)

with strong current (limit of 14° ranges)

settings Iso = 2 A

T = 0.05 s

for injection **i** = 20 A, the protection is activated:

cosω = 2/20 = 0.1 hence ω = 84.2°

□ in normal zone 180° + 0° ±84.2° i.e. [φo] equal to 104° to 256°, no processing outside this range.

□ in inverse zone 360° + 0° ±84.2° i.e. [φo] equal to 284° to 76° (436°), no porcessing outside this range.

■ angle θo = 30° (see figures 3 and 4 graphs)

settings Iso = 2 A

T = 0.05 s

for injection **i** = 5 A, the protection is activated:

cosω = 2/5 = 0.4 hence ω = 66.4°

□ in normal zone 180° + 30° ±ω i.e. [φo] equal to 143.6° to 276.4°.

□ in inverse zone 360° + 30° ±66.4° i.e. [φo] equal to 323.6° to 96.4° (456.4°).

■ angle θo = -45° (see figures 3 and 4 graphs)

setttings Iso = 2 A

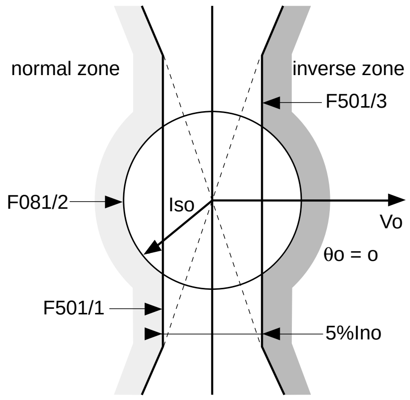
T = 0.05 s

for injection **i** = 10 A, the protection is activated:

cosω = 2/10 = 0.2 hence ω = 78.4°

□ in normal zone 180° +(-45° ±ω) i.e. [φo] equal to 56.6° to 213.4°.

□ in inverse zone 360° +(-45° ±66.4°) i.e. [φo] equal to 248.6° to 21.4° (381.4°).



Corresponding program logic diagram:

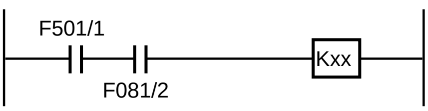


Fig 1

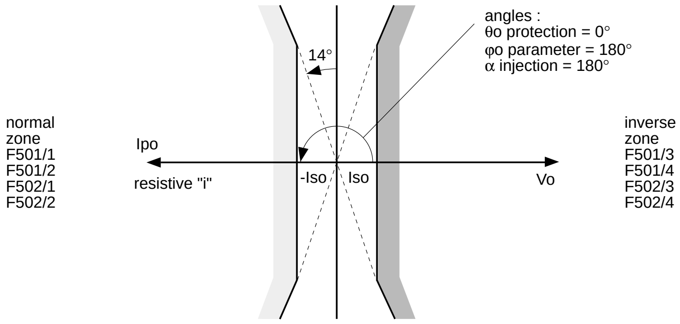


Fig 2

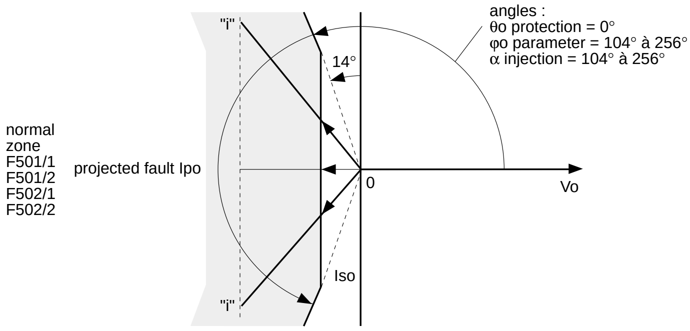


Fig 3

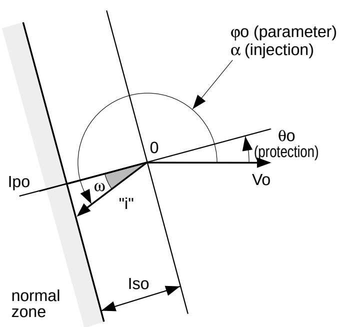
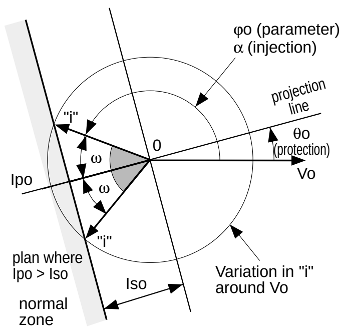


Fig 4



Special cases

■ the injection unit performs a special phase shift and angle measurement, which makes it necessary to make an angle correspondence chart.

Example

Injection according to wiring diagram B7 (**i** is 180° from Vo).

injection unit	pocket terminal
a	φo
+ 180°	+ 180°
+ 90°	+ 270°
0°	0° or 360°
- 90°	+ 90°
- 180°	+ 180°

The voltage is created electronically and has a phase shift with respect to the current that serves as the reference for phase shift measurement.

■ when combined with an earth fault protection set point, the directional protection can use the inverse time time delay. The combination is made via customized program logic.

Directional earth fault protection for compensated networks

ANSI code	67NC	
function n°	F48X	1 ≤ X ≤ 2

In order to use this function, it is necessary to be familiar with the overcurrent and residual voltage protection function procedures and settings (refer to appropriate sections).

Equipment

- single-phase current and voltage generators
- phase shifter with angle indicator
- ammeters
- voltmeter
- chronometer 1616
- calculator
- adapter for ECA module
- documentation

Wiring

- diagram B5 or B6 or B7
- protective relays:

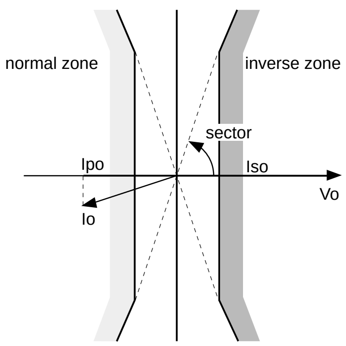
F481/1, F481/2 for normal zone set point 1
F481/3, F481/4 for inverse zone set point 2
F481/5 for Vo > Vso.

F482/1, F482/2 for normal zone set point 1
F482/3, F482/4 for inverse zone set point 2
F482/5 for Vo > Vso.

Test

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

■ **status** parameter setting
□ select **Fn** network frequency
□ set **Unp** to the phase-to-phase voltage value
□ select **Uns** the VT secondary circuit phase-to-phase voltage
□ select the Vo measurement method
□ select the value of the CT primary circuit
□ select the Io measurement method
□ check the microswitches on the **3U/Vo**, **ECM** or **ECA** modules.



(1) this function may only be activated if your program logic has been customized.
(2) remember to reactivate these protections if need be at the end of testing.
X = number of the protective relay.

Procedure

■ **protection** parameter setting**: CNSdir, E/F**

□ set **Iso** to the desired value

□ select sector **angle** 83° or 86°

□ set **T** the protection time delay

□ set **Vso**

□ set **Tmem** disengaging time

□ disable the following protections:

- related to Vo if measurement is by the sum of the 3 VTs: **U U/V; U U/V X; U O/V; U O/V X, N Vol Disp** (if included)

- related to Io if measurement is by the sum of the 3 CTs: **O/C X**, **E/F X** and **unbalance.**

Checking of Iso set point
■ parameter setting

□ set **Iso** to the desired value

□ set **T** to 0.05 s

■ test

□ inject voltage which corresponds to Vo > Vso (see chapter on N Vol Disp)

□ once the activation zone has been determined (normal or inverse), phase shift between **i** and **u** of 0° for inverse zone and of 180° for normal zone

□ inject current **i**, gradually increasing it until the relay linked to the protection picks up

□ read the **Iso** value on the ammeter.

□ stop the current injection

□ press reset (1) on Sepam 2000 to erase the messages and deactivate the output.

Checking of T
■ parameter setting

□ set **T** to the desired value

■ test

□ present current **i** to twice Iso and the injection unit angle in accordance with the zone concerned

□ reset Sepam 2000 and the chronometer

□ start up injection and the chronometer at the same time

□ the output relay stops the chronometer

□ read **T** on the chronometer

Checking of protection disengaging time
This time delay is activated on the falling edge of each fault signal. It processes very brief transient faults which, when repetitive, allow **T** to be reached.

The relay linked with the protection must not be a latching relay in order for this check to be performed.

■ parameter setting

□ set **Tdis** to the desired value

■ test

□ set up the chronometer wiring so that it will start up when injection stops and the dropping out of the protective relay will stop the counting operation

□ create a fault by injecting current and voltage

□ reset the chronometer to zero

□ stop current or voltage injection and start up the chronometer

□ when the Sepam relay drops out, read the **Tdis** value on the chronometer

Checking of the protection activation zone (sector)
■ parameter setting

□ set **T** to 0.05 s

□ select the **sector**

■ test

□ inject voltage which corresponds to Vo > Vso (see section on **N Vol Disp**)

□ preset current Io to twice Iso, with a phase shift of 90° and then 270° with respect to Vo

□ vary the phase shift angle a of the injection unit so as to determine the angle limits of the activation zone

sector	normal zone	inverse zone
83°	97°…180°…263°	277°…0°…83°
86°	94°…180°…266°	274°…0°…86°

□ reset to zero when leaving the zone each time the output relay is activated.

Thermal overload protection

ANSI code	49
function n°	F431

Equipment

■ single-phase current generator
■ ammeters
■ chronometer
■ CSP adapter
■ calculator
■ documentation

Wiring

■ diagram B1 or B2 or B8 or B9 or B10
■ protective relays:
F431/1 corresponding to OL1
F431/2 corresponding to OL2

Test

■ read the section entitled **measurement and testing method**
■ **status** parameter setting
□ select the value of the CT primary circuit
□ set the value of Ib (rated current given by the manufacturer on the manufacturer plate of the motor or transformer)
□ check the microswitches (1 A or 5 A) which correspond to the CT secondary circuits
□ or check and set the microswitches on the ECA module

Procedure

■ set **protection** parameters: **thermal**
□ set OL1, OL2 (% heat rise set points)
□ set Adjust (none, low, average or high)
□ set T1 (heating time constant)
□ set T2 (cooling time constant)
□ disable: **O/C X**, **Unbalance**, **E/F X** if sum of CTs is used

Checking of heat rise time
■ parameter setting
□ preset **i** to the desired value (X times Ib)
■ test
□ stop injection
□ set the chronometer to zero
Cold curve
□ reset **Heating** to zero on the pocket terminal (password + clear)
□ start up injection and the chronometer at the same time
□ monitor the injection value on the ammeter (stability)
□ use the pocket terminal to monitor heat rise **Heating**
When OL2 is reached:
□ the Sepam 2000 output relay stops the chronometer
□ read the **t** value measured by the chronometer
□ stop the injection
□ press **reset** [(1)] on Sepam 2000 to erase the messages and reset the relay (if Heating < OL2)
■ example: heat rise
Case of a transformer (T1 = T2, Adjust = None)
In = 400 A
Ib = 280 A
□ set OL1 = 95%
□ set OL2 = 115%
□ set T1 = 5 mn
□ set T2 = 5 mn
□ set Adjust = None
See the chart which gives t/T1 for f(OL, I/Ib).
In the example, i = 1.3 Ib
For an injection **i** = Ib + 30% = 1.3 x 280 = 364 A the protection trips OL1 in a time period of t1 = 0.8258 x 5 x 60 = 247.7 s (4 mn 8 s) and OL2 in a time period of t2 = 1.1409 x 5 x 60 = 342.2 s (5 mn 42 s)
Monitor Heating the variation in heat rise on the pocket terminal.

(1) this function may only be activated if your program logic has been customized.
(2) remember to reactivate the protections at the end of testing if required.
X = number of the protective relay.

Setting Adjust = None does not take into account the unbalance value and does not allow single-phase injection to be used.

■ example: heat rise
Case of an unbalanced motor. Use of diagram B9.

In = 400 A

Ib = 280 A

I1, I2, I3

□ set OL1 = 95%

□ set OL2 = 115%

□ set T1 = 5 mn

□ set T2 = 20 mn

□ set Adjust = High (= 9)

□ Heating = 0%

The equivalent current value should be calculated so as to enable the user to select the right I/Ib ratio in the chart that gives t/T1 for f(OL, I/Ib).

In the example i = 1.3 Ib

$ieq^2 = (Ib+30\%Ib)^2 + 9([Ib+30\%Ib] / 1.732)^2$

i.e. $ieq^2 = 364^2 + 9(210)^2$ fi ieq = 728 A

hence I/Ib = 728 A/280 A = 2.6

For an injection **i** = 364 A, in accordance with diagram B9 or B10, the protection will trip OL1 in a time period of t1 = 0.1514 x 5 x 60 = 45 s and OL2 in a time period of t2 = 0.1865 x 5 x 60 = 55.9 s

Monitor **Heating** the variation in heat rise **Heating** on the pocket terminal.

Hot curve

□ reach Heating = 100%

□ start up injection and the chronometer at the same time

□ monitor the injection value on the ammeter (stability)

□ use the pocket termial to monitor the variation in heat rise Heating

When OL2 is reached

□ the Sepam 2000 output relay stops the chronometer

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

□ stop the injection

□ press **reset** (1) on Sepam 2000 to erase the messages and reset the relay (if Heating > OL).

Practical method of protection time measurement and testing using initial heat rise

□ set OL2 to the initial heat rise value Ei

□ reset heat rise to zero using the pocket terminal (password + clear)

□ start up injection and the chronometer

When OL2 = Ei is reached

□ the chronmeter indicates the time **ti**

□ set OL2 to the desired value

□ reset heat rise Heating to zero using the pocket terminal (access code + clear)

□ start up injection and the chronometer.

When OL2 is reached

□ the chronmeter indicates the time **tf**.

□ the protection operating time starting from initial heat rise Ei is t = tf - ti.

Cold curves: t/T1 = f(OL, I/Ib)

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

Example of chart use
For an operation set point OL 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 OL = 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 = 167.8 s

I/Ib **OL (%)**	**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

Cold curves

I/Ib OL (%)	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

Thermal overload protection (cont'd)

Cold curves

I/Ib OL (%)	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(OL, I/Ib)

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

Example of chart use
For an operation set point OL 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 OL = 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 = 23.7 s

I/Ib OL (%)	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

Thermal overload protection (cont'd)

Hot curves

I/Ib OL (%)	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 OL (%)	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

Sensitive earth fault protection

ANSI code	50G-51G
function n°	F101

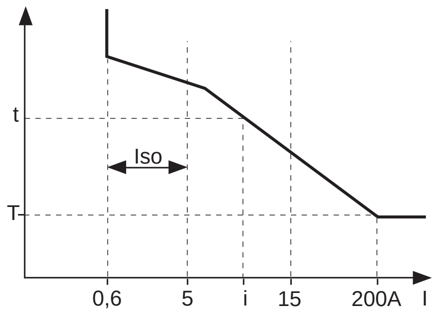
Equipment

The test equipment and procedures are the same as those used for CT earth fault protection.

The protection operates according to a particular set of curves (see **protection function** sheets) and may be used to measure very low currents via a single core balance CT.

In addition, a **F101/3** relay which switches to 1 when there is fault current greater than 15 A, and an internal relay for disabling protection **K857**, are available for program logic.

The chart of characteristic values following corresponds to the curve that is used in distribution systems, called **EPATR B**, and it is used as the basis for calculating protection activation times.



Test

■ **status** parameter setting

□ select the **30 A CT** value for Ino

Procedure

■ **protection** parameter setting

□ set Iso to the desired value (minimum value for detecting a 0.6 A to 5 A fault)

□ set T which corresponds to protection activation for 200 A fault current

■ test the different points on the curve

□ preset the injection i and make a note of the value

□ stop the injection and reset the chronometer to zero

□ press **reset** if required (1)

□ start up injection and the chronometer at the same time

□ check the injection value on the ammeter (stability)

□ Sepam's 2000 output relay stops the chronometer

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

□ compare with the value given in the curve and calculate using the charts

□ check the **meter** and **I TRIP0** (1) value on the pocket terminal

□ stop the injection

□ press **reset** (1) on Sepam 2000 to erase the messages and reset the output relay

example

Setting Iso = 1 A

T = 0.5 s

What is the tripping time for injections of **i** = 2 A and **i** = 15 A?

Use the chart to determine the operating time required to obtain:

i = 2 A → t = 65.34 x 0.5 = 32.67 s

i = 15 A→ t = 12.5 x 0.5 = 6.25 s

Io (A)	time delay (s) t=1s	t=0.8s	Io (A)	time delay (s) t=1s	t=0.8s	Io (A)	time delay (s) t=1s	t=0.8s
0.6	153.24	122.59	6.5	28.25	22.60	50.0	3.86	3.09
0.7	137.40	109.92	7.0	26.29	21.03	55.0	3.53	2.82
0.8	125.00	100.00	7.5	24.58	19.66	60.0	3.24	2.59
0.9	115.00	92.00	8.0	23.08	18.46	65.0	2.99	2.39
1.0	106.74	85.39	8.5	21.75	17.40	70.0	2.79	2.23
1.1	99.76	79.81	9.0	20.58	16.46	75.0	2.60	2.08
1.2	93.81	75.05	9.5	19.51	15.61	80.0	2.44	1.95
1.3	88.64	70.91	10.0	18.56	14.85	85.0	2.30	1.84
1.4	84.11	67.29	11.0	16.91	13.53	90.0	2.18	1.74
1.5	80.10	64.08	12.0	15.54	12.43	95.0	2.06	1.65
1.6	76.53	61.22	13.0	14.38	11.50	100.0	1.96	1.57
1.7	73.30	58.64	14.0	13.38	10.70	110.0	1.79	1.43
1.8	70.40	56.32	15.0	12.50	10.00	120.0	1.65	1.32
1.9	67.75	54.20	16.0	11.74	9.39	130.0	1.53	1.22
2.0	65.34	52.27	17.0	11.06	8.85	140.0	1.41	1.13
2.5	55.79	44.63	18.0	10.46	8.37	150.0	1.33	1.06
3.0	49.04	39.23	19.0	9.93	7.94	160.0	1.24	0.99
3.5	43.96	35.17	20.0	9.44	7.55	170.0	1.18	0.94
4.0	40.00	32.00	25.0	7.60	6.08	180.0	1.11	0.89
4.5	36.80	29.44	30.0	6.36	5.09	190.0	1.05	0.84
5.0	34.15	27.32	35.0	5.48	4.38	200.0	1.00	0.80
5.5	31.93	25.54	40.0	4.80	3.84	>200	1.00	0.80
6.0	30.01	24.01	45.0	4.29	3.43			

(1) this function may only be activated if your program logic has been customized.

Negative sequence unbalance protection

ANSI	**code 46**
function n°	F45X 1 ≤ X ≤ 2

Equipment

■ single-phase current generator

■ ammeters

■ adapter for ECA module

■ chronometer

■ documentation

Wiring

■ diagram B1,B8, B9 or B10

■ protective relays:
F451/1 F451/2
F452/1 F452/2.

Test

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

■ **status** parameter setting

□ select the value of the CT primary circuits
□ set Ib

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

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

Procedure

■ set the **protection** parameters: **Unbalance**

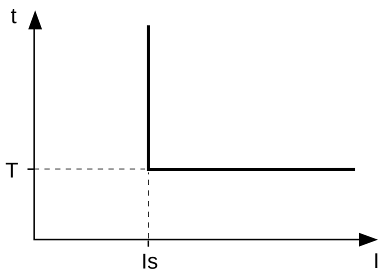
□ select the **definite** curve

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

□ set **T** to the desired value

□ disable protections [2]: **O/C X**, **E/F X** (when sum of 3 CTs is used)

Testing of definite time Is set point



■ parameter setting

□ set **T** to 0.1 s

□ the current **i** to be injected varies according to the injection diagram used and the number of CTs set in the status menu:

- diagram B1: 2CT **status**: i = 1.732 Is
- diagram B1: 3CT **status**: i = 3 Is
- diagram B9: 2 or 3 CT **status**: i = 1.732 Is

■ test

□ gradually inject current **i** until the output relay linked with the protection in program logic picks up, and monitor **Ii** on the pocket terminal

□ read the **i** current value on the ammeter

□ check **measurement** and **I TRIP** [1] value on the display unit or pocket terminal

□ stop the injection

□ press **reset** [1] on the Sepam 2000 to erase the messages and reset the output relay.

Testing of time delay T
■ **protection** parameter setting: **Unbalance**

□ set **T** to the desired value

■ test

□ prepare the injection **i** with 1.2 times the value of **Is**

□ set the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's 2000 output relay stops the chronometer

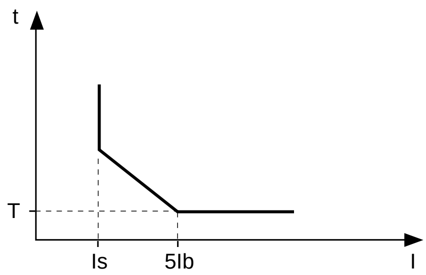
□ read the **T** value measured by the chronometer.

[1] this function may only be activated if your program logic has been customized.
[2] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Ii (% Ib)	K
10	99.95
15	54.50
20	35.44
25	25.38
30	19.32
33.33	16.51
35	15.34
40	12.56
45	10.53
50	9.00
55	8.21
57.5	7.84
60	7.55
65	7.00
70	6.52
75	6.11
80	5.74
85	5.42
90	5.13
95	4.87
100	4.64
110	4.24
120	3.90
130	3.61
140	3.37
150	3.15
160	2.96
170	2.80
180	2.65
190	2.52
200	2.40

Ii (% Ib)	K
210	2.29
220	2.14
230	2.10
240	2.01
250	1.94
260	1.86
270	1.80
280	1.74
290	1.68
300	1.627
310	1.577
320	1.53
330	1.485
340	1.444
350	1.404
360	1.367
370	1.332
380	1.298
390	1.267
400	1.236
410	1.18
420	1.167
430	1.154
440	1.13
450	1.105
460	1.082
470	1.06
480	1.04
490	1.02
≥ 500	1

Testing of IDMT set points and time delay
The set point and time delay are IDMT and correspond to the curve and chart coordinates (see in appendix).



■ **protection** parameter setting: **Unbalance**
□ select the **IDMT** curve
□ set **Is** as a % of Ib
□ set **T**
□ disable the **O/C and E/F X** protections (if sum of 3 CTs is used)
■ checking of tripping time
□ preset the injection i > 1.732 Is or 3 Is (according to the injection wiring diagram)
□ stop the injection and reset the chronometer to zero
□ press **reset** if required [(1)]
□ start up injection and the chronometer at the same time
□ check the injection value on the ammeter (stability)
□ Sepam's 2000 output relay stops the chronometer
□ read the **t** value measured by the chronometer
□ check the **measurement** and the **I TRIP** [(1)] values on the pocket terminal
□ stop the injection
□ press **reset** [(1)] on Sepam 2000 to erase the messages and reset the output relay

example
status In = 400 A   Ib = 320 A

Finding settings
For a given unbalance value of 80A that is supposed to trip in 5 s, the IDMT curve determined by **T** should be selected using the chart which gives K in relation to Ii (%Ib).

In the example above, Ii = 25% Ib, hence k = 25.38

T should be set to 5/25.38 = 197 ms
T = 200 ms will be selected

Setting Is ≤ 25% of Ib, T = 200 ms

Injection
In accordance with the injection diagram used:

- diagram B1 (2CT): i = 80 x 1.732 = 138 A
- diagram B1 (3CT): i = 80 x 3 = 240 A
- diagram B9 (2 or 3CT): i = 138 A

The operating time measured should be:
t = 25.38 x 0.2 = 5 s

[(1)] this function may only be activated if your program logic has been customized.
X = number of the protective relay.

Starts per hour protection

ANSI code	66
function n°	F421

Equipment

■ single-phase or three-phase current generator
■ ammeter
■ adapter for ECA module
■ chronometer
■ calculator
■ documentation

Wiring

■ diagram B1 or B2 or B8
■ protective relays:
F421/1 total or consecutive
F421/2 consecutive
F421/3 total
F421/4 lock-out between starts by **T**

Test

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

This protection function is linked to **thermal overload** protection.

The test is largely dependent on the use of protective relays in program logic, in particular for the assigned messages and lock-outs. This is why the descriptions which follow mainly apply to the standard schemes, but may still be used for other customized applications.

■ **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 ECA module
■ **thermal overload protection** parameter setting (see section on thermal overload protection)

Procedure

■ Protection parameters setting: **Start/Hour**
□ set: N Start = number of permissible consecutive starts per hour
□ set: C Start = number of permissible consecutive starts for a motor for which the heat rise **Heating** has reached the **thermal overload** set point **OL1**.
□ set: C Start = number of permissible consecutive starts for a motor for which the heat rise **Heating** is below the **thermal overload** set point **OL1**.
□ set **T**: to temporarily disable [(1)] start orders which follow stop orders (in systems, this time is linked to the type of load driven by the motor)
□ disable the **O/C**, **Unbalance** and **E/F** set points [(2)] if the sum of the 3 CTs is used.

Testing of total number Nt
■ parameter setting
□ enter the password and press the "clear" key before starting the test
□ set **N Start** = **H Start** = **C Start**
■ test
□ inject a current greater than 5% of Ib
□ stop injection for a time period greater than **T**

Remark:
If current injection is controlled by a static contactor, it is necessary to ensure that leakage current is less than 5% of Ib and does not interfere with testing.
□ repeat this operation N Start times
□ at the same time, use the pocket terminal to check that the number of remaining starts decreases on the counter
□ the display indicates the waiting period at the Nth Start time before the motor can be started again.

This time is calculated as follows:

60 mn - (time of Nth Start - time of first start included in the calculation period).

■ Example with total starts.

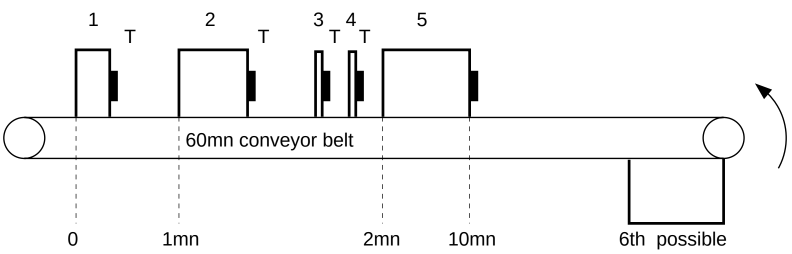


Image of waiting period between starts (N Start = 5)

[(1)] this function may only be activated if your program logic has been customized.
[(2)] remember to reactivate the protections at the end of testing.

Testing of number of consecutive cold starts

■ parameter setting

□ set **N Start** > (**H Start** = **C Start**)

□ enter the password and press the "clear" key before starting the test

■ test

□ inject a current greater than 5% of Ib

□ stop injection for a period greater than **T**

□ repeat this operation Nf Start times

□ at the same time, use the pocket terminal to check that the number of remaining starts decreases on the counter

□ the display indicates the waiting period at the N Start time before the motor can be started again

This period is calculated as follows:

60/Nt - (time of N^{th} C start - time of 1^{st} C start)

■ Example:

N Start = 10

C Start = 5

H Start = 5

The number of C Start starts take place in less than 6 mn (60/10):

□ first start at t = 0

□ second start at t = 1 mn

□ third start at t = 1.5 mn followed by a fourth and a fifth at t = 2 mn

The waiting period is therefore 4 mn
6 mn - (t5 - t1).

After 4 mn, a 6th start is possible and the waiting period will be 1 mn, etc … until, for instance, the 10^{th} (N Start) at t = 15 mn.

The waiting period is therefore
60 mn - 15 mn = 45 mn.

After 45 mn, an 11^{th} start is possible after a waiting period of 1 mn.

Testing of number of consecutive hot starts

This test is the same as the test for the number of consecutive cold starts.

The number of hot starts is only counted when the thermal overload protection heat rise **Heating** is greater than the **OL1** set point.

See the section on **thermal overload protection** regarding parameter setting.

Testing of T ("Time between starts") [1]

This test serves to test that the "number of remaining starts" counter does not process starts made during the time delay.

■ parameter setting

□ set **N Start**, **H Start** and **C Start**

□ set **T** to the desired value

■ test

□ inject a current greater than 5% of Ib

□ stop injection and start up the chronometer

□ inject the current again before the end of T and check on the pocket terminal that the "remaining starts" counter has not moved

□ inject the current again after the end of T and check on the pocket terminal that the "remaining starts" counter has decremented (by 1).

[1] this function may only be activated if your program logic has been customized.

Excessive starting time and locked rotor protection

ANSI code	51LR
function n°	F441

Equipment

■ single-phase current generator
■ contactor
■ ammeter
■ chronometer
■ adapter for ECA module
■ documentation

Wiring

■ diagram B1 or B2 or B8 or B12
■ protective relays:
F441/1 for excessive starting time
F441/2 for start time delay in progress
F441/3 for locked rotor
F441/4 for excessive starting time or locked rotor
F441/5 for **i** greater than 5% Ib

Test

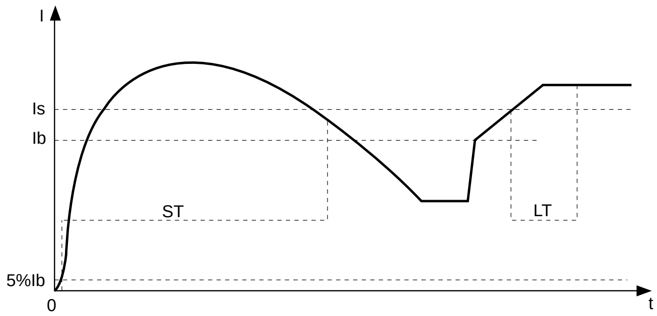
■ read the section entitled **measurement and testing method**
The protection may be tested on each phase individually with single-phase current.
■ **status** parameter setting
□ select the **In** value of the CT primary circuits
□ set the value of Ib
□ check the microswitches on the ECM module
□ or check and set the microswitches on the ECA module.

[1] this function may only be activated if your program logic has been customized.
[2] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Procedure

■ **protection** parameter setting: **LR/ESt**
□ set **Is** to the desired value as a % of Ib
□ set **ST** motor start time
□ set **LT** locked rotor time
□ disable the protections [2]:
O/C X, **Unbalance**, **E/F X** (if sum of 3 CTs is used)

Testing of Is set point (diagram B1 or B2 or B8).



■ 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 > 5% 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 B8)
■ parameter setting
□ set **ST** to the desired value
■ test
□ preset the injection to 1.2 times Is
□ stop the injection and reset Sepam 2000 and the chronometer to zero [1]
□ start up injection and the chronometer at the same time
□ Sepam's 2000 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 5% of Ib and does not interfere with testing.

Testing of locked rotor time LT (diagram B12)
■ parameter setting
□ set **ST** to 0.5 s
□ set **LT** to the desired value
■ test
□ preset the injection as follows:
- contactor closed i > Is
- with load resistance Is > **i** > 5% Ib
□ stop injection and reset Sepam 2000 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 2000 output relay stops the chronometer
□ read the **t** value on the chronometer

Phase undercurrent protection

ANSI code	37
function n°	F221

Equipment

■ single-phase current generator

■ power resistor

■ contactor

■ ammeter

■ chronometer

■ adapter for ECA module

■ documentation

Wiring

■ diagram B1 or B8 or B12

■ protective relays: F221/1, F221/2

Test

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

Undercurrent protection is single-phase et 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 ECA module.

Procedure

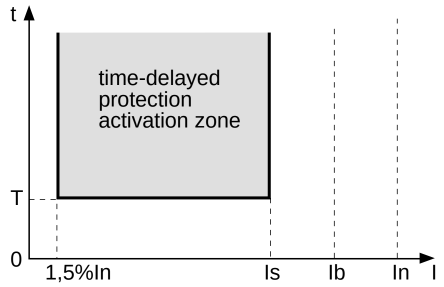
■ **protection** parameter setting: **U/current**

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

□ set **T** to the desired value

□ disable the protections [2]:
O/C, **Unbalance**, **E/F** (if sum of 3 CTs is used)

Testing of set point



■ parameter setting

□ set **T** to 0.05 s

■ test

□ preset the current to **i** > Is

□ inject the current **i**

□ gradually reduce the current until the output relay linked with the protection in program logic picks up

□ read the **i** value on the ammeter

Testing of time delay

■ parameter setting

□ set **T** to the desired value

■ test

□ first method (diagram B1 or B8)

- preset **i** below set point Is
(1.5% In < **i** < Is)
- cut off current completely (be careful of injection unit leakage current)
- press the Sepam's 2000 **reset** key [1]
- start up injection and the chronometer at the same time
- Sepam's 2000 output relay stops the chronometer after a period **T**
- read the **t** value on the chronometer

□ second method with resistor (B12 diagram)

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

with load resistance i> 1.5% In

contactor closed i> Is

- inject current with the contactor closed.
- press the Sepam's 2000 **reset** key [1]
- cut off the contactor power supply and start up the chronometer at the same time
- the Sepam's 2000 output relay stops the chronometer after a period **T**
- read the **t** value on the chronometer

[1] this function may only be activated if your program logic has been customized.
[2] remember to reactivate the protections at the end of testing.

Phase-to-phase undervoltage protection

ANSI code	27	
function n°	F32X for U13 phase-to-phase undervoltage protection F33X for U13' phase-to-phase undervoltage protection F34X for U21 phase-to-phase undervoltage protection F35X for U21' phase-to-phase undervoltage protection F36X for U32 phase-to-phase undervoltage protection F37X for U32' phase-to-phase undervoltage protection	$1 \leq X \leq 2$

Equipment

■ single-phase or three-phase voltage generator

■ voltmeters

■ chronometer

■ documentation

Wiring

■ diagram B3 or B4

■ protective relays:

F321/1, F321/2 F322/1,F322/2 for U13

F331/1, F331/2 F332/1,F332/2 for U13'

F341/1, F341/2 F342/1,F342/2 for U21

F351/1, F351/2 F352/1,F352/2 for U21'

F361/1, F361/2 F362/1,F362/2 for U32

F371/1, F371/2 F372/1,F372/2 for U32'

Test

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

Since the different phase-to-phase undervoltage protections are single-phase, the tests may be performed by using a single-phase injection unit and disabling the other set points
(by setting them to 999 kV).

■ **status** parameter setting

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

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

□ select the number of connected VTs given that:

- **U13 U/V** does not exist if the number of VTs is 2

- **U32 U/V** and **U13 U/V** do not exist if the number of VTs is 1

- **U13 U/V** does not exist in compact
Sepam 2000 S25 models

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

Procedure

■ **protection** parameter setting: **U21 U/V X**

□ disable the other protection set points (Us = 999 kV)

□ set **Us** to the desired value (in kV)

□ set **T** to the desired value

Checking of set point

■ parameter setting

□ set **T** to 0.05 s

■ test

□ inject voltage Uns into U21

□ 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** [1] on Sepam 2000 to erase the message and reset the output relay

Checking of time delay

■ parameter setting

□ set **T** 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 undervoltage protection

□ set the chronometer to zero

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

□ Sepam's 2000 output relay stops the chronometer

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

[1] this function may only be activated if your program logic has been customized.
[2] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Remanent undervoltage protection

ANSI code	27R	
function n°	F25 for U' remanent undervoltage protection F35 for U remanent undervoltage protection	1 ≤ X ≤ 2

Equipment

■ single-phase voltage generator

■ voltmeters

■ chronometer

■ documentation

Wiring

■ B3 or B4 diagram

■ protective relays:

F251/1, F251/2

F252/1, F252/2 (2)

F351/1, F351/2

F352/1, F352/2 (2)

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

Procedure

■ **protection** parameter setting: **REM U/V**

□ disable the U21 U/V X protection set points (3) (Us = 999 kV)

□ set Us of protection's **REM U/V** to the desired value (in kV).

Checking of set point

■ parameter seting

□ set **T** to 0.05 s

■ test

□ inject Uns voltage into U21

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

□ read the value on the voltmeter

□ increase the voltage to Uns

□ press **reset** (1) on Sepam 2000 to erase the message and reset the output relay

Checking of time delay

■ parameter setting

□ set **T** 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 undervoltage protection F35X/2

□ set the chronometer to zero

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

□ Sepam's 2000 output relay stops the chronometer

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

(1) this function may only be activated if your program logic has been customized.
(2) only one protective relay is used in standard applications
(3) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Positive sequence undervoltage and phase rotation direction check protection

ANSI code	27D - 47	
function n°	F38X	1 ≤ X ≤ 2

Equipment

■ three-phase voltage generator

■ voltmeters

■ chronometer

■ documentation

Wiring

■ diagram B4

■ protective relays:

F381/1, F381/2 for set point 1

F382/1, F382/2 for set point 2 (2)

F381/3, F382/3 (2) for phase rotation direction check

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 number of wired VTs to 3U

Procedure

■ set **P Seq U/V X protection** parameters

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

□ set **Vsd** to the desired value (in kV)

□ disable the other protection set points, the **U U/V x, U U/V** and **N Vol Disp** (when sum of VTs is used)

Checking of set pont

■ parameter setting

□ set **T** to 0.05 s test

□ gradually reduce the three voltages at the same time until the relay linked with the protection picks up

□ read the **Vd** value on the pocket terminal

□ increase the voltages to Vns

□ press **reset** (1) on Sepam 2000 to erase the message and reset the output relay

Checking of time delay

■ parameter setting

□ set **T** 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 positive sequence undervoltage protection F38X/2

□ set the chronometer to zero

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

□ Sepam's 2000 output relay stops the chronometer

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

Checking of phase rotation (1)

The protection considers that the network connected to Sepam 2000 is turning in reverse when the positive sequence voltage is less than 10% Un and the phase-to-phase voltages are greater than 80% Un.

■ inject the rated voltages in **inverse** order: the **rotation** message is displayed and power readout is disabled.

■ note

Balanced network

Vd = Vn = Un/√3

Unbalanced network

Loss of 1 phase

□ Vd = 0.66 Vn = 0.385 Un

Two phases fault

□ Vd = 0.5 Vn = 0.288 Un

Three phases fault

□ Vd = 0 V

Two phase to earth fault

□ Vd = 1/3 Vn = 0.192 Un

(1) this function may only be activated if your program logic has been customized.
(2) only one protective relay is used in standard applications
(3) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Phase-to-phase overvoltage protection

ANSI code	59	
function n°	F28X for U32 overvoltage protection F30X for U21 overvoltage protection	1≤ X ≤ 2

Equipment

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

Wiring

■ diagram B3 or B4
■ protective relays:
F281/1, F281/2, F282/1, F282/2 (2) for U32 voltage
F301/1, F301/2, F302/1, F302/2 for U21 voltage

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
□ select the number of connected VTs

Procedure

■ **protection** parameters**:**
U 21 O/V, U21 O/V X, **U32 O/V, U32 O/V X** (2)
□ set **Us** to the desired value
□ set **T** to the desired value
□ disable the lowest protection set point (3)

Testing of set point
■ protection parameters settings:
□ set **T** to 0.05 s to obtain the shortest output relay response time
■ test
□ inject voltage Uns into U21
□ gradually increase U21 voltage until the output relay picks up
□ read the voltage value on the voltmeter and on the Sepam 2000 display unit
□ stop injection
□ press **reset** (1) on Sepam 2000 to erase the messages and reset the output relay

Testing of time delay T
■ **protection** parameter settings:
□ set **T** to the desired value
■ test
□ prepare the injection with 1.2 times the value of **Us**
□ set the chronometer to zero
□ start injection and the chronometer at the same time
□ Sepam's 2000 output relay stops the chronometer
□ read the value measured by the chronometer

(1) this function may only be activated if your program logic has been customized.
(2) this function is not used in standard applications (checking of U21 is sufficient).
(3) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Neutral voltage displacement protection

ANSI code	59N
function n°	F39X for Vo neutral voltage displacement $1 \leq X \leq 2$ F41X for Vo' neutral voltage displacement

Equipment

■ single-phase and three-phase voltage generators

■ voltmeters

■ chronometer

■ calculator

■ documentation

Wiring

■ diagram B4 or B7

■ protective relays:

F391/1, F391/2

F392/1, F392/2

F411/1, F411/2

F412/1, F412/2

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 the number of connected VTs given that measurement by the sum of Vo voltages can only be used with 3 VTs

□ 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 3U/Vo 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)

Procedure

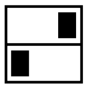
■ **protection** parameter setting**: N Vol Disp**

□ set **Uso** to the desired value

□ set **T** to the desired value

□ disable the lowest protection set point and **P Seq U/V X**

Testing by injection with sum of the 3 voltages (diagram B4)
Cut off Sepam's 2000 auxiliary power supply to set the microswitches (SW1).



Measurement of Vo by sum of 3VTs

Testing of set point

■ **status** parameter setting

□ select **number** = **3U**

□ select **Vnso** = **sum 3V**

■ **protection** parameter setting: **N Vol Disp**

□ set **Vso** to the desired value

□ set **T** to 0.05 s

□ wire all the voltage inputs

■ 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 and on the pocket terminal

The value will be: **u** = Vso

□ stop injection

□ press **reset** [1] on Sepam 2000 to erase the messages and reset the output relay

Testing of time delay T (sum of VTs)

■ **protection** parameter setting: **N Vol Disp**

□ set **T** 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 2000 output relay stops the chronometer

□ read the value measured by the chronometer
It is possible to conduct the test with a single-phase voltage generator. Remember to short-circuit the 2 voltage inputs which are not being used via terminal A2.

Example: microswitches set for sum of VTs

■ **status** parameter setting

□ Unp = 20 kV

□ Uns = 100 V

□ number = 3U

□ Vnso = 3 V

■ **protection** parameter setting

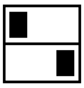
□ Uso = 11.5 kV

□ T = 0.5 s

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.

[1] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Testing by injection into input A1-A2 (diagram B7) external VTs
Cut off Sepam's 2000 auxiliary power supply to set the microswitches (SW1).



Measurement of Vo
by external VT

Testing of set point

■ **status** parameter setting

□ select **Vnso** = **Uns/1.732** or **= Uns/3**

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

■ **protection** parameter setting**: N Vol Disp**

□ set **Vso** to the desired value

□ set **T** to 0.05 s to obtain the shortest output relay response time

■ test

□ gradually inject Vo voltage until the output relay picks up

□ read the voltage value on the voltmeter and on the pocket terminal

□ stop injection

□ press **reset** [1] on Sepam 2000 to erase the messages and reset the output relay

Testing of time delay

■ **protection** parameter setting**: N Vol Disp**

□ set **T** 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 2000 output relay stops the chronometer

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

Example: microswitches on external VT

■ **status** parameter setting

□ Unp = 20 kV

□ Uns = 100 V

□ Vso = 11.5 kV

□ T = 0.5 s

Vnso = Uns/1.732 for injection of u > 57.7 V in accordance with diagram B7

Vnso = Uns/3 for injection of u > 33.3 V in accordance with diagram B7

The protection will trip after a period T = 0.5 s.

[1] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Negative sequence overvoltage protection

ANSI code	47	
function n°	F40X	$1 \le X \le 2$

Equipment

■ 3-phase voltage generator

■ voltmeter

■ chronometer

■ documentation

Wiring

■ B4 diagram

■ protective relays:

F401/1, F401/2,

F402/1, F402/2

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 the number of connected VTs

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

Procedure

■ **protection** parameter setting**: Neq Sq O/V**

□ set **Vsi** to the desired value (en kV)

□ disable the protections: **U U/V; U U/V X; U O/V; U O/V X**

Testing of set point

■ parameter setting

□ set **T** to 0.05 s

■ test

□ wire all the voltage inputs

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

□ read the injection voltage value on the voltmeter and on the pocket terminal.

The value will be **3Vsi**

□ stop injection

□ press **reset** (1) on Sepam 2000 to erase the message and reset the output relay.

testing of time delay T

■ parameter setting

□ set **T** to the desired value

■ test

□ prepare the injection of a voltage greater than 3 times the value of **Vsi**

□ set the chronometer to zero

□ start injection and the chronometer at the same time

□ Sepam's 2000 output relay stops the chronometer

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

Please note:

This test may be performed using a single-phase voltage generator:

■ don't change the SW1 microswitch settings

■ set the status parameters in the same way as for the 3-phase arrangement

■ inject the voltage according to diagram B3, with the following in addition:

□ terminals A1 and A6

□ terminals A2, A3 and A4

in this case, the maximum reverse voltage that can obtained is Vn/3. Therefore the reverse voltage setting must not be set higher (i.e. 19% of Un).

(1) this function may only be activated if your program logic has been customized.

(2) remember to reactivate the protections at the end of testing.

X = number of the protective relay.

Underfrequency protection

ANSI code	81L	
function n°	F56X	1 ≤ X ≤ 4

Equipment

■ single-phase voltage generator with frequency variator

■ voltmeter

■ chronometer

■ documentation

Wiring

■ diagram B3

■ protective relays:

F561/1, F561/2, F561/3

F562/1, F562/2, F562/3

Test

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

Since the different underfrequency protections are single-phase, the tests may be performed by using a single-phase injection unit on the U21 voltage input and disabling the other set points (by setting them to 999 kV).

■ **status** parameter setting

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

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

□ select the number of connected VTs

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

Procedure

■ **protection** parameter setting**: UNDER/F X; UNDER/F**

□ set **Fs** to the desired value

□ disable the other underfrequency protection set points (Fs = 999 Hz)

□ disable the **U U/V** or **U U/V X** set points (2)

Testing of set point

■ parameter setting

□ set **T** to 0.1s

■ test

□ inject a voltage of at least 35% **Uns** and frequency **Fn** into U21

□ gradually reduce the frequency injected into U21 until the Sepam 2000 relay linked to the protection picks up

□ read the value on the frequency indicator

□ increase the frequency to Fn or cut off the voltage

□ press **reset** (1) on Sepam 2000 to erase the message and reset the output relay.

Testing of time delay

■ parameter setting

□ set **T** to the desired value

■ test

□ preset voltage (**Uns**) and frequency below the set point **Fs**

□ stop injection

□ set the chronometer to zero

□ start up injection and the chronometer at the same time

□ Sepam's 2000 output relay stops the chronometer

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

(1) this function may only be activated if your program logic has been customized.
(2) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Overfrequency protection

ANSI code	81H	
function n°	F57X	1 ≤ X ≤ 2

Equipment

■ single-phase voltage generator with frequency variator

■ voltmeter

■ chronometer

■ documentation

Wiring

■ B3 diagram

■ protective relays:

F571/1, F571/2, F571/3

F572/1, F572/2, F572/3

Test

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

Since the different overfrequency protections are single-phase, the tests may be performed by using a single-phase injection unit on the U21 voltage input and disabling the other set points (by setting them to 999 kV).

■ **status** parameter setting

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

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

□ select the number of connected VTs

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

Procedure

■ **protection** parameter setting**: OVER/F X; OVER/F**

□ set **Fs** to the desired value

□ disable the other overfrequency protection set points (Fs = 999 Hz)

□ disable the **U U/V** or **U U/V X** set points (2)

Testing of set point

■ parameter setting

□ set **T** to 0.1 s

■ test

□ inject a voltage of at least 35% **Uns** and frequency **Fn** into U21

□ gradually increase the frequency injected into U21 until the Sepam 2000 relay linked to the protection picks up

□ read the value on the frequency indicator

□ decrease the frequency to **Fn** or cut off the voltage

□ press **reset** (1) on Sepam 2000 to erase the message and reset the output relay.

Testing of time delay

■ parameter setting

□ set **T** to the desired value

■ test

□ preset voltage (**Uns**) and frequency above the set point **Fs**

□ stop injection

□ set the chronometer to zero

□ start injection and the chronometer at the same time

□ Sepam's 2000 output relay stops the chronometer

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

(1) this function may only be activated if your program logic has been customized.
(2) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Rate of change of frequency protection

ANSI code	81R	
function n°	F58X	$1 \le X \le 2$

Equipment

■ single-phase voltage generator with frequency variator

■ voltmeter

■ frequency meter

■ chronometer

■ documentation

Wiring

■ B4 diagram

■ protective relays:

F581/1, F581/2, F581/3, F581/4, F581/5, F581/6

F582/1, F582/2, F582/3, F582/4, F582/5, F582/6

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

□ set the **number** of connected VT to 3U

Procedure

■ protection parameter setting: **LOMx**
□ set the dFs/dt set point to the desired value
□ set T to the desired value
□ disable the set points of the **UNDER/F** and **OVER/F** as well as the **U U/V** and **U O/V** (2) protections

Testing of the set point
■ parameter setting
□ set T to 0.1 s
■ test
□ inject 3 phase-to-neutral voltages equal to at least 50% Vn (with Vn = Uns/√3) and at rated frequency
□ change the voltage frequencies consistently until the Sepam 2000 contact related to the protection picks up.
The change may be increasing or decreasing:
- for an increasing change, the frequency should change, in a time t, from Fn to Fn + (dFs/dt x t + 0.1 Hz)
- for a decreasing change, the frequency should change, in a time t, from Fn to Fn - (dFs/dt x t + 0.1 Hz).
The value of t may be equal to 1 second as long as the following inequation is followed:
42.2 Hz ≤ 50 ± (dF/dt x t + 0.1 Hz) ≤ 56.2 Hz pour une fréquence nominale à 50 Hz
51.3 Hz ≤ 60 ± (dF/dt x t + 0.1 Hz) ≤ 67.8 Hz for a rated frequency of 60 Hz
□ stop the injection
□ press reset (1) on Sepam 2000 to erase the messages and de-activate the outputs.

Testing of the time delay
■ parameter setting
□ set **T** to the desired value
□ set the chronometer to zero
■ test
□ inject 3 phase-to-neutral voltage equal to at least 50% Uns/√3 and at rated frequency
□ change the voltage frequencies consistently in accordance with the test method described earlier, making sure that the injection time t is greater than the setting of T
□ start up the chronometer and frequency changing at the same time
□ the Sepam 2000 output relay stops the chronometer
□ read the t value displayed by the chronometer.

(1) this function may only be activated if your program logic has been customized.
(2) remember to reactivate the protections at the end of testing.
X = number of the protective relay.

Underpower protection

ANSI code	37P
function n°	F551

Equipment

■ single-phase current and voltage generators

■ phase shifter with angle indicator

■ ammeters

■ voltmeter

■ chronometer

■ calculator

■ adapter for ECA module

■ documentation

Wiring

■ diagram B5

■ protective relays:

F551/1, F551/2 for real underpower

F551/3, F551/4 for reverse real power

Test

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

The real underpower protection may be tested by injecting single-phase voltage and current, in accordance with diagram B5, into U21 and I1 respectively.

■ **status** parameter setting

Enter all data items:

□ **Fn** network frequency

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

□ **Uns** phase-to-phase voltage of the VT secondary circuits

□ **number** of VTs connected (set 1U for a single-phase testing)

□ select **In** CT primary value

□ check and set the microswitches on the **3U/Vo**, **ECM** and **ECA** modules

□ choose the direction of power flow: **feeder** or **incomer**

Procedure

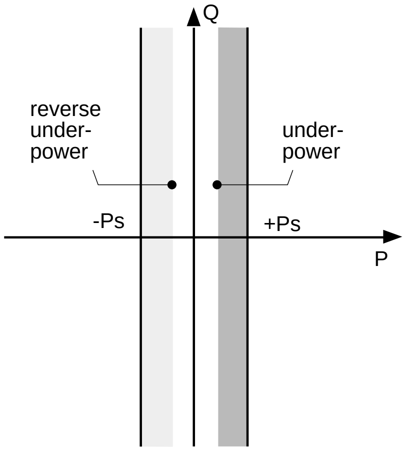
■ **protection** parameter setting**: Under/P**

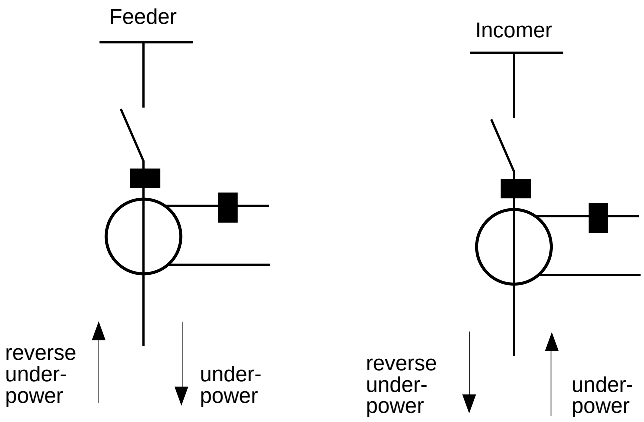
□ set **Ps** set point to the desired value

□ set **T** to the desired value (see curves in **metering and protection function** documentation)

□ disable the following protections [1]:

O/C; Unbalance; E/F (if sum of 3 CTs is used); Reverse Q; U U/V; U/current; N Vol Disp (if sum of 3 VTs is used)





[1] remember to reactivate the protections at the end of testing.

Testing Ps set point

□ using single-phase, inject **Uns** into the U21 input and current **I** into the I1 input, with a phase shift of a between I and U in accordance with the following chart:

	Reverse U/P	Under P
feeder	180°	0°
incomer	0°	180°

□ press the Sepam 2000 "reset" key

□ gradually decrease the current until the associated output relay picks up

□ read the real power value on the Sepam 2000 display unit or on the pocket terminal

□ calculate the real power value:

P = Uns X I

or P = Uns X I.cos a

Testing of time delay

■ parameter setting

□ set **T** to the desired value

■ test

□ inject voltage **Uns** into U21 and rated current **I1**

□ press the Sepam 2000 "reset" key

□ set the chronometer to zero

□ stop current injection and start the chronometer at the same time

□ the Sepam 2000 relay stops the chronometer

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

Real overpower protection

ANSI code	32P
function n°	F531

Equipment

- single-phase current and voltage generators
- phase shifter with angle indicator
- ammeters
- voltmeter
- chronometer
- calculator
- adapter for ECA module
- documentation

Wiring

- diagram B5
- protective relays:

F531/1, F531/2 for overpower

F531/3, F531/4 for reverse power

Test

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

The real overpower protection may be tested by injecting single-phase voltage and current, in accordance with diagram B5, into U21 and I1 respectively.

- **status** parameter setting: enter all data items

□ **Fn** network frequency

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

□ **Uns** phase-to-phase voltage of the VT secondary circuits

□ **number** of VTs connected
(set 1U for single-phase testing)

□ select **In** CT primary value

□ check and set the microswitches on the **3U/Vo**, **ECM** and **ECA** modules

□ choose the direction of power flow:
feeder or **incomer**

Procedure

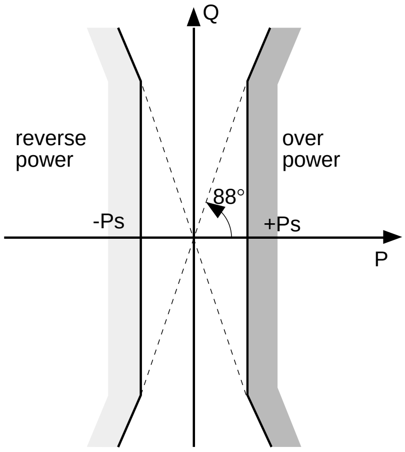
- **protection** parameter setting**: Reverse P** (used as standard) or **Over P**

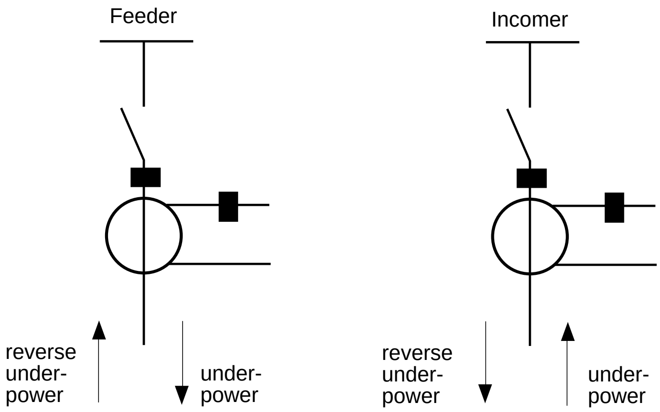
□ set **Ps** set point to the desired value

□ set **T** to the desired value (see curves in **metering and protection function** documentation)

□ disable the following protections [1]:

O/C; Unbalance; E/F (if sum of 3 CTs is used); Reverse Q; U/UV; U/current; N Vol Disp (if sum of 3 VTs is used)





[1] remember to reactivate the protections at the end of testing.

Testing Ps set point

□ using single-phase, inject **Uns** into the U21 input and current **I** into the I1 input, with a phase shift of a between I and U in accordance with the following chart:

	Reverse P	Over P
feeder	180°	0°
incomer	0°	180°

□ gradually increase the current until the associated output relay picks up

□ read the real power value on the Sepam 2000 display unit or on the pocket terminal

□ calculate the real power value:

P = Uns X I

or P = Uns X I.cos a

Testing the operating plan

□ using single-phase, inject **Uns** into the U21 input and current **I** into the I1 input I = 2 Ps / Uns

□ vary the phase shift a between **Uns** and **I** from 0° to 360°.

The protection should operate for the following values of a:

	Reverse P	Over P
feeder	-120° and 120°	-60° and 60°
incomer	-60° and 60°	-120° and 120°

Testing of time delay

■ parameter setting

□ set **T** to the desired value

■ test

□ inject voltage **Uns** into U21

□ preset current **I1** to twice the value of **Ps/Uns** in phase or shifted by 180° according to the type of protection being tested (reverse power or overpower)

□ stop current injection only

□ press the Sepam 2000 **reset** key and set the chronometer to zero

□ start current injection and the chronometer at the same time

□ the Sepam 2000 relay stops the chronometer

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

Reactive overpower protection

ANSI code	32Q
function n°	F541

Equipment

- ■ single-phase current and voltage generators
- ■ phase shifter with angle indicator
- ■ ammeters
- ■ voltmeter
- ■ chronometer
- ■ calculator
- ■ adapter for ECA module
- ■ documentation

Wiring

■ diagram B5

■ protective relays:

F541/1, F541/2 for overpower

F541/3, F541/4 for reverse overpower,

Test

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

The reactive overpower protection may be tested by injecting single-phase voltage and current,
in accordance with diagram B5, into U21 and I1 respectively.

■ **status** parameter setting: enter all data items

□ **Fn** network frequency

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

□ **Uns** phase-to-phase voltage of the VT secondary circuits

□ **number** of VTs connected
(set 1U for single-phase testing)

□ select **In** the CT primary value

□ check and set the microswitches on the **3U/Vo**, **ECM** and **ECA** modules

□ **number** of VTs connected

□ choose the direction of power flow:
feeder or **incomer**

Procedure

■ **protection** parameter setting**:**

Reverse Q (used as standard) or **Over / Q**

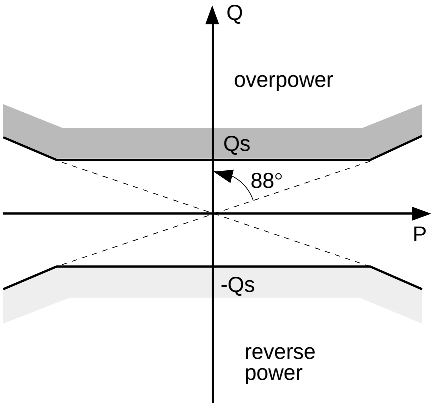
□ set **Qs** set point to the desired value

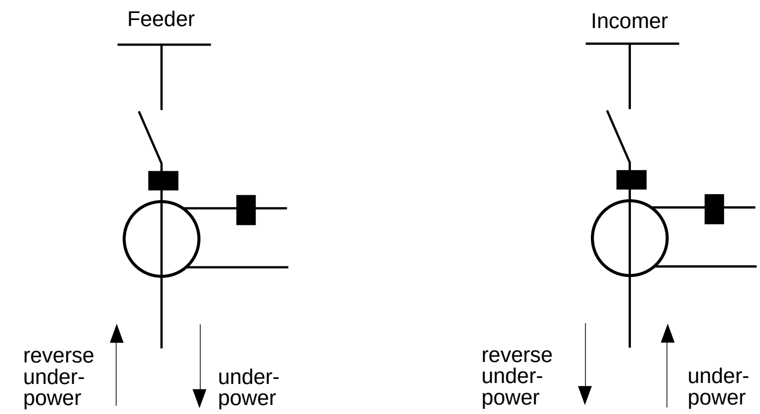
□ set **T** to the desired value (see in **metering and protection function** documentation)

□ disable the following protections [1]:

O/C X; Unbalance; E/F X (if sum of 3 CTs is used); Over P or Reverse P;

U U/V X; U/current; N Vol Disp (if sum of 3 VTs is used)





[1] remember to reactivate the protections at the end of testing.

Testing of Qs set point

◻ using single-phase, inject **Uns** into the U21 input and current **I** into the I1 input, with a phase shift of a between I and U in accordance with the following chart:

	Reverse Q	Over Q
feeder	-90°	90°
incomer	90°	-90°

◻ gradually increase the current until the associated output relay picks up

◻ read the reactive power value on the Sepam 2000 display unit or on the pocket terminal

◻ calculate the reactive power value:

Q = Uns X I

or Q = Uns X I. sin a

Testing the operating plan

◻ using single-phase, inject **Uns** into the U21 input and current **I** into the I1 input I = 2 Qs / Uns

◻ vary the phase shift a between **Uns** and **I** from 0° to 360°.

The protection should operate for the following values of a:

	Reverse Q	Over Q
feeder	-30° and -150°	30° and 150°
incomer	30° and 150°	-30° and -150°

Testing of time delay

■ parameter setting

◻ set **T** to the desired value

■ test

◻ inject voltage **Uns** into U21

◻ preset current **I1** to 1.2 times the value of **Qs/Uns** with a phase shift of +90° or +270° according to the type of protection being tested (reactive overpower or reactive reverse power)

◻ stop current injection only

◻ press the Sepam 2000 **reset** key and set the chronometer to zero

◻ start up current injection and the chronometer at the same time

◻ the Sepam 2000 relay stops the chronometer

◻ read the **t** value on the chronometer.

Temperature monitoring by RTD protection

ANSI code	49T - 38		
function n°	F46X for RTD monitoring	X is the RTD number	1 ≤ X ≤ 6
	F47Y for additional RTD monitoring	Y is the RTD number	1 ≤ Y ≤ 6

Equipment

■ 500 ohm multitour potentiometer

■ ohmmeters

■ chronometer

■ documentation

Wiring

■ B11 diagram

■ protective relays:

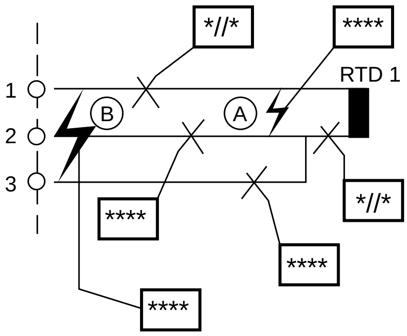
F46X/1, F47X/1 for set point 1

F46X/2, F47X/2 for set point 2

F46X/3, F47X/3 for RTD fault

Test

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



Procedure

According to the channel to be tested, temporarily strap the other RTD inputs.

■ **protection** parameter setting**: RTD X**

Testing of temperature set point

■ parameter setting

□ set set point 1 **Ts1** of channel **X** to the desired temperature

□ set set point **Ts2** of channel **X** to the desired temperature

■ test

□ preset the variable resistor to about 100Ω

□ press **reset** (1)

□ gradually increase the resistance (according to temperative/resistance table)

□ the output relay which corresponds to set point 1 will pick up after a maximum of 3 s when the resistance value reaches ts1

□ same for set point 2

□ monitor the temperature evolution in degrees Celsius of the channel on the display unit (**Wh/ °C** key) or pocket terminal and the increase in resistance on the ohmmeter.

Testing of off-limit zones

■ wire **cut**

□ remove the wire from the channel being tested

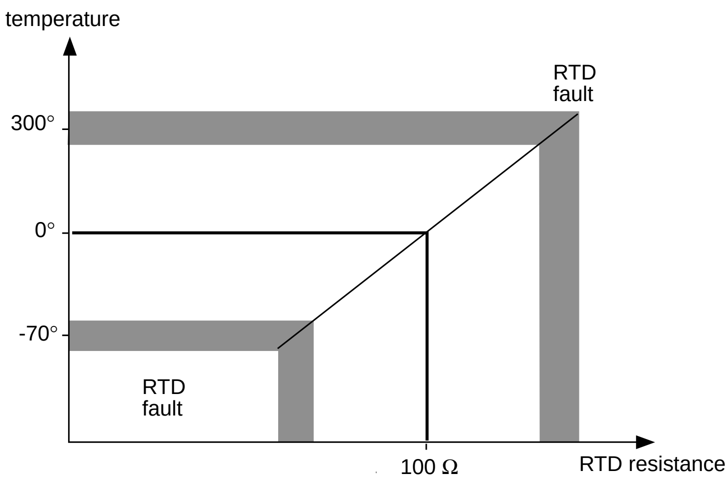
□ or simulate a temperature greater than 330°

■ probe **shorted**

□ short (A) or (B)

□ or simulate a temperature less than -70°

Please note:
(*//*) or (****) on the display unit or pocket terminal correspond to the diagram below.



(1) this function may only be activated if your program logic has been customized.

Resistance values as a function of temperature

°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω
-80	68.3										
-50	80.31	0	100.00	50	119.40	100	138.50	150	157.31	200	175.84
-49	80.70	1	100.39	51	119.78	101	138.88	151	157.69	201	176.21
-48	81.10	2	100.78	52	120.16	102	139.26	152	158.06	202	176.57
-47	81.50	3	101.17	53	120.55	103	139.64	153	158.43	204	176.94
-46	81.89	4	101.56	54	120.93	104	140.04	154	158.81	204	177.31
-45	82.29	5	101.95	55	121.32	105	140.39	155	159.18	205	177.68
-44	82.69	6	102.34	56	121.70	106	140.77	156	159.55	206	178.04
-43	83.08	7	102.73	57	122.09	107	141.15	157	159.93	207	178.41
-42	83.48	8	103.12	58	122.47	108	141.53	158	160.30	208	178.78
-41	83.88	9	103.51	59	122.86	109	141.91	159	160.67	209	179.14
-40	84.27	10	103.90	60	123.24	110	142.29	160	161.04	210	179.51
-39	84.67	11	104.29	61	123.62	111	142.66	161	161.42	211	179.88
-38	85.06	12	104.68	62	124.01	112	143.04	162	161.79	212	180.24
-37	85.46	13	105.07	63	124.39	113	143.42	163	162.16	213	180.61
-36	85.85	14	105.46	64	124.77	114	143.80	164	162.53	214	180.97
-35	86.25	15	105.85	65	125.16	115	144.17	165	162.90	215	181.34
-34	86.64	16	106.24	66	125.54	116	144.55	166	163.27	216	181.71
-33	87.04	17	106.63	67	125.92	117	144.93	167	163.65	217	182.07
-32	87.43	18	107.02	68	126.31	118	145.31	168	164.02	218	182.44
-31	87.83	19	107.40	69	126.69	119	145.68	169	164.39	219	182.80
-30	88.22	20	107.79	70	127.07	120	146.06	170	164.76	220	183.17
-29	88.62	21	108.18	71	127.45	121	146.44	171	165.13	221	183.53
-28	89.01	22	108.57	72	127.84	122	146.81	172	165.50	222	183.90
-27	89.40	23	108.96	73	128.22	123	147.19	173	165.87	223	184.26
-26	89.80	24	109.35	74	128.60	124	147.57	174	166.24	224	184.63
-25	90.19	25	109.73	75	128.98	125	147.94	175	166.61	224	184.99
-24	90.59	26	110.12	76	129.37	126	148.32	176	166.98	226	185.36
-23	90.98	27	110.51	77	129.75	127	148.70	177	167.35	227	185.72
-22	91.37	28	110.90	78	130.13	128	149.07	178	167.72	228	186.09
-21	91.77	29	111.28	79	130.51	129	149.45	179	168.09	229	186.45
-20	92.16	30	111.67	80	130.89	130	149.82	180	168.46	230	186.82
-19	92.55	31	112.06	81	131.27	131	150.20	181	168.83	231	187.18
-18	92.95	32	112.45	82	131.66	132	150.57	182	169.20	232	187.54
-17	93.34	33	112.83	83	132.04	133	150.95	183	169.57	233	187.91
-16	93.73	34	113.22	84	132.42	134	151.33	184	169.94	234	188.27
-15	94.12	35	113.61	85	132.80	135	151.70	185	170.31	235	188.63
-14	94.52	36	113.99	86	133.18	136	152.08	186	170.68	236	189.00
-13	94.91	37	114.38	87	133.56	137	152.45	187	171.05	237	189.36
-12	95.30	38	114.77	88	133.94	138	152.83	188	171.42	238	189.72
-11	95.69	39	115.15	89	134.32	139	153.20	189	171.79	239	190.09
-10	96.09	40	115.54	90	134.70	140	153.58	190	172.16	240	190.45
-9	96.48	41	115.93	91	135.08	141	153.95	191	172.53	241	190.81
-8	96.87	42	116.31	92	135.46	142	154.32	192	172.90	242	191.18
-7	97.26	43	116.70	93	135.84	143	154.70	193	173.26	243	191.54
-6	97.69	44	117.08	94	136.22	144	155.07	194	173.63	244	191.90
-5	98.04	45	117.47	95	136.60	145	155.45	195	174.00	245	192.26
-4	98.44	46	117.85	96	136.98	146	155.82	196	174.37	246	192.63
-3	98.83	47	118.24	97	137.36	147	156.19	197	174.74	247	192.99
-2	99.22	48	118.62	98	137.74	148	156.57	198	175.10	248	193.35
-1	99.61	49	119.01	99	138.12	149	156.94	199	175.47	249	193.71
										250	194.07
										270	202.60

Motor/generator differential protection

ANSI code	87M - 87G
function n°	F621

Equipment

- 2 current generators
- 2 ammeters
- 2 adapters for ECA modules
- "protection function" documentation
- calculator

Wiring

- diagrams B1 and B13
- protective relays: F621/4

Test

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

This function operates on the 3 phases individually and may be tested with single-phase, one phase at a time.

The test calls for the use of two current injection units. In order for the measurements to be accurate, the two currents must be in phase.

- **status** parameter setting

□ check the microswitches on the two ECM or ECA

Procedure

- **Protection** parameter setting: **motor diff** or **gene diff**

□ set **Is** as a % of **In** to the desired value (5% to 50% of In)

□ disable the following protections [(2)]:
O/Cx, E/Fx (if sum of 3 CTs is used), **thermal** overload, **unbalance**, **Start Hour**, **LR/ESt**

testing of operation

□ determine the operating point to be tested, i.e :

choose the value of **It**/**In**

choose the value of **Is**/**In**

□ read in the chart which follows the minimum value of Id/In that trips the protection, with Id/In ≥ 1.2 Is/In

□ preset the injections:

□ inject the two currents IA and Id at the same time according to diagram B13,

with $IA = It - \frac{Id}{2}$

□ check on F621/4 that the function has picked up

□ cut off the injections

□ press the "reset" button [(1)] on Sepam 2000 to earase the messages and make the relay drop out again.

- example

□ testing the protection for a through- current of In and an Is setting of 20% of In

□ use the chart to read:
for It/In = 1 and Is/In = 0.2
read the value of Id/In: 0.2669

Preset Is = 0.84 In et Id = 0.32 In

□ inject the 2 currents at the same time

□ the relay picks up

□ press reset [(1)] on Sepam 2000 to erase the message and make the relay drop out again.

Testing of tripping time

□ wire according to diagram B1; use a single current generator (I' = 0)

□ given **I** = 1,2 In

□ preset **I1** to 40 A, i.e. 1 A in the secondary circuit

□ set the chronometer to zero

□ start injection and the chronometer at the same time

□ after the chronometer is stopped by the Sepam 2000 relay, read the time (about 40 ms)

[(1)] this function may only be activated if your program logic has been customized.
[(2)] remember to reactivate the protections at the end of testing.
X = number of the protective relay.

It/In	Is/In									
	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
0	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
0.1	0.0530	0.1015	0.1510	0.2008	0.2506	0.3005	0.3504	0.4004	0.4503	0.5003
0.2	0.0612	0.1061	0.1541	0.2031	0.2525	0.3021	0.3518	0.4016	0.4503	0.5012
0.3	0.0729	0.1132	0.1591	0.2069	0.2556	0.3046	0.354	0.4035	0.4531	0.5028
0.4	0.0866	0.1224	0.1658	0.2121	0.2598	0.3082	0.3571	0.4062	0.4555	0.505
0.5	0.1015	0.1741	0.2187	0.2652	0.2652	0.3127	0.361	0.4096	0.4586	0.5077
0.6	0.1173	0.1458	0.1837	0.2264	0.2716	0.3182	0.3657	0.4138	0.4623	0.5111
0.7	0.1335	0.1591	0.1944	0.2352	0.2789	0.3245	0.3712	0.4187	0.4667	0.5151
0.8	0.15	0.1732	0.2062	0.2449	0.2872	0.3317	0.3775	0.4243	0.4717	0.5196
0.9	0.1668	0.1879	0.2187	0.2556	0.2963	0.3396	0.3845	0.4305	0.4773	0.5247
1	0.1837	0.2031	0.2318	**0.2669**	0.3062	0.3482	0.3921	0.4373	0.4835	0.5303
1.5	0.2698	0.2834	0.3046	0.3321	0.3644	0.4004	0.4391	0.4799	0.5223	0.566
2	0.3571	0.3674	0.3841	0.4062	0.4330	0.4637	0.4975	0.5338	0.5723	0.6124
2.5	0.4448	0.4531	0.4667	0.4851	0.5077	0.5341	0.5637	0.5961	0.6307	0.6673
3	0.5327	0.5397	0.5511	0.5668	0.5863	0.6093	0.6354	0.6643	0.6955	0.7289
3.5	0.6207	0.6267	0.6366	0.6502	0.6673	0.6876	0.7108	0.7368	0.7651	0.7955
4	0.7089	0.7141	0.7228	0.7348	0.75	0.7681	0.789	0.8124	0.8381	0.866
4.5	0.7971	0.8018	0.8095	0.8202	0.8338	0.8502	0.8691	0.8904	0.9139	0.9396
5	0.8853	0.8895	0.8965	0.9062	0.9186	0.9334	0.9507	0.9702	0.9918	1.0155
5.5	0.9736	0.9774	0.9838	0.9926	1.0039	1.0175	1.0333	1.0513	1.0714	1.0933
6	1.0618	1.0654	1.0712	1.0793	1.0897	1.1023	1.1169	1.1336	1.1522	1.1726

Restricted earth fault protection

ANSI code	64 REF
function n°	F641, F651, F661

Equipment

■ single-phase current generator

■ ammeter

■ documentation

Wiring

■ B7, B14, B15 diagram

■ protective relays:

F641/1, F651/1, F661/1

Test

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

■ check the SW microswitches

■ **status** parameter setting:

□ choose the Io measurement method, by CSH core balance CT or TC + CSH30

□ check the connection of the core balance CT to the connector

□ make the function settings

Procedure

Checking of set point

The Iso set point is checked by simulating a fault between the neutral point CT and a phase CT, when the circuit breaker is open. In this case, only the neutral point CT detects the fault. There is zero restaint current.

■ wire according to the B7 diagram

■ inject a current in the the CSH neutral I current measurement sensor (CSH sensor installed at the neutral point or CSH 30 associated with the CT installed at the neutral point) and progressively raise the current being injected until it exceeds the setting value.

■ check the current value measured on the ammeter at the time the output contact associated with the function picks up (or read the TRIP 0 value if trip current measurement is associated with the function)

■ stop the injection

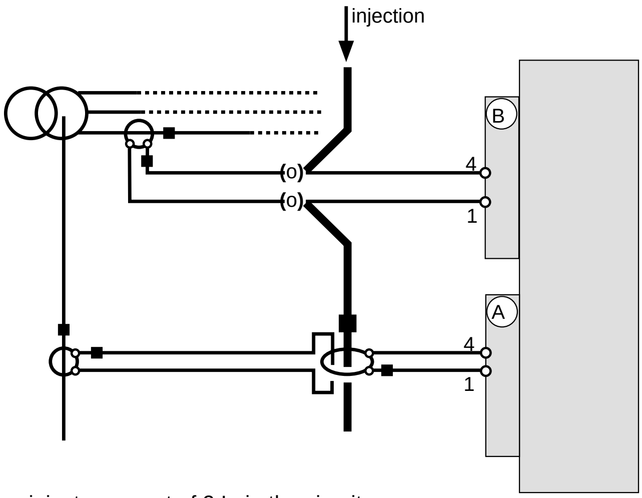
■ press reset [1] on Sepam 2000 to erase the messages and reset the output relay

testing of stability

The stability can be checked by considering a phase-to-earth fault outside the zone to be protected.

This test is only possible if Ino is equal to In for the winding to which the restricted earth fault protection is linked.

■ wire (according to B14 or B15 diagram) to inject the same current in series in the CSH neutral point current measurement sensor and in one of the phase current inputs to simulate a fault outside the zone, for example:



■ inject a current of 2 In in the circuit

■ check that the output contact associated with the function remains dropped out

■ stop the injection.

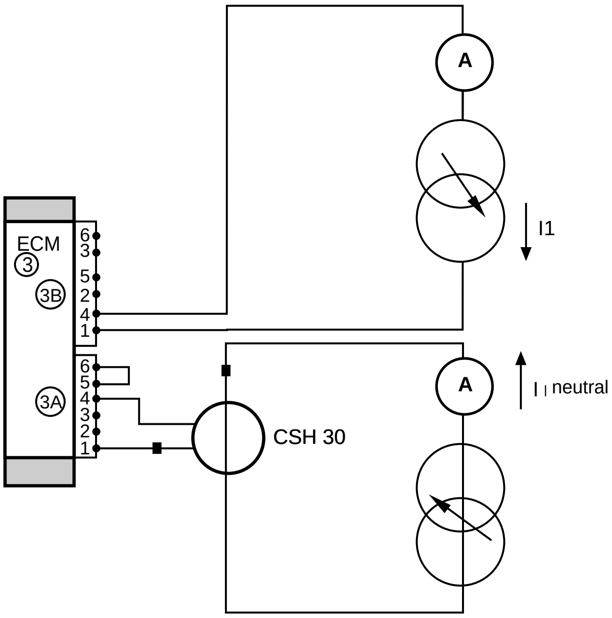
[1] this function cannot be activated if the control logic has been customized.

Checking of the slope

The slope can be checked by simulating a phase-to-earth fault inside the zone to be protected on a network with the circuit breaker closed. In this case, the fault is detected by the neutral point CT and partially by the phase CT.

■ To facilitate the test and calculations, set Ino to the same value as In.

■ To perform the test, wire according to the diagram opposite.



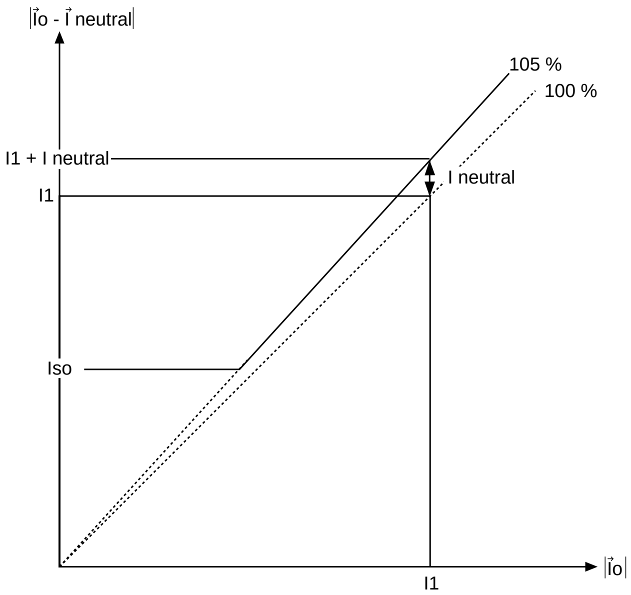
■ Inject a current through the CSH30 interposing ring CT and a phase current in the opposite direction.
The restraint current is equal to I1, the differential current is equal to I1 + I neutral.
When there is no I neutral, the slope is equal to 100%.

■ Gradually inject Io until tripping occurs.

■ Record I neutral and I1 and calculate
100 x (I1 + I neutral)/I1 and compare to 105%.

■ Stop the injection.

■ Press reset [(1)] on Sepam 2000 to erase the messages and reset the output to 0.



(1) this function cannot be activated if the control logic has been customized

Synchronism check

ANSI code	25
function n°	F171, F181

Equipment

■ single-phase current generator [1]

■ voltmeter

■ documentation

Wiring

■ B3, B16 diagram

■ protective relays:

F171/3, F181/3

Test

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

■ check the SW microswitches

■ **status** parameter setting:

□ mains frequency (50 or 60 Hz)

□ Unp, mains phase-to-phase voltage.

□ Uns, phase-to-phase voltage of the VT secondary circuit

□ number of VTs connected.

□ make the function settings.

Procedure

testing of operation with the phase and the voltage indicator
(a single single-phase voltage generator is required).

■ apply rated voltage Uns between terminals 4 and 5 and between terminals 2 and 1.

□ use the pocket terminal to measure:

phase shift phase dphi = 0°

voltages U = Un and U' = Un

□ check that the output associated with the function (F171/3 or F181/3) picks up

■ apply rated voltage Uns between terminals 4 and 5 and between terminals 2 and 1.

□ use the pocket terminal to measure:

phase shift phase dphi = 180°

voltages U = Un and U' = Un

□ check that the output associated with the function (F171/3 or F181/3) does not pick up

■ set the chosen operating mode: mode 1, 2, 3 or 4

□ apply rated voltage Uns: between terminals 4 and 5 which correspond to U or between terminals 2 and 1 which correspond to U' or no voltage according to the chosen mode.

□ check that the output associated with the function (F171/3 or F181/3) picks up

testing of operation with frequency and voltage
(optional test that calls for two single-phase voltage generators)

Apply rated voltage Uns to the rated frequency of one of the voltage generators between terminals 4 and 5

■ apply rated voltage Uns to the other voltage generator between terminals 2 and 1

□ at a frequency F = Fn - dFs - 0.02 Hz

check that the output associated with the function (F171/3 or F181/3) is dropped out

□ at a frequency F = Fn + dFs + 0.02 Hz

check that the output associated with the function (F171/3 or F181/3) is dropped out

□ at a frequency F = Fn - dFs /2

check that the output associated with the function (F171/3 ou F181/3) picks up and drops out periodically

□ at a frequency F = Fn + dFs/2

check that the output associated with the function (F171/3 ou F181/3) picks up and drops out periodically.

■ apply the signal at the rated frequency Fn of the other voltage generator between terminals 2 and 1

□ with an amplitude U = Uns - dUs - 5%

check that the output associated with the function (F171/3 or F181/3) is dropped out

□ with an amplitude U = Uns + dUs + 5%

check that the output associated with the function (F171/3 or F181/3) is dropped out

□ with an amplitude U = Uns - dUs/2

check that the output associated with the function (F171/3 or F181/3) is picked up

□ with an amplitude U = Uns + dUs/2

check that the output associated with the function (F171/3 or F181/3) is picked up.

[1] 2 single-phase generators, one with variable frequency, are necessary for the optional tests

Protection against circuit breaker faults

ANSI code	50BF + 62
function n°	F981

Equipment

■ current generator

■ ammeter

■ chronometer

■ documentation

Wiring

■ B1, B2, B8 diagram

■ protective relays:

F981/1, F981/2

Test

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

■ check the SW microswitches

■ **status** parameter setting:

□ frequency
□ phase CT
□ make the function settings

Procedure

testing of the retripping function
■ preset current injection to I ≥ 1.2 Is

■ set the chronometer to zero

■ inject the current into the phase current 1 input

■ activate the phase 1 I logic input and start up the chronometer at the same time

■ check that the F981/1 output associated with the function stops the chronometer

■ check that the chronometer displays time T1

■ stop the injection and activation of the phase 1 logic input

■ press reset on Sepam 2000 to erase the messages and reset the output.

The test may be repeated by injecting the current into the phase 2 or 3 current input and activating the phase 2 or 3 logic input of the corresponding phase, or the three-phase logic input.

testing of the adjacent circuit breaker tripping function
■ preset the current current injection I ≥ 1.2 Is.

■ set the chronometer to zero

■ inject the current into the phase 1 current input

■ activate the phase 1 I logic input and start up the chronometer at the same time

■ check that the F981/2 output associated with the function stops the chronometer

■ check that the chronometer displays time T2

■ stop the injection and activation of the phase 1 logic input

■ press reset on Sepam 2000 to erase the messages and reset the output.

The test may be repeated by injecting the current into the phase 2 or 3 current input and activating the phase 2 or 3 logic input of the corresponding phase, or the three-phase logic input

Appendix

	chapter/page
testing equipment	**2**/2
test wiring diagram B1 to B16	**2**/3 to **2**/18
commissioning tests	**2**/19

Measurement and testing equipment required according to the type of test

The injection apparatus should transmit a pure sine wave signal (with no harmonics [2].

Measuring instruments
The instruments should have accuracy and tolerance characteristics which are at least equivalent to those of Sepam 2000 (minimum class 1).

Current generator
- single-phase and/or three-phase: différential protection test require 2 current generators
- 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 [1]
- dynamic range: 0 to 100 V rms, sine wave
- frequency range: 45 Hz to 65 Hz

Phase shifter [1]
- accuracy of 360°/1°

Please note:

Some units perform and display voltage phase shift using the current as a reference. This is liable to cause angle interpretation errors.

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

Ohmmeter
- 0 to 1 kΩ 0.03%

Ammeter
- 0 to 10 A rms

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

ACE 907 injection interface
- rated current: 1 A (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)

Variable resistors
- 0 to 500 ohms, 0.03%, 1/4 W (simulation of RTDs)

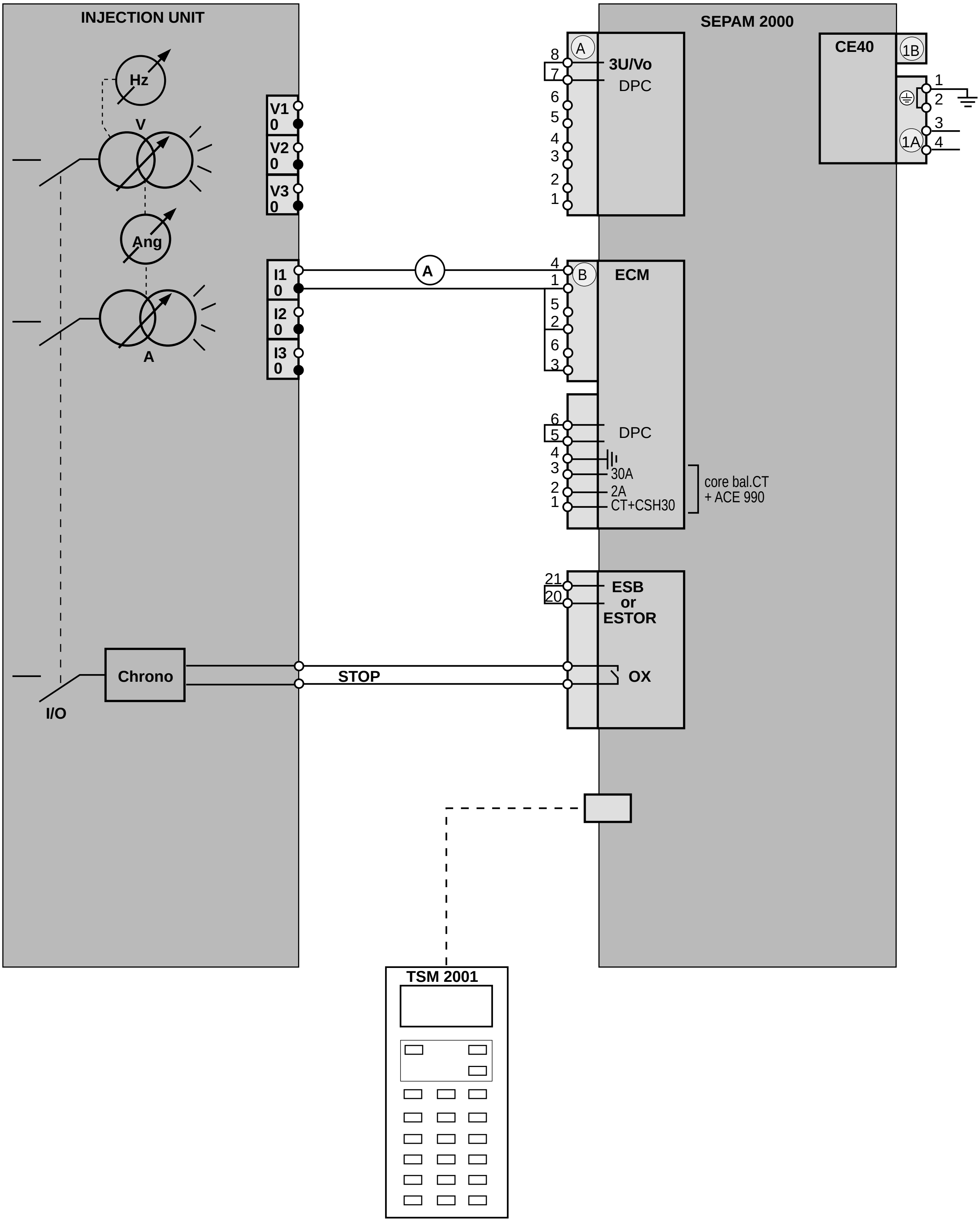
Power resistor
- 1 ohm ≥ 25W (simulation of undercurrent)

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

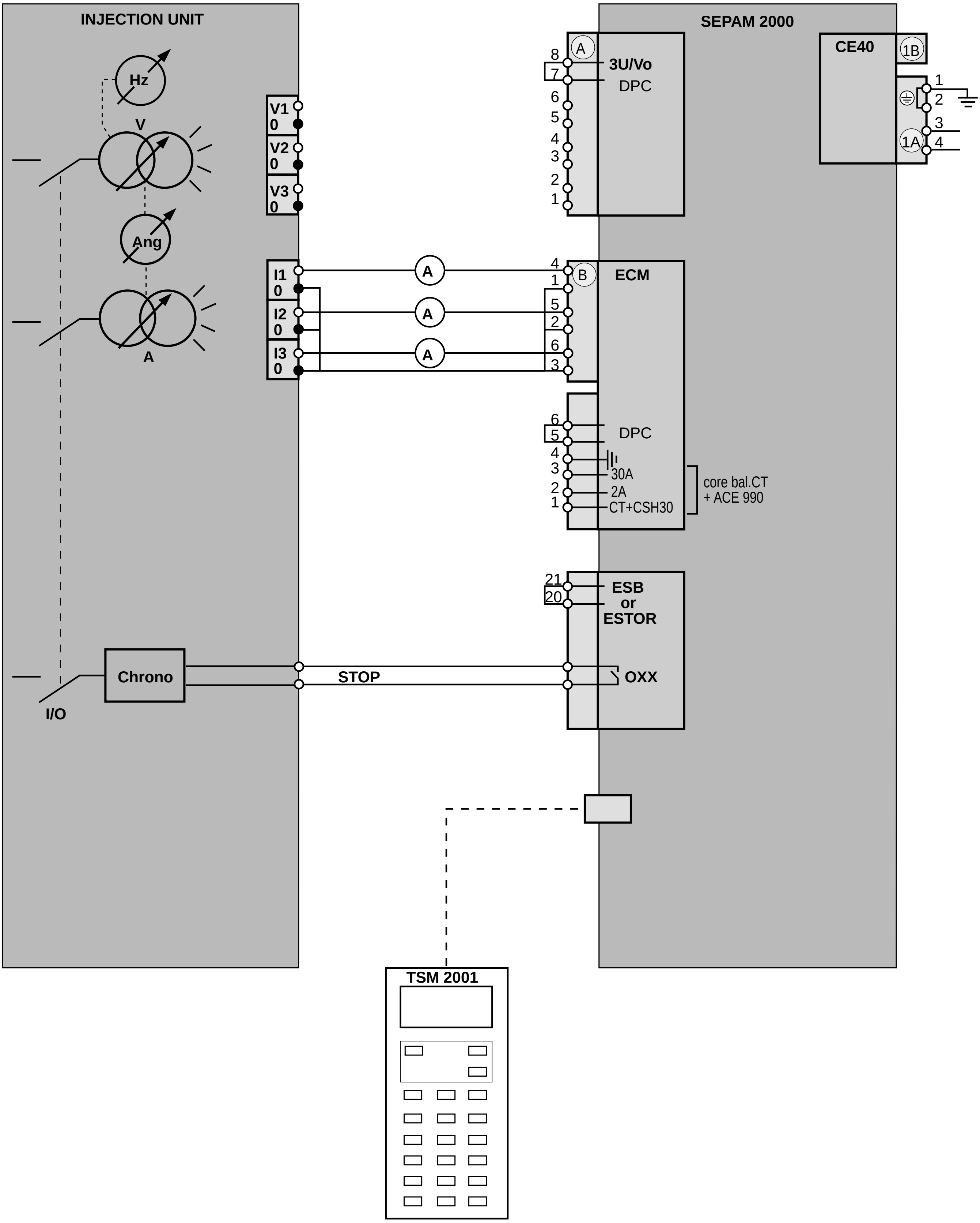
[1] these instruments are very often linked to the voltage generator and include their own measurement indicators.
[2] in order to validate the tests, it is recommended to use an oscilloscope to verify the shape of the injection unit signals and to use a spectral analyzer to verify the amplitude of level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

Test wiring diagram

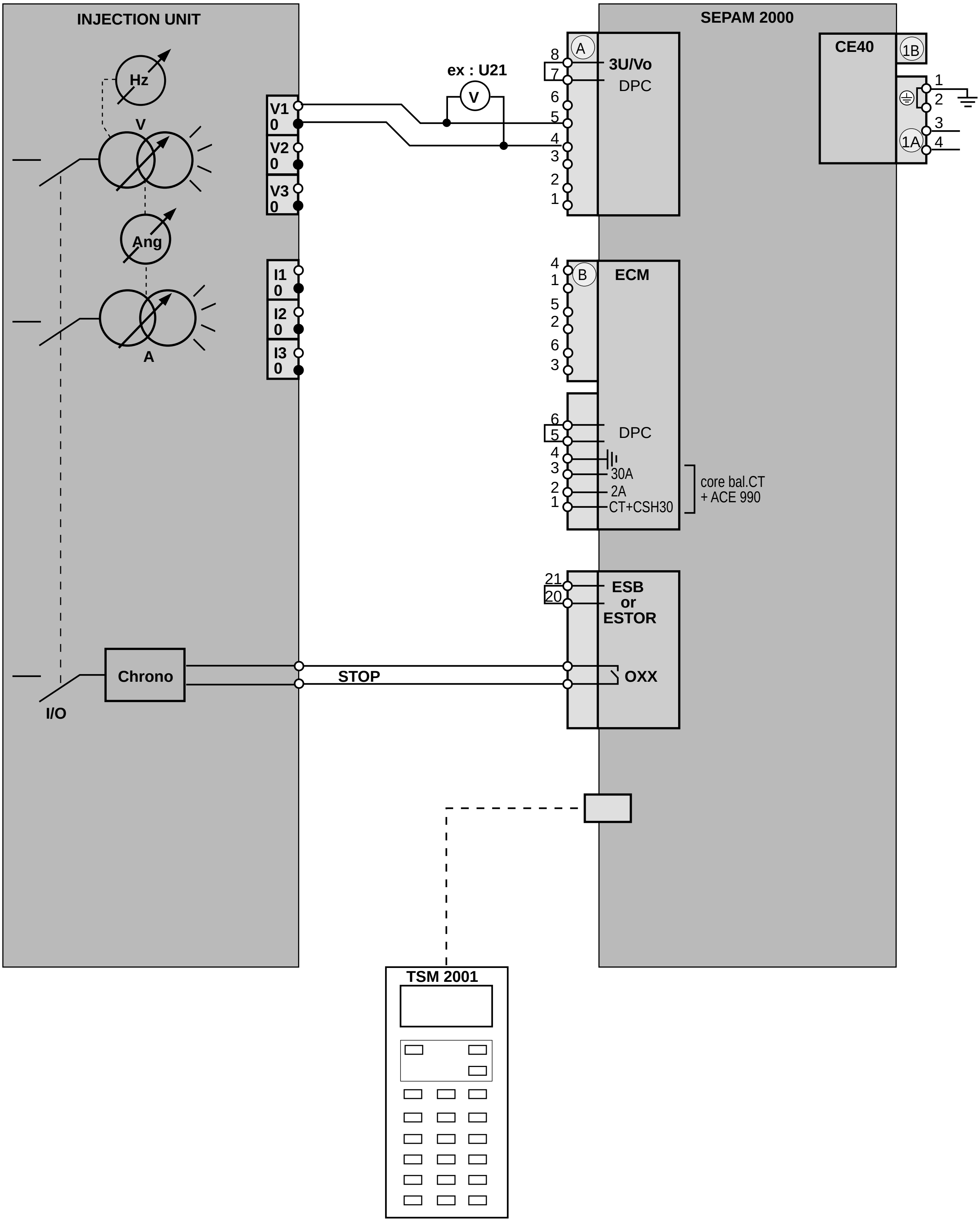
B1: single-phase current injection (phase / neutral)



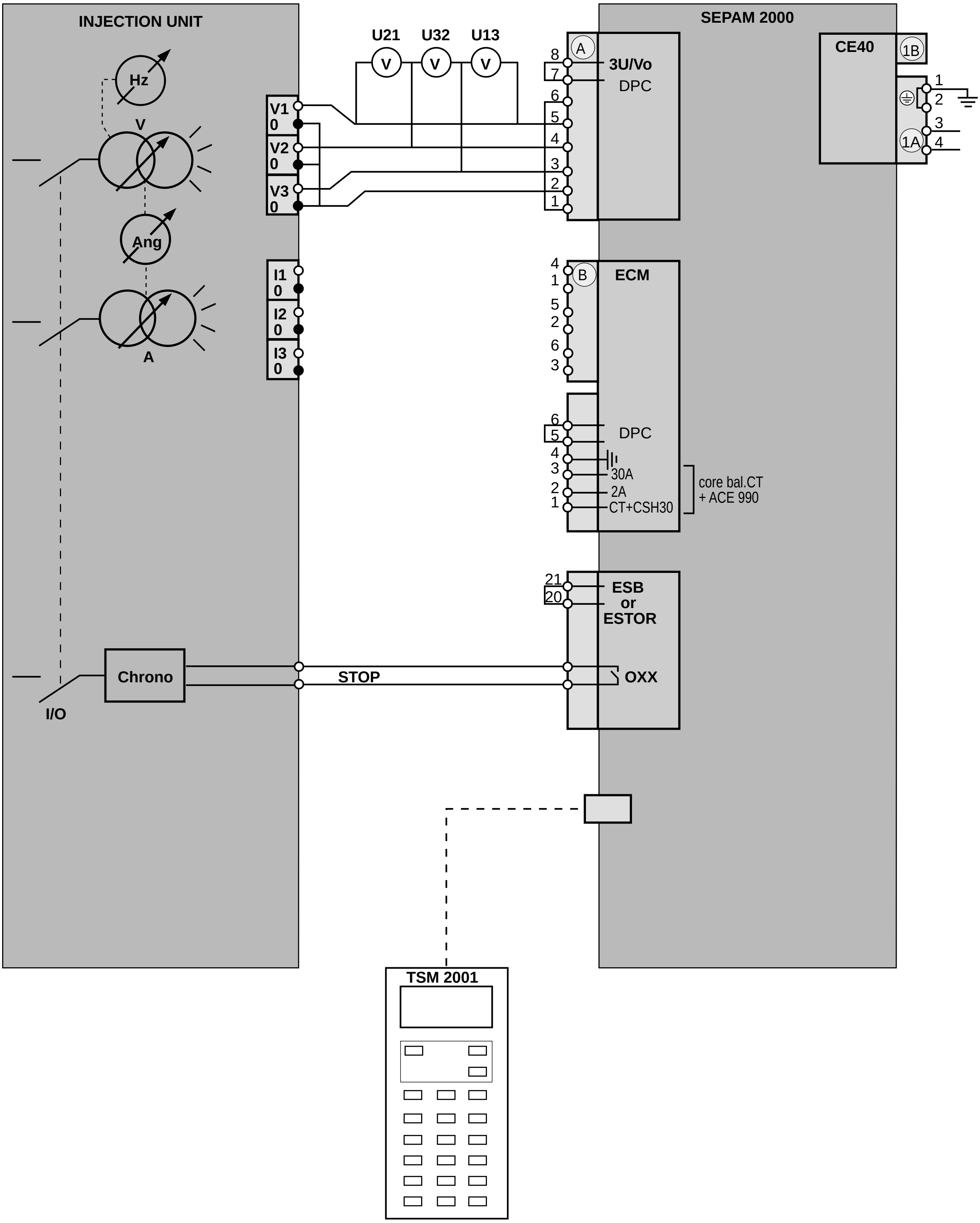
B2: three-phase current injection



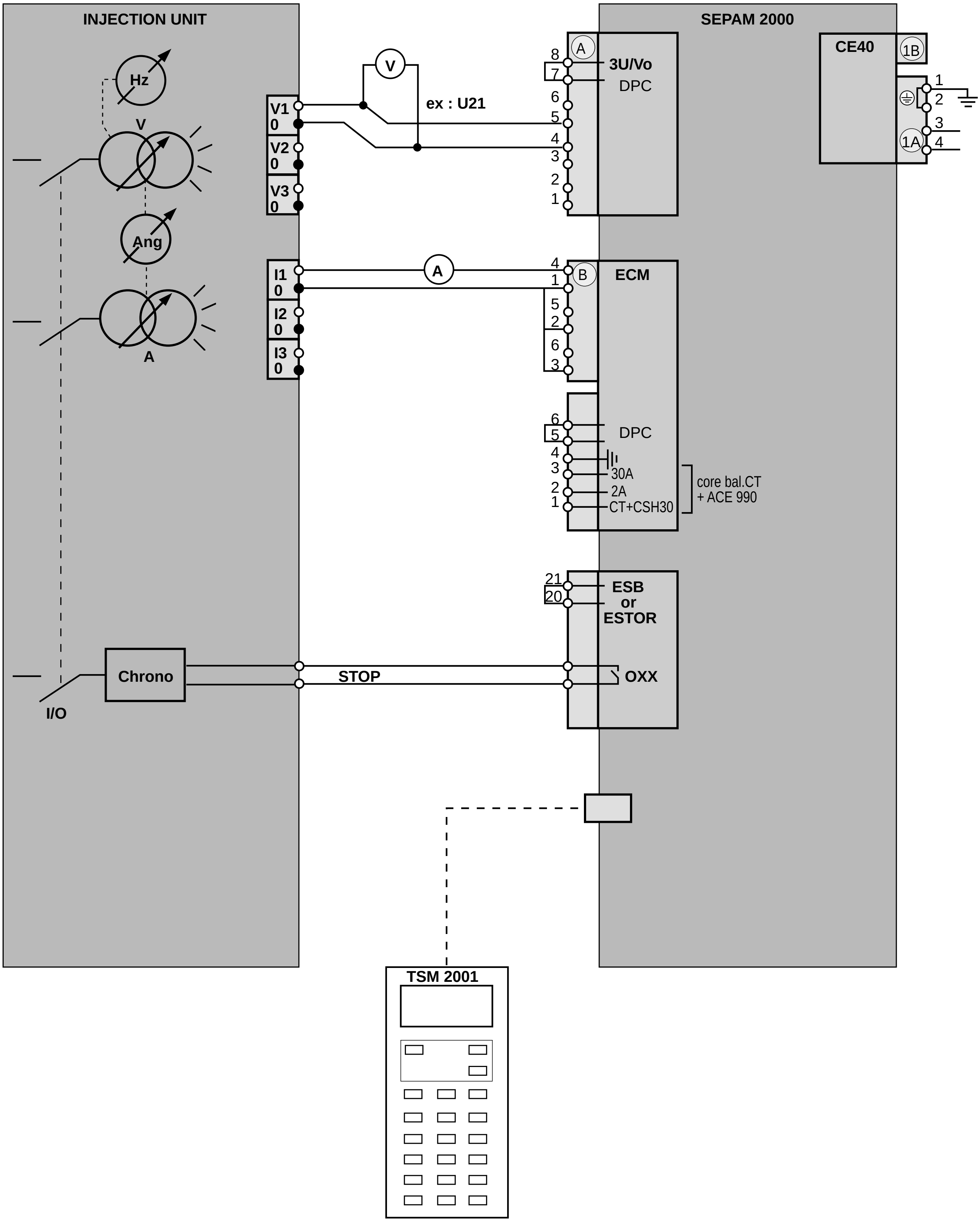
B3: single-phase voltage injection



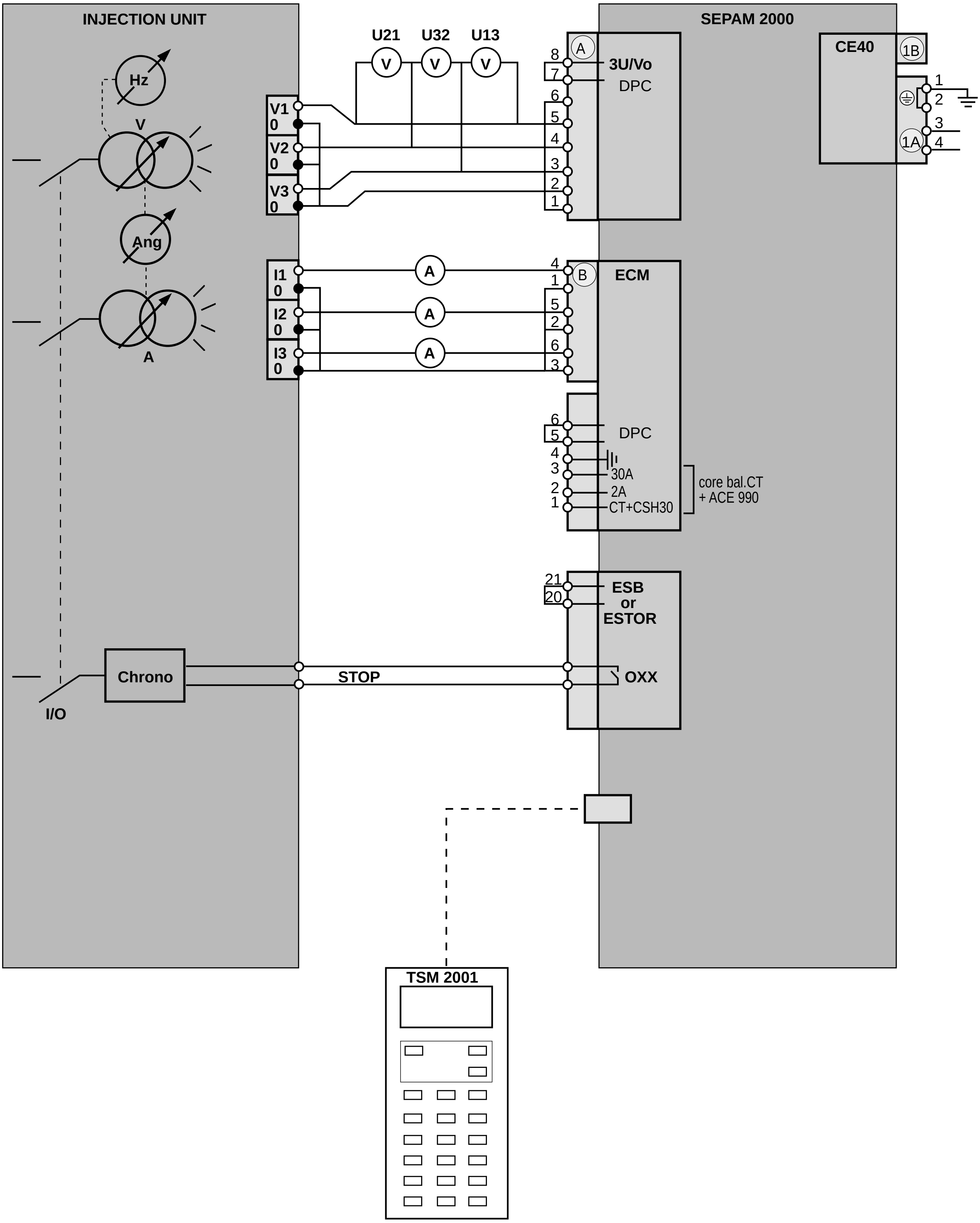
B4: three-phase voltage injection



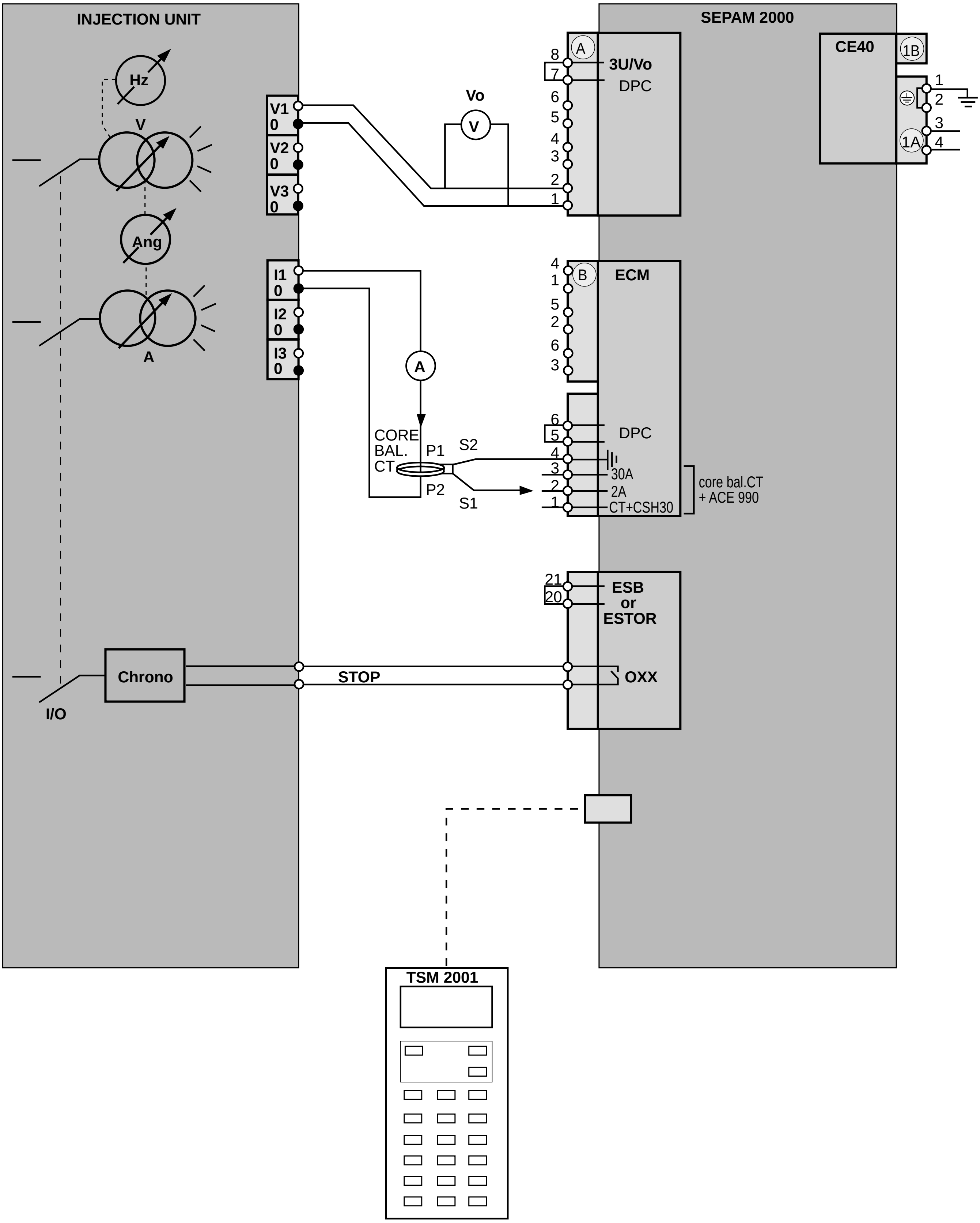
B5: single-phase current and voltage injection



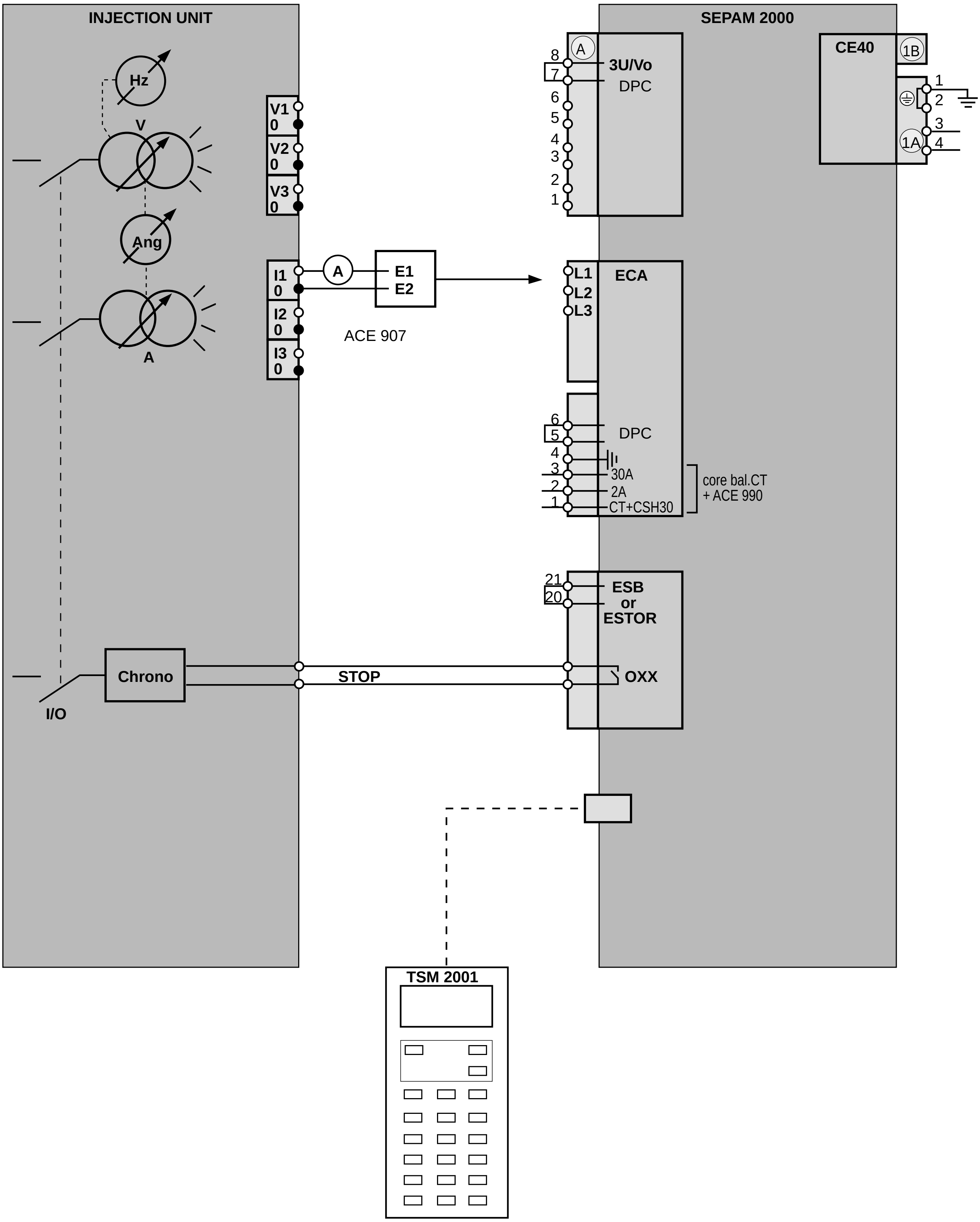
B6: three-phase current and voltage injection



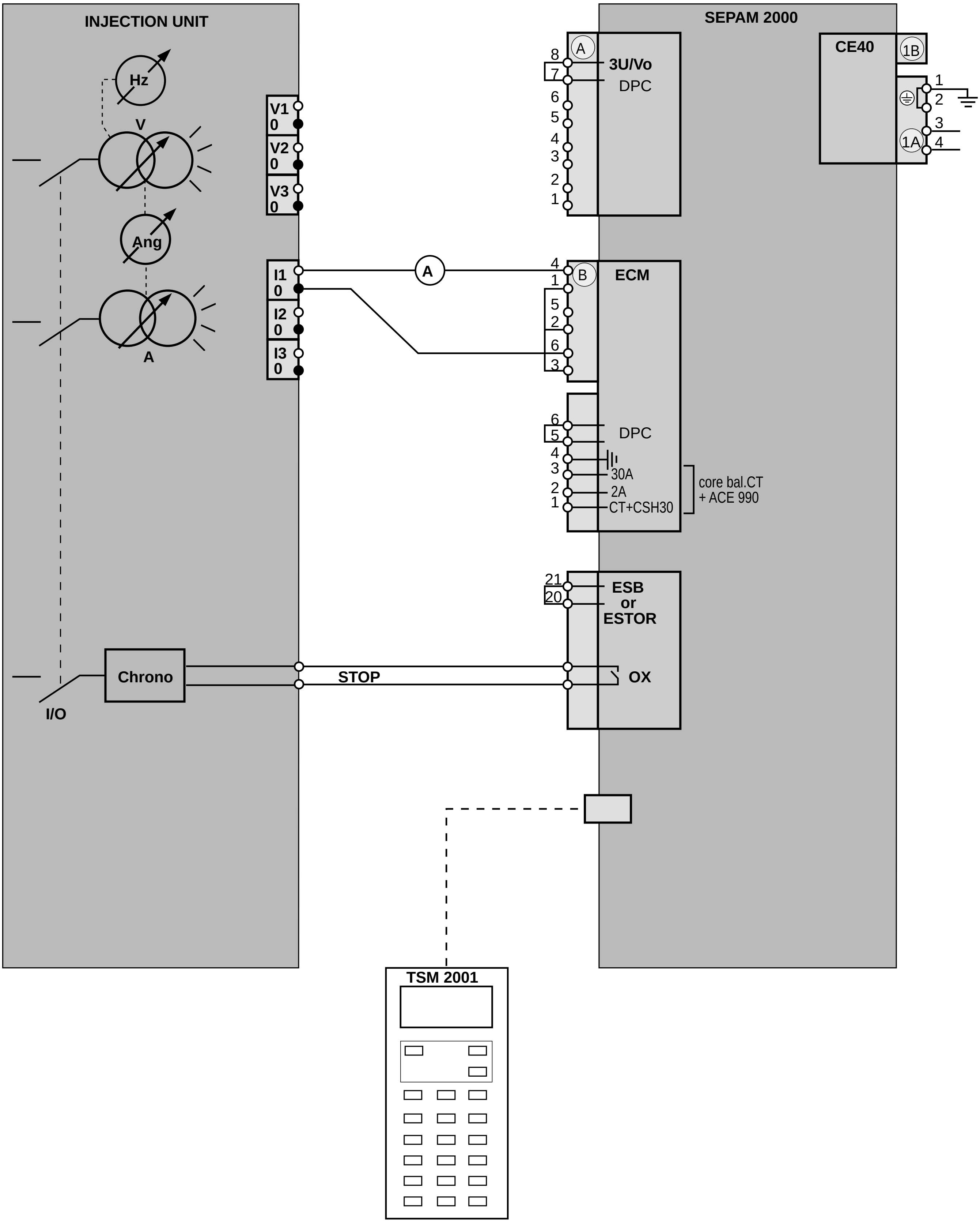
B7: single-phase current and voltage injection with core balance CT



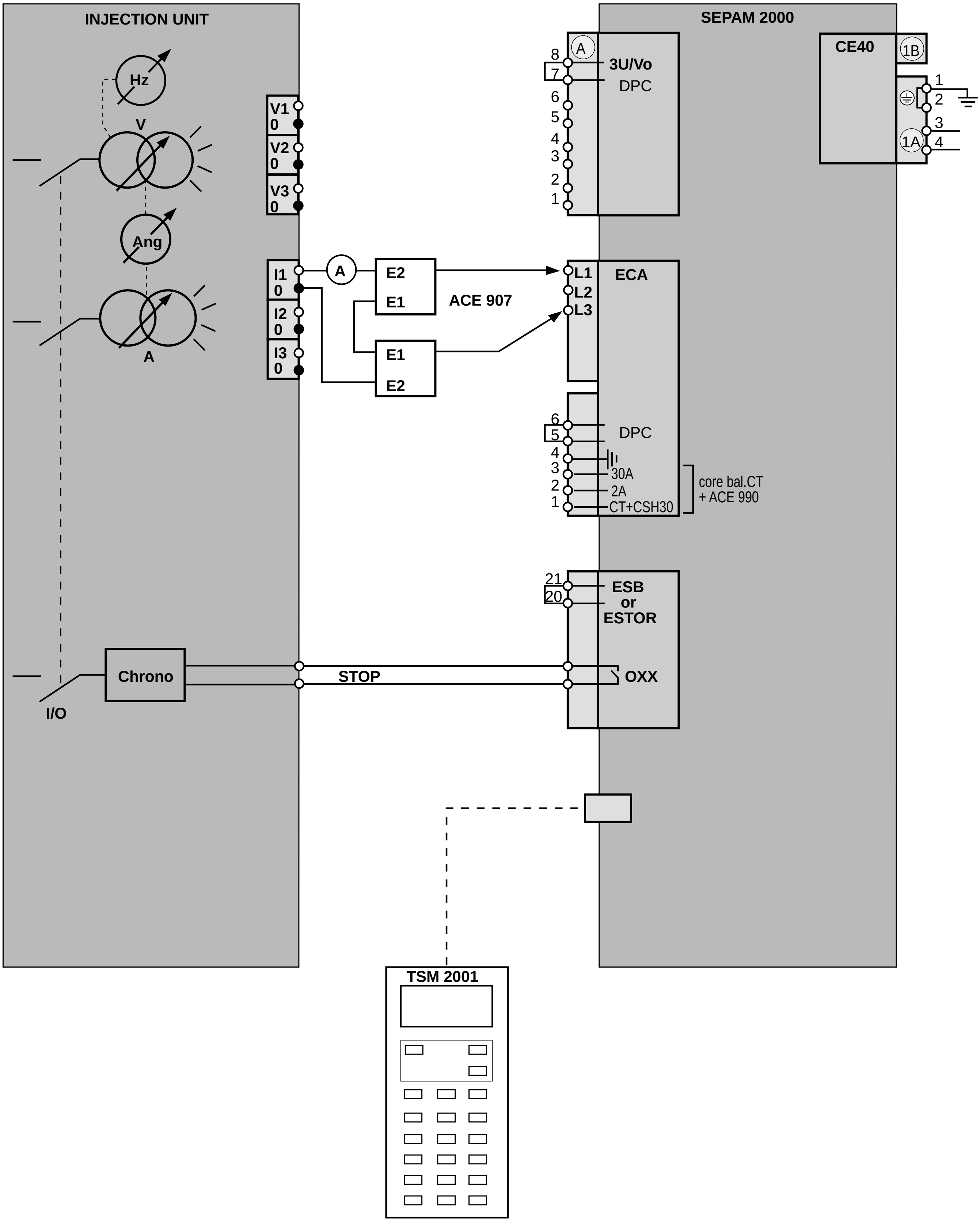
B8: current injection with CSA adapter



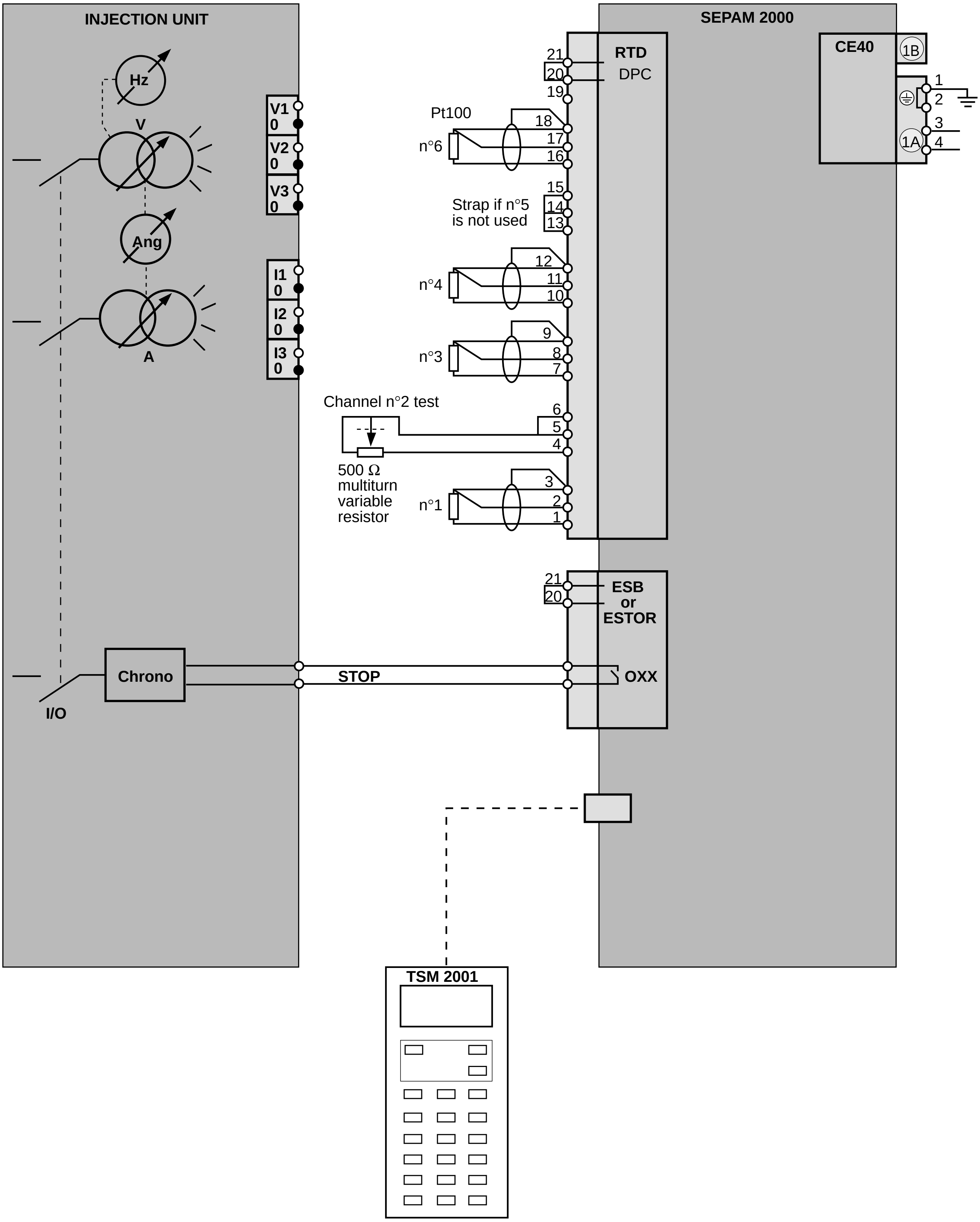
B9: single-phase injection into 2 current inputs



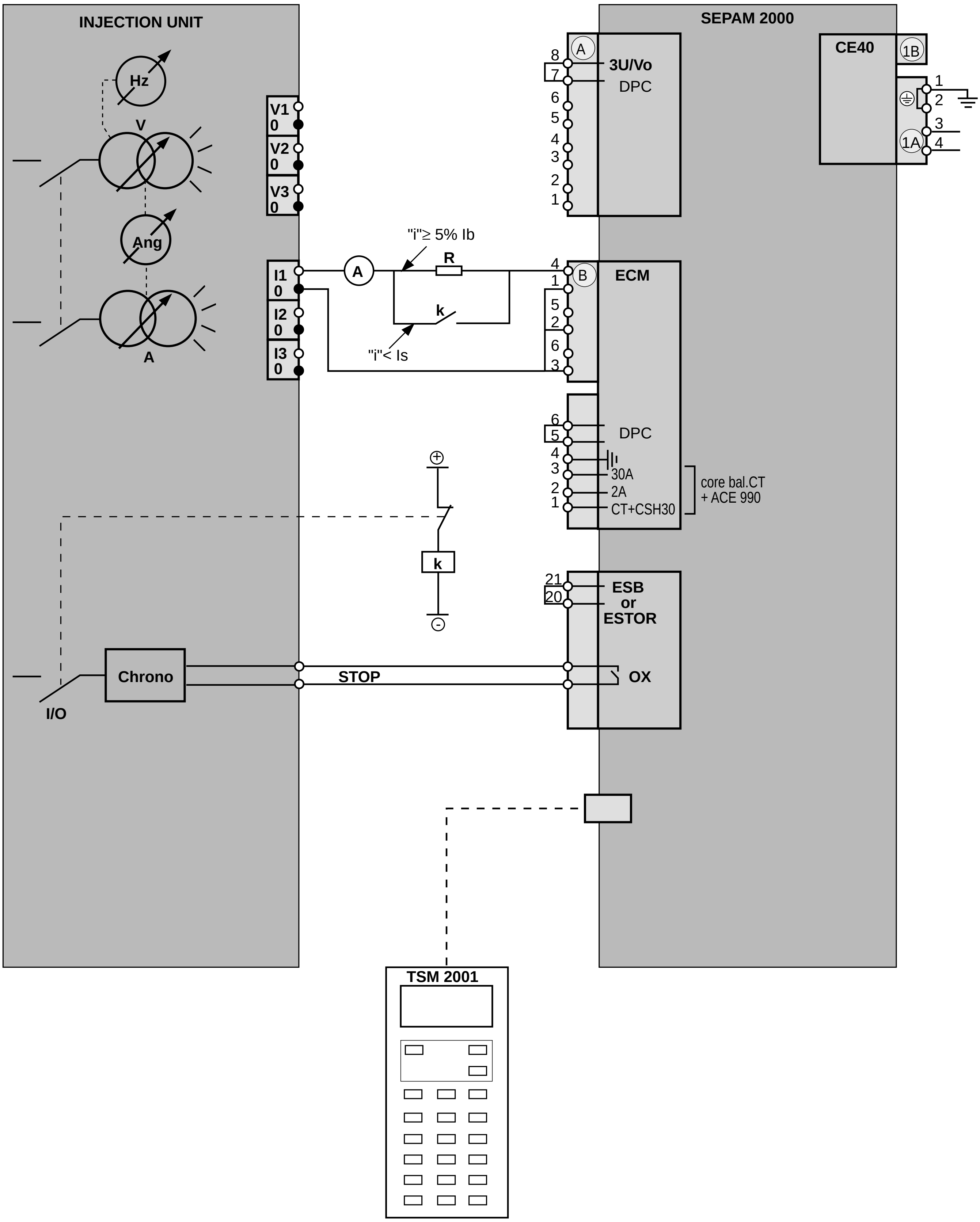
B10: single-phase current injection into 2 CSP current inputs



B11: RTD temperature monitoring test

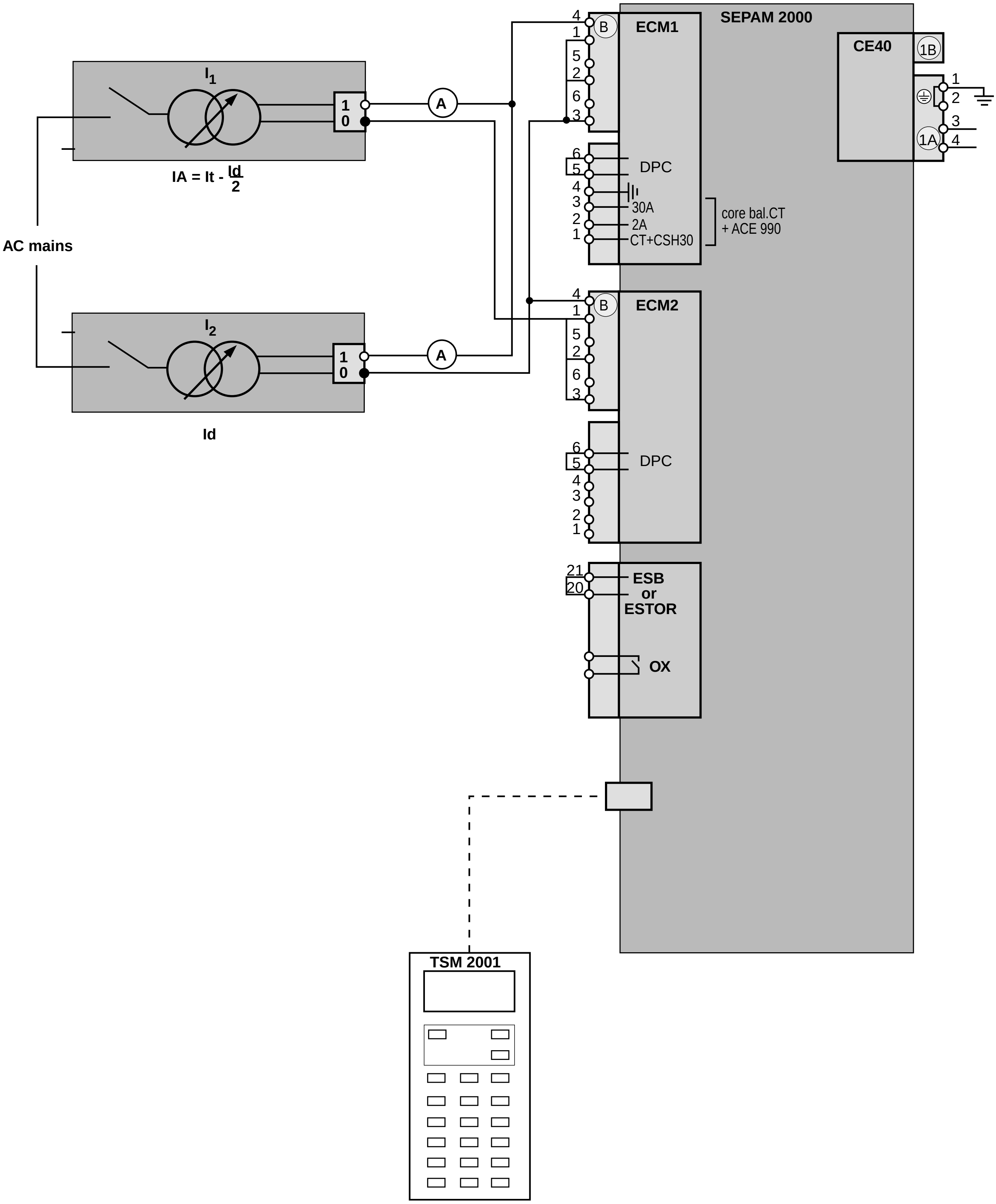


B12: undercurrent and locked rotor test

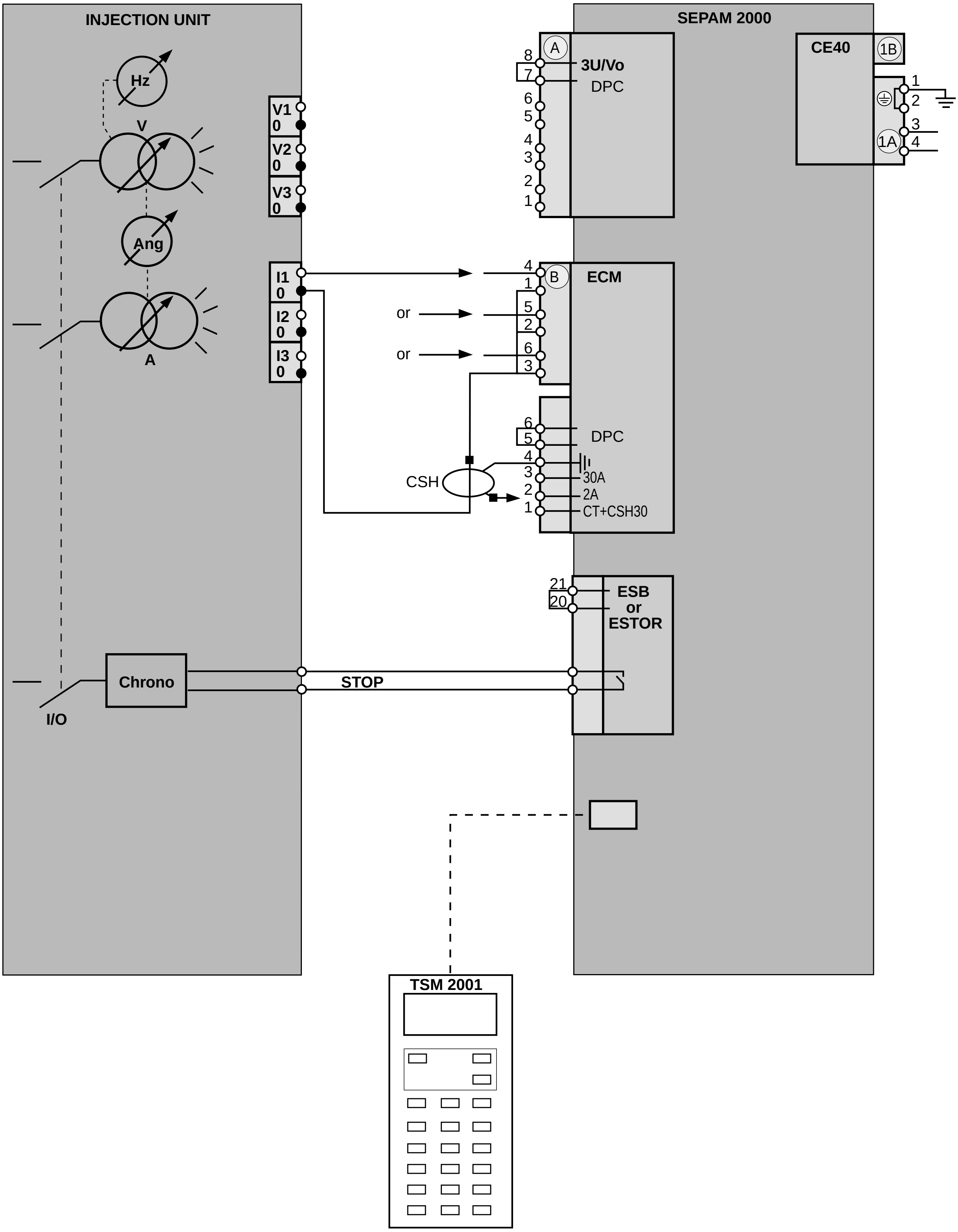


B13: differential protection test

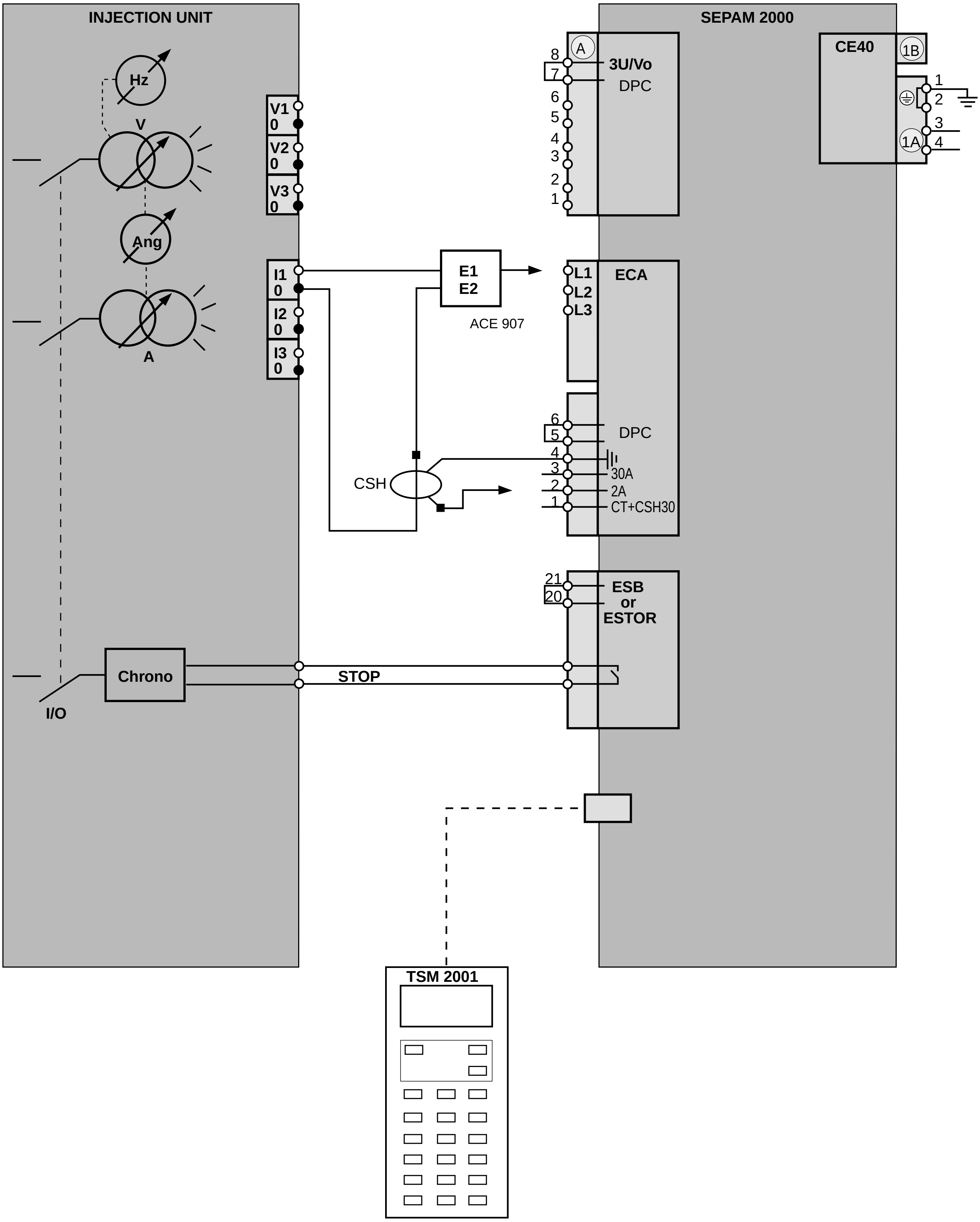
Test with 2 injection boxes



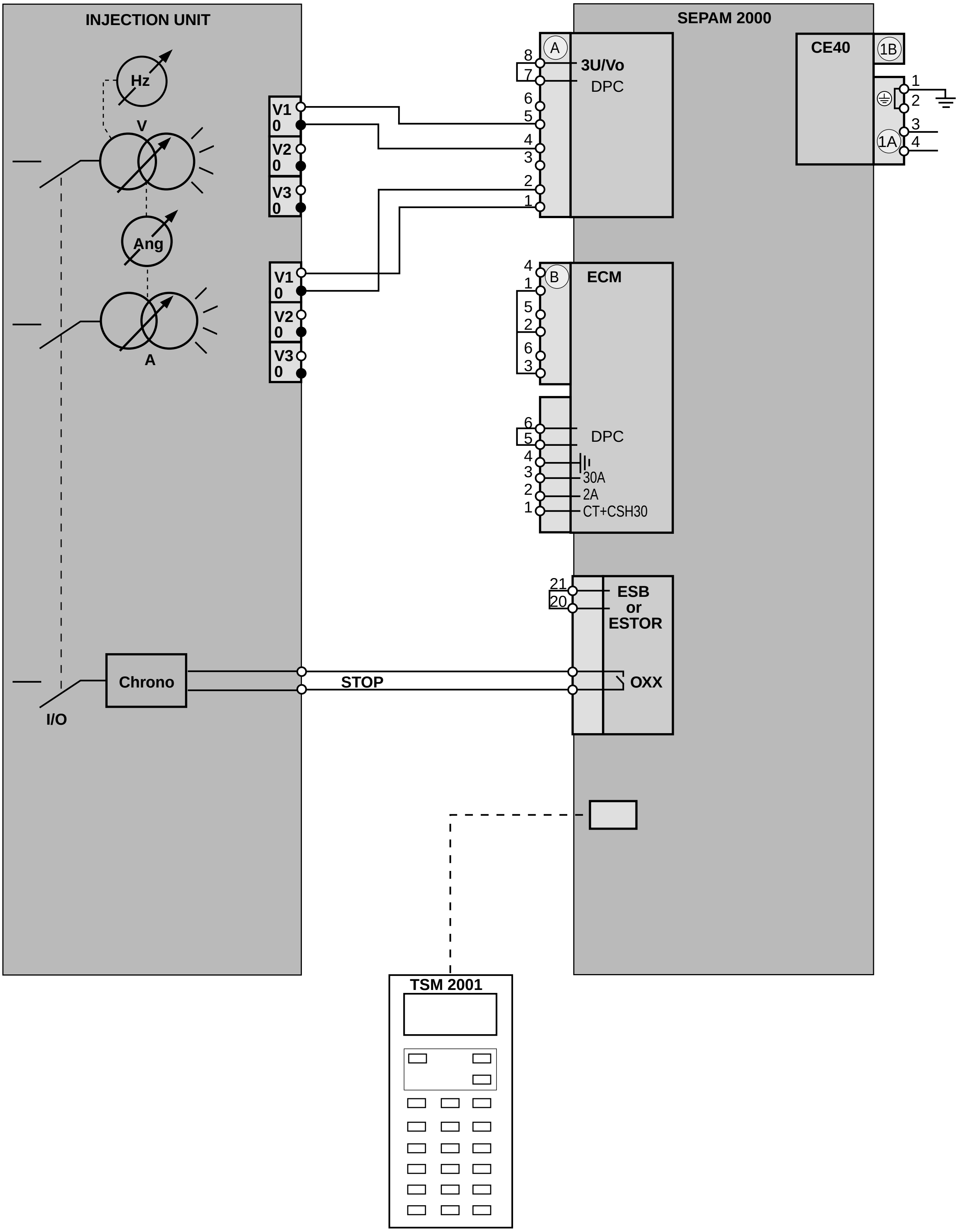
B14: restricted earth fault protection test



B15 : restricted earth fault protection test



B16 : synchronism check test with frequency and voltage (optional test)



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 …)

□ cabling

□ etc …

■ an X 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 2000 documentation:

□ use and commissioning (3140750A),

□ metering and protection functions (3140747A),

□ control and monitoring functions (3140748A).

Testing – setting record sheets
Contents

	chapter/page
test sheets	**3/**2

TEST SHEET	Sepam 2000
Project :	Type of Sepam 2000 ☐☐☐
Switchboard:	
Panel:	serial number ☐☐☐☐☐☐☐
....	

Commissioning tests
Check current and voltage sensor wiring and phase rotation order beforehand.
Set the status parameters and set the protections according to the **setting record sheet**.

type of test		scheme	result	display	
Sepam connected to current sensors only [1]					
secondary injection of rated current	I1 = 1 or 5 A I2 = 1 or 5 A I3 = 1 or 5 A	**B6**	primary rated current	I1 = ... I2 = ... I3 = ...	☐
Sepam connected to current and voltage sensors					
3-phase secondary injection	rated current (1 or 5 A) rated voltage (Uns) phase shift φ = -30° inductive	**B6**	$P = +\frac{3Un.In}{2}$ $Q = +\frac{\sqrt{3}Un.In}{2}$	P = + ... Q = + ...	feeder ☐
			$P = -\frac{3Un.In}{2}$ $Q = -\frac{\sqrt{3}Un.In}{2}$	P = - .... Q = -	incomer ☐
residual current according to assembly					
Sum 3I 3-phase secondary injection in 1 phase	rated current (1 or 5 A) rated current (1 or 5 A)	**B6**	residual I = 0 residual I = rated I	Ir = ... Ir = ...	☐ ☐
CSH primary injection primary injection	30 A 0.2 A	**B7**	28.5 ≤ residual I ≤ 31.5 A 0.18 ≤ residual I ≤ 0.22 A	Ir = ... Ir = ...	☐ ☐
CT (with CSH 30 or ACE 990) secondary injection(with CSH 30) primary injection	rated current (1 or 5 A)	**B7**	residual I = rated I residual I = injected current	Ir = ...	☐
residual voltage according to assembly					
VT in broken delta single-phase secondary injection	$\frac{Uns}{\sqrt{3}}$	**B7**	residual voltage = phase voltage	Vo = ...	☐
VT in star 3-phase secondary injection	$\frac{Uns}{\sqrt{3}}$	**B6**	residual voltage = phase voltage	Vo = ...	☐
logic input / output wiring					
check the conformity of logic input and output connection					☐
circuit breaker/contactor program logic					
closing control	by closing button		closing of device		☐
tripping control	by tripping button		opening of device		☐
pilot wire test (standard Sepam)					
test the link (KP18)			(message) RECEIVE.BI (on upstream Sepam)		☐

Tests carried out on: ☐☐/☐☐/☐☐ **by:** ______________________	**Signature**	**Signature**

Comments: ______________________

[1] see "Testing" documentation

Program logic parameters (customized logic)

KP	0 or 1	comments		KP	0 or 1	comments	
KP1			☐	KP33			☐
KP2			☐	KP34			☐
KP3			☐	KP35			☐
KP4			☐	KP36			☐
KP5			☐	KP37			☐
KP6			☐	KP38			☐
KP7			☐	KP39			☐
KP8			☐	KP40			☐
KP9			☐	KP41			☐
KP10			☐	KP42			☐
KP11			☐	KP43			☐
KP12			☐	KP44			☐
KP13			☐	KP45			☐
KP14			☐	KP46			☐
KP15			☐	KP47			☐
KP16			☐	**KP**	**0 or 1 impulse**		
KP17			☐	KP48			☐
KP18			☐	KP49			☐
KP19			☐	KP50			☐
KP20			☐	KP51			☐
KP21			☐	KP52			☐
KP22			☐	KP53			☐
KP23			☐	KP54			☐
KP24			☐	KP55			☐
KP25			☐	KP56			☐
KP26			☐	KP57			☐
KP27			☐	KP58			☐
KP28			☐	KP59			☐
KP29			☐	KP60			☐
KP30			☐	KP61			☐
KP31			☐	KP62			☐
KP32			☐	KP63			☐
				KP64			☐

Program logic parameters (customized logic)

time delay (value)		comments		time delay (value)		comments	
T1	s		☐	T31	s		☐
T2	s		☐	T32	s		☐
T3	s		☐	T33	s		☐
T4	s		☐	T34	s		☐
T5	s		☐	T35	s		☐
T6	s		☐	T36	s		☐
T7	s		☐	T37	s		☐
T8	s		☐	T38	s		☐
T9	s		☐	T39	s		☐
T10	s		☐	T40	s		☐
T11	s		☐	T41	s		☐
T12	s		☐	T42	s		☐
T13	s		☐	T43	s		☐
T14	s		☐	T44	s		☐
T15	s		☐	T45	s		☐
T16	s		☐	T46	s		☐
T17	s		☐	T47	s		☐
T18	s		☐	T48	s		☐
T19	s		☐	T49	s		☐
T20	s		☐	T50	s		☐
T21	s		☐	T51	s		☐
T22	s		☐	T52	s		☐
T23	s		☐	T53	s		☐
T24	s		☐	T54	s		☐
T25	s		☐	T55	s		☐
T26	s		☐	T56	s		☐
T27	s		☐	T57	s		☐
T28	s		☐	T58	s		☐
T29	s		☐	T59	s		☐
T30	s		☐	T60	s		☐

☐ tick off the box when the setting is done

SETTING RECORD SHEET	Sepam 2000 Substation
Project:	Type of Sepam 2000 S_ _ _
Switchboard:	
Panel:	serial number _ _ _ _ _ _ _
....	

Status menu parameters

menu	name	function		
frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz	☐
phase CT ratio			board 2 (ECM or ECA)	
	In	CT rating or CSP (in Amps)	_ _ _ _ ☐ A ☐ kA	☐
	Ib	basis current (in Amps)	_ _ _ _ ☐ A ☐ kA	☐
	number	number of current sensors	☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM or ECA)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or Sum2 3I for CSP	☐
			☐ 2 A core bal. CT ☐ 30 A core bal. CT	☐
			☐ CT + CSH 30 for S26, S36	☐
			_ _ _ _ ☐ A ☐ kA	
			☐ _ _ _ _ ☐ A ☐ kA for S25, S35	☐
			☐ core bal. CT + ACE 990 _ _ _ _ ☐ A ☐ kA	☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn	☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35	☐
	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	☐ Sum 3V ☐ Uns/$\sqrt{3}$ ☐ Uns/3	☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables	☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	_ _ periods	☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400	☐
	address	Sepam station number in network	_ _ _ _	☐
	parity	transmission format	☐ even ☐ odd ☐ no parity	☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21	☐
		events N.B. For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 _ _ _ _ _ _ _ _ KTS9 to 16 _ _ _ _ _ _ _ _ KTS17 to 24 _ _ _ _ _ _ _ _ KTS25 to 32 _ _ _ _ _ _ _ _ KTS33 to 40 _ _ _ _ _ _ _ _ KTS41 to 48 _ _ _ _ _ _ _ _ KTS49 to 56 _ _ _ _ _ _ _ _ KTS57 to 64 _ _ _ _ _ _ _ _ I1 I2 _ _ I11 to I18 _ _ _ _ _ _ _ _ I21 to I28 _ _ _ _ _ _ _ _ I31 to I38 _ _ _ _ _ _ _ _	

Status menu parameters (cont'd)

menu	name	function				
Microswitch settings		voltage board	SW1			☐
		current board	board 2		board 3	
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)	
			SW2	SW2	SW2	☐
			SW1	SW1	SW1	☐

put an X in the box to indicate switch setting
e.g. switch set to right

☐ X

Sepam 2000 substation program logic parameters

KP	0 or 1			KP	0 or 1		
KP1	⌴	open/close control	☐	KP16	⌴	input I12 BI receipt and inhibit recloser / inhibit recloser	☐
KP2	⌴	open/close control	☐	KP17	⌴	display of programmed program logic	☐
KP4	⌴	external protection NO/NC	☐	KP18	⌴	BI pilot wire test	☐
KP6	⌴	recloser enabled/disabled	☐	KP19	⌴	reset operation counter	☐
KP7	⌴	reclosing cycle 1 inactive / active	☐	KP20	⌴	reset phase fault tripping counter	☐
KP8	⌴	reclosing cycle 2 inactive / active	☐	KP22	⌴	reset specific recloser counters	☐
KP9	⌴	reclosing cycle 3 inactive / active	☐	KP36	⌴	reverse P with annunciation / tripping	☐
KP10	⌴	reclosing cycle 1 inactive / active	☐	KP38	⌴	remote setting active / inactive	☐
KP11	⌴	cycle 1 tripping time-delayed / instantaneous	☐	**KP**	**0 or 1 impulse**		
KP12	⌴	cycle 2 tripping time-delayed / instantaneous	☐	KP50	⎍	inhibition of disturbance recording records	☐
KP13	⌴	cycle 3 tripping time-delayed / instantaneous	☐	KP51	⎍	automatic triggering of disturbance recording	☐
KP14	⌴	cycle 4 tripping time-delayed / instantaneous	☐	KP52	⎍	manual triggering of disturbance recording	☐
KP15	⌴	definitive tripping time-delayed / instantaneous	☐				

time delay (value)					time delay (value)				
T1	⌴⌴⌴	s	recovery of open/closed data upon change in device position	☐	T10	⌴⌴⌴	s	confirmation waiting time after successful reclosing	☐
T2	⌴⌴⌴	s	duration of closing order	☐	T11	⌴⌴⌴	s	duration of cycle 1 isolation	☐
T3	⌴⌴⌴	s	inhibition of transmit blocking input after tripping	☐	T12	⌴⌴⌴	s	duration of cycle 2 isolation	☐
T5	⌴⌴⌴	s	duration of remote control tripping impulse	☐	T13	⌴⌴⌴	s	duration of cycle 3 isolation	☐
T6	⌴⌴⌴	s	duration of remote control closing impulse	☐	T14	⌴⌴⌴	s	duration of cycle 4 isolation	☐
					T15	⌴⌴⌴	s	duration of recloser inhibition with manual circuit breaker closing	☐
					T16	⌴⌴⌴	s	confirmation of pressure switch fault	☐
					T25	⌴⌴⌴	s	tripping pulse	☐
					T26	⌴⌴⌴	s	closing pulse	☐

Sepam 2000 Substation

function	identification	setting							
overcurrent		curve		Is		T			
	F011		☐		☐		☐		
	F012		☐		☐		☐		
	F013		☐		☐		☐		
	F014		☐		☐		☐		
earth fault		curve		Iso		T			
	F081		☐		☐		☐		
	F082		☐		☐		☐		
	F083		☐		☐		☐		
	F084		☐		☐		☐		
undervoltage		Us		T					
	F321-341-361		☐		☐				
remanent undervoltage		Us		T					
	F351		☐		☐				
overvoltage		Us		T					
	F301		☐		☐				
	F302		☐		☐				
directional overcurrent		curve		θ		Is		T	
	F511-F521		☐		☐		☐		☐
directional earth fault		angle		Iso		T			
	F501		☐		☐		☐		
reverse power		Ps		T					
	F531		☐		☐				
underfrequency		Fs		T					
	F561		☐		☐				
	F562		☐		☐				
overfrequency		Fs		T					
	F571		☐		☐				
	F572		☐		☐				
rate of change of frequency		dFs/dt		T					
	F581								
	F582								

☐ tick off the box when the setting is done

Settings made on: ___ / ___ / ___ **by:** ______	**Signature**	**Signature**

Comments: ______

SETTING RECORD SHEET	Sepam 2000 Busbars
Project: .... Switchboard: .... Panel:	Type of Sepam 2000 B___ serial number _______

Status menu parameters

menu	name	function		
rated frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz	☐
phase CT ration			board 2 (ECM or ECA)	
	In	CT rating or CSP (in Amps)	____ ☐ A ☐ kA	☐
	Ib	basis current (in Amps)	____ ☐ A ☐ kA	☐
	number	number of current sensors	☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM or ECA)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or Sum2 3I for CSP ☐ 2 A core bal. CT ☐ 30 A core bal. CT ☐ CT + CSH 30 for S26, S36 ____ ☐ A ☐ kA ☐ ____ ☐ A ☐ kA for S25, S35 ☐ core bal. CT + ACE 990 ____ ☐ A ☐ kA	☐ ☐ ☐ ☐ ☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn	☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35	☐
	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	☐ Sum 3V ☐ Uns/√3 ☐ Uns/3	☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables	☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	__ periods	☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400	☐
	address	Sepam station number in network	___	☐
	parity	transmission format	☐ even ☐ odd ☐ no parity	☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21	☐
		events N.B.: For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 ________ KTS9 to 16 ________ KTS17 to 24 ________ KTS25 to 32 ________ KTS33 to 40 ________ KTS41 to 48 ________ KTS49 to 56 ________ KTS57 to 64 ________ I1 I2 __ I11 to I18 ________ I21 to I28 ________ I31 to I38 ________	

Status menu parameters (cont'd)

menu	name	function	3U +Vo 1		3U + Vo 2	
Microswitch settings		voltage board	SW1		SW1	☐
		current board	board 2		board 3	
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)	
			SW2	SW2	SW2	☐
			SW1	SW1	SW1	☐

put an X in the box
to indicate switch
setting
e.g. switch set to right

☐ X

Sepam 2000 substation program logic parameters

KP	0 or 1	
KP1	open/close control	☐
KP2	open/close control	☐
KP4	external protection NO/NC	☐
KP17	display of programmed program logic	☐
KP18	BI pilot wire test	☐
KP19	reset operation counter	☐
KP20	reset phase fault tripping counter	☐

KP	0 or 1	
KP33	choice of type of load shedding	☐
KP35	acknowledgment of operating mode with voltage absent for synchro-check	☐
KP38	remote setting active / inactive	☐

KP	0 or 1 impulse	
KP50	inhibition of disturbance recording records	☐
KP51	automatic triggering of disturbance recording	☐
KP52	manual triggering of disturbance recording	☐

time delay (value)			
T1	s	recovery of open/closed data upon change in device position	☐
T2	s	duration of closing order	☐
T3	s	inhibition of transmit blocking input after tripping	☐
T5	s	duration of remote control tripping impulse	☐
T6	s	duration of remote control closing impulse	☐

time delay (value)			
T7		extension of dF/dT = 1 (KP33=1)	☐
T16		confirmation of pressure switch fault	☐
T8	s	maintain output O33 for synchro-check	☐
T10	s	maintain closing request for synchro-check	☐
T24		duration of load shedding pulse (O31)	☐
T25		duration of load shedding pulse (O32)	☐
T26		duration of load shedding pulse (O33)	☐
T27		duration of load shedding pulse (O34)	☐

Sepam 2000 Busbars

function	identification	setting					
overcurrent		curve		Is		T	
	F011		☐		☐		☐
	F012		☐		☐		☐
	F013		☐		☐		☐
	F014		☐		☐		☐
earth fault		curve		Iso		T	
	F081		☐		☐		☐
	F082		☐		☐		☐
	F083		☐		☐		☐
	F084		☐		☐		☐
undervoltage		Us		T			
	F321-341-361		☐		☐		
	F322-342-362		☐		☐		
	F241-331-371		☐		☐		
	F242-332-372		☐		☐		
positive sequence		Vsd		T			
undervoltage	F381		☐		☐		
	F382		☐		☐		
remanent undervoltage		Us		T			
	F351		☐		☐		
	F251		☐		☐		
overvoltage		Us		T			
	F301		☐		☐		
	F302		☐		☐		
	F311		☐		☐		
	F312		☐		☐		
neutral voltage		Vso		T			
displacement	F391		☐		☐		
underfrequency		Fs		T			
	F561		☐		☐		
	F562		☐		☐		
	F563		☐		☐		
	F564		☐		☐		
overfrequency		Fs		T			
	F571		☐		☐		
	F572		☐		☐		
rate of change		dFs/dt		T			
of frequency	F581		☐		☐		
	F582		☐		☐		

function	identification	dUs		dFs		dφs		Us high		Us low
synchro-check	F181		☐		☐		☐		☐	
		mode		Ta						
			☐		☐					

☐ tick off the box when the setting is done

Settings made on: __ __ __ **by:** ________	**Signature**	**Signature**

Comments: ________

SETTING RECORD SHEET	Sepam 2000 Transformer
Project: .... Switchboard: .... Panel:	Type of Sepam 2000 T___ serial number _______

Status menu parameters

menu	name	function			
rated frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz		☐
phase CT ratio			board 2 (ECM 1 or ECA)	board 3 (ECM 2)	
	In	CT rating or CSP (in Amps)	____ ☐ A ☐ kA	____ ☐ A ☐ kA	☐
	Ib	basis current (in Amps)	____ ☐ A ☐ kA	____ ☐ A ☐ kA	☐
	number	number of current sensors	☐ I1-I3 ☐ I1-I2-I3	☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM 1 or ECA)	board 3 (ECM 2)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or sum2 3I for CSP ☐ 2 A core bal. CT ☐ 30 A core bal. CT ☐ CT + CSH 30 for S26, S36 ____ ☐ A ☐ kA ☐ ____ ☐ A ☐ kA for S25, S35 ☐ core bal. CT + ACE 990 ____ ☐ A ☐ kA		☐ ☐ ☐ ☐ ☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn		☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35		☐
	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	☐ Sum 3V ☐ Uns/√3 ☐ Uns/3		☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables		☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	__ periods		☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400		☐
	address	Sepam station number in network	____		☐
	parity	transmission format	☐ even ☐ odd ☐ no parity		☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21		☐
		events N.B.: For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 ________ KTS9 to 16 ________ KTS17 to 24 ________ KTS25 to 32 ________ KTS33 to 40 ________ KTS41 to 48 ________ KTS49 to 56 ________ KTS57 to 64 ________ I1 I2 __ I11 to I18 ________ I21 to I28 ________ I31 to I38 ________		

Status menu parameters (cont'd)

menu	name	function			
Microswitch settings		voltage board	SW1		
		current board	board 2		board 3
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)
			SW2	SW2	SW2
			SW1	SW1	SW1

put an X in the box to indicate switch setting
e.g. switch set to right

☐ X

Sepam 2000 transformer program logic parameters

KP	0 or 1	
KP1		open/close control
KP2		open/close control
KP4		external protection NO/NC
KP5		Buchholz / thermostat / DGPT NO/NC
KP6		tripping / alarm input I23
KP7		tank earth leakage choice
KP17		display of programmed control scheme

KP	0 or 1	
KP18		BI pilot wire test
KP19		reset operation counter
KP20		reset phase fault tripping counter
KP38		remote setting active / inactive

KP	0 or 1 impulse	
KP50		inhibition of disturbance recording records
KP51		automatic triggering of disturbance recording
KP52		manual triggering of disturbance recording

time delay (value)			
T1		s	recovery of open/closed data upon change in device position
T2		s	duration of closing order
T3		s	inhibition of transmit blocking input after tripping

time delay (value)			
T5		s	duration of remote control tripping impulse
T6		s	duration of remote control closing impulse
T16		s	confirmation of pressure switch fault

Sepam 2000 Transformer					
function	**identification**	**setting**			
thermal overload		Adjust.	T1 and T2	OL1 alarm	OL2 trip
	F431	0	☐	☐	☐
overcurrent		curve	Is	T	
	F011	☐	☐	☐	
	F012	☐	☐	☐	
	F013	☐	☐	☐	
	F014	☐	☐	☐	
earth fault		curve	Iso	T	
	F081	☐	☐	☐	
	F082	☐	☐	☐	
	F083	☐	☐	☐	
	F084	☐	☐	☐	
neutral voltage displacement		Vso	T		
	F391	☐	☐		
directional overcurrent		curve	θ	Is	T
	F521	☐	☐	☐	☐
directional earth fault		angle	Iso	T	
	F501	☐	☐	☐	
tank frame leakage		curve	Is	T	
	F021	☐	☐	☐	
neutral		curve	Iso	T	
	F091	☐	☐	☐	
	F092	☐	☐	☐	
undervoltage		Us	T		
	F321-341-361	☐	☐		
remanent undervoltage		Us	T		
	F351	☐	☐		
overvoltage		Us	T		
	F301	☐	☐		
	F302	☐	☐		
RTD		Ts1	Ts2		
	F461	☐	☐		
	F462	☐	☐		
	F463	☐	☐		
	F464	☐	☐		
	F465	☐	☐		
	F466	☐	☐		
restricted earth fault		Is			
	F651	☐			

☐ tick off the box when the setting is done

Settings made on: __/__/__ **by:** __________	**Signature**	**Signature**

Comments: __________

SETTING RECORD SHEET

Project: ....
Switchboard: ....
Panel: ....
....

Sepam 2000 Motor

Type of Sepam 2000 M

serial number

Status menu parameters

menu	name	function		
rated frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz	☐
phase CT ratio			board 2 (ECM 1 or ECA) / board 3 (ECM 2)	
	In	CT rating or CSP (in Amps)	☐ A ☐ kA / ☐ A ☐ kA	☐
	Ib	basis current (in Amps)	☐ A ☐ kA / ☐ A ☐ kA	☐
	number	number of current sensors	☐ I1-I3 ☐ I1-I2-I3 / ☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM 1 or ECA) / board 3 (ECM 2)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or sum2 3I for CSP ☐ 2 A core bal. CT ☐ 30 A core bal. CT ☐ CT + CSH 30 for S26, S36 ☐ A ☐ kA ☐ ☐ A ☐ kA for S25, S35 ☐ core bal. CT + ACE 990 ☐ A ☐ kA	☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn	☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35	☐
	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	☐ Sum 3V ☐ Uns/√3 ☐ Uns/3	☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables	☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	periods	☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400	☐
	address	Sepam station number in network		☐
	parity	transmission format	☐ even ☐ odd ☐ no parity	☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21	☐
		events N.B.: For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 KTS9 to 16 KTS17 to 24 KTS25 to 32 KTS33 to 40 KTS41 to 48 KTS49 to 56 KTS57 to 64 I1 I2 I11 to I18 I21 to I28 I31 to I38	

Status menu parameters (cont'd)

menu	name	function				
Microswitch settings		voltage board	SW1			☐
		current board	board 2		board 3	
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)	
			SW2	SW2	SW2	☐
			SW1	SW1	not used SW1	☐

put an X in the box to indicate switch setting
e.g. switch set to right ☐ X

Sepam 2000 motor program logic parameters

KP1	open/close control		☐
KP2	open/close control		☐
KP3	open/close control		☐
KP4	external protection NO/NC		☐
KP17	display of programmed control scheme		☐
KP18	BI pilot wire test		☐
KP19	reset operation counter		☐
KP20	reset phase fault tripping counter		☐
KP21	reset to zero of running hours counter		☐
KP38	remote setting active / inactive		☐

KP	**0 or 1 impulse**	
KP50	storage of disturbance recording records	☐
KP51	automatic triggering of disturbance recording	☐
KP52	manual triggering of disturbance recording	☐

time delay (value)			
T1	s	recovery of open/closed data upon change in device position	☐
T2	s	duration of closing order	☐
T3	s	inhibition of transmit blocking input after tripping	☐
T4	s	external load shedding order	☐
T5	s	duration of tripping pulse from a remote control order	☐

time delay (value)			
T6	s	duration of remote control closing impulse	☐
T8	s	maximum duration of voltage sag enabling restart	☐
T9	s	restart staggering	☐
T16	s	confirmation of pressure switch fault	☐

Sepam 2000 Moteur

function	identification	setting				
thermal overload		Adjust.	T1	T2	OL1 warm state	OL2 trip
	F431	☐	☐	☐	☐	☐
overcurrent		curve	Is	T		
	F011	☐	☐	☐		
	F012	☐	☐	☐		
earth fault		curve	Iso	T		
	F081	☐	☐	☐		
	F082	☐	☐	☐		
negative sequence /		curve	Is	T		
unbalance	F451	☐	☐	☐		
locked rotor /		Is	ST	LT		
excessive starting time	F441	☐	☐	☐		
undercurrent		Is	T			
	F221	☐	☐			
number of starts		n° start per hour	n° cold start	n° hot start	T	
	F421	☐	☐	☐	☐	
positive sequence		Vsd	T			
undervoltage	F381	☐	☐			
	F382	☐	☐			
directional earth fault		angle	Iso	T		
	F501	☐	☐	☐		
reverse power		Ps	T			
	F531	☐	☐			
reactive overpower		Qs	T			
	F541	☐	☐			
RTD		Ts1	Ts2			
	F461	☐	☐			
	F462	☐	☐			
	F463	☐	☐			
	F464	☐	☐			
	F465	☐	☐			
	F466	☐	☐			
	F471	☐	☐			
	F472	☐	☐			
	F473	☐	☐			
	F474	☐	☐			
	F475	☐	☐			
	F476	☐	☐			
motor differential		Is				
	F621	☐				

☐ tick off the box when the setting is done

Settings made on: ___ by: ___	Signature	Signature

Comments: ___

SETTING RECORD SHEET	Sepam 2000 Capacitor
Project: .... Switchboard: .... Panel:	Type of Sepam 2000 C serial number

Status menu parameters

menu	name	function			
rated frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz		☐
phase CT ratio			board 2 (ECM 1 or ECA)	board 3 (ECM 2)	
	In	CT rating or CSP (in Amps)	☐ A ☐ kA	☐ A ☐ kA	☐
	Ib	basis current (in Amps)	☐ A ☐ kA	☐ A ☐ kA	☐
	number	number of current sensors	☐ I1-I3 ☐ I1-I2-I3	☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM 1 or ECA)	carte 3 (ECM 2)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or sum2 3I for CSP ☐ 2 A core bal. CT ☐ 30 A core bal. CT ☐ CT + CSH 30 for S26, S36 ☐ A ☐ KA ☐ ☐ A ☐ KA for S25, S35 ☐ core bal. CT + ACE 990 ☐ A ☐ kA		☐ ☐ ☐ ☐ ☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn		☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35		☐
	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	☐ Sum 3V ☐ Uns/$\sqrt{3}$ ☐ Uns/3		☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables		☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	periods		☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400		☐
	address	Sepam station number in network			☐
	parity	transmission format	☐ even ☐ odd ☐ no parity		☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21		☐
		events N.B.: For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 KTS9 to 16 KTS17 to 24 KTS25 to 32 KTS33 to 40 KTS41 to 48 KTS49 to 56 KTS57 to 64 I1 I2 I11 to I18 I21 to I28 I31 to I38		

Status menu parameters (cont'd)

menu	name	function				
Microswitch settings		voltage board	SW1			☐
		current board	board 2		board 3	
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)	
			SW2	SW2	SW2	☐
			SW1	SW1	SW1	☐

put an X in the box to indicate switch setting
e.g. switch set to right

☐ X

Sepam 2000 capacitor program logic parameters

KP	0 or 1			KP	0 or 1 impulse	
KP1	open / close control	☐		KP50	inhibition of disturbance recording records	☐
KP2	open/close control	☐		KP51	automatic triggering of disturbance recording	☐
KP4	external protection NO/NC	☐		KP52	manual triggering of disturbance recording	☐
KP17	display programmed control scheme	☐		KP54	capacitor 1 switch closing	☐
KP18	BI pilot wire test	☐		KP55	capacitor 1 switch opening	☐
KP19	reset operation counter	☐		KP56	capacitor 2 switch closing	☐
KP20	reset phase fault tripping counter	☐		KP57	capacitor 2 switch opening	☐
KP21	running hours counter reset	☐		KP58	capacitor 3 switch closing	☐
KP36	choice of number of capacitors	☐		KP59	capacitor 3 switch opening	☐
KP37	choice of number of capacitors	☐		KP60	manual capacitor control	☐
KP38	remote setting enable / disable	☐		KP61	automatic capacitor control	☐

Status menu parameters (cont'd)

Sepam 2000 capacitor program logic parameters

time delay (value)					time delay (value)				
T1		s	recovery of open/closed data upon change in device position	☐	T26		s	duration of capacitor 2 tripping pulse	☐
T2		s	duration of closing order	☐	T27		s	duration of capacitor 3 tripping pulse	☐
T3		s	inhibition of transmit blocking input after tripping	☐	T28		s	duration of capacitor 1 closing pulse	☐
T5		s	duration of remote control tripping impulse	☐	T29		s	duration of capacitor 2 closing pulse	☐
T6		s	duration of remote control closing impulse	☐	T30		s	duration of capacitor 3 closing pulse	☐
T7		s	duration reclosing inhibition after tripping	☐	T31		s	after tripping, duration of inhibition of capacitor 1 closing	☐
T21		s	capacitor 1 opening time delay	☐	T32		s	after tripping, duration of inhibition of capacitor 2 closing	☐
T22		s	capacitor 2 opening time delay	☐	T33		s	after tripping, duration of inhibition of capacitor 3 closing	☐
T23		s	capacitor 3 opening time delay	☐	T34		s	time delay for recovery of capacitor 1 switch open/closed information	☐
T24		s	circuit breaker opening time delay	☐	T35		s	time delay for recovery of capacitor 2 switch open/closed information	☐
T25		s	duration of capacitor 1 tripping pulse	☐	T36		s	time delay for recovery of capacitor 3 switch open/closed information	☐

Sepam 2000 Capacitor

function	identification	setting				
thermal overload		Adjust.	T1	T2	OL1 hot status	OL2 tripping
	F431	☐	☐	☐	☐	☐
overcurrent		curve	Is	T		
	F011	☐	☐	☐		
	F012	☐	☐	☐		
earth fault		curve	Iso	T		
	F081	☐	☐	☐		
	F082	☐	☐	☐		
neutral unbalance		curve	Iso	T		
1 capacitor	F091	☐	☐	☐		
	F092	☐	☐	☐		
neutral unbalance		Is	T			
3 capacitor	F111	☐	☐			
	F112	☐	☐			
	F121	☐	☐			
	F122	☐	☐			
	F131	☐	☐			
	F132	☐	☐			
undervoltage		Us	T			
	F321-341-361	☐	☐			
overvoltage		Us	T			
	F281	☐	☐			
	F282	☐	☐			
	F301	☐	☐			
	F302	☐	☐			

☐ tick off the box when the setting is done

Settings made on:	Signature	Signature
by:		

Comments:

SETTING RECORD SHEET	Sepam 2000 Generator
Project: ... Switchboard: ... Panel:	Type of Sepam 2000 G serial number

Status menu parameters

menu	name	function		
rated frequency	Fn	network frequency	☐ 50 Hz ☐ 60 Hz	☐
phase CT ratio			board 2 (ECM 1 or ECA) / board 3 (ECM 2)	
	In	CT rating or CSP (in Amps)	board 2: ☐ A ☐ kA / board 3: ☐ A ☐ kA	☐
	Ib	basis current (in Amps)	board 2: ☐ A ☐ kA / board 3: ☐ A ☐ kA	☐
	number	number of current sensors	board 2: ☐ I1-I3 ☐ I1-I2-I3 / board 3: ☐ I1-I3 ☐ I1-I2-I3	☐
Io sensor			board 2 (ECM 1 or ECA) board 3 (ECM 2)	
	Ino	residual current measurement	☐ Sum 3I for CT ☐ Sum1 3I or sum2 3I for CSP	☐
			☐ 2 A core bal. CT ☐ 30 A core bal. CT	☐
			☐ CT + CSH 30 for S26, S36	☐
			☐ A ☐ kA	
			☐ ☐ A ☐ kA for S25, S35	☐
			☐ core bal. CT + ACE 990 ☐ A ☐ kA	☐
max. demand interval	interval	max. demand integration time	☐ 5 mn ☐ 10 mn ☐ 15 mn ☐ 30 mn ☐ 60 mn	☐
VT ratio	number	number of wired VTs	☐ V ☐ 1U ☐ 3U S26, S36 ☐ U21 ☐ U21-U32 ☐ 3U S25, S35	☐
	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	☐ Sum 3V ☐ Uns/$\sqrt{3}$ ☐ Uns/3	☐
power flow direction	incomer feeder	reverses the signs of power and energy measurements	☐ Incomer = cables to busbars ☐ Feeder = busbars to cables	☐
disturbance recording	pretrig	number of periods before triggering event of the disturbance recording	periods	☐
communi-cation	bauds	transmission speed	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400	☐
	address	Sepam station number in network		☐
	parity	transmission format	☐ even ☐ odd ☐ no parity	☐
time tagging	synchro	type of synchronization used	☐ via network ☐ via input I11 ☐ via input I21	☐
		events N.B.: For each event, choose 0 or 1 0 = not time-tagged 1 = time-tagged all events are set to 0 by default KTS33 to 64 for S26, S36 only	KTS1 to 8 KTS9 to 16 KTS17 to 24 KTS25 to 32 KTS33 to 40 KTS41 to 48 KTS49 to 56 KTS57 to 64 I1 I2 I11 to I18 I21 to I28 I31 to I38	

Status menu parameters (cont'd)

menu	name	function				
Microswitch settings		voltage board	SW1			☐
		current board	board 2		board 3	
			CT (ECM 1)	CSP (ECA)	CT (ECM 2)	
			SW2	SW2	SW2	☐
			SW1	SW1	SW1	☐

put an X in the box to indicate switch setting
e.g. switch set to right ☐ X

Sepam 2000 generator program logic parameters

KP	0 or 1		
KP1		open/close control	☐
KP2		open/close control	☐
KP4		external protection NO/NC	☐
KP5		undervoltage tripping, setting 1	☐
KP6		undervoltage tripping, setting 2	☐
KP7		undervoltage tripping, setting 1	☐
KP8		undervoltage tripping, setting 2	☐
KP9		neutral voltage displacement tripping	☐
KP10		underfrequency tripping	☐
KP11		overfrequency tripping	☐
KP12		generator shutdown by reverse power active	☐
KP13		lockout by undervoltage setting 1	☐
KP14		lockout by undervoltage setting 2	☐
KP15		lockout by undervoltage setting 1	☐

KP	0 or 1		
KP16		lockout by undervoltage setting 2	☐
KP17		display of programmed program logic	☐
KP18		BI pilot wire test	☐
KP19		reset operation counter	☐
KP20		reset phase fault tripping counter	☐
KP21		reset to zero of running hours counter	☐
KP33		for G01, G02, G12 used with G00, deactivation of reverse power P and Q for G00, assignment of outputs O21 to O24	☐
KP34		closing without synchro-check for G00, use of I18	☐
KP35		for G03, G04: acknowledgment of operating mode with voltage absent	☐
KP38		remote setting active / inactive	☐

KP	0 or 1 impulse		
KP50		inhibition of disturbance recording records	☐
KP51		automatic triggering of disturbance recording	☐
KP52		manual triggering of disturbance recording	☐

time delay (value)				
T1		s	recovery of open/closed data upon change in device position	☐
T2		s	duration of closing order	☐
T3		s	inhibition of transmit blocking input after tripping	☐

time delay (value)				
T5		s	duration of remote control tripping impulse	☐
T6		s	duration of remote control closing impulse	☐
T10		s	maintaining of closing request with synchro-check	☐
T16		s	confirmation of pressure switch fault	☐

Sepam 2000 Generator

function	identification	setting				
overcurrent		curve	Is	T		
	F011	☐	☐	☐		
	F012	☐	☐	☐		
	F013	☐	☐	☐		
	F014	☐	☐	☐		
	F021	☐	☐	☐		
	F022	☐	☐	☐		
thermal overload		Adjust.	T1	T2	OL1 alarm	OL2 trip.
	F431	☐	☐	☐	☐	☐
voltage restrained		curve	Is	T		
overcurrent	F191	☐	☐	☐		
negative sequence /		curve	Is	T		
unbalance	F451	☐	☐	☐		
earth fault		curve	Iso	T	R and H2	
	F061	☐	☐	☐		
	F062	☐	☐	☐		
	F063	☐	☐	☐		
	F064	☐	☐	☐		
	F071	☐	☐	☐		
	F072	☐	☐	☐		
	F091	☐	☐	☐	☐	
	F092	☐	☐	☐	☐	
undercurrent		Us	T			
	F321-341-361	☐	☐			
	F322-342-362	☐	☐			
overcurrent		Us	T			
	F301	☐	☐			
	F302	☐	☐			
positive sequence		Vso	T			
undervoltage	F391	☐	☐			
underfrequency		Fs	T			
	F561	☐	☐			
overfrequency		Fs	T			
	F571	☐	☐			
directional overcurrent		curve	angle	Is	T	
	F511-F521	☐	☐	☐	☐	
directional earth fault		θo	Iso	T		
	F501	☐	☐	☐		
reverse power		Ps	T			
	F531	☐	☐			
reactive overpower		Qs	T			
	F541	☐	☐			
RTD		Ts1	Ts2			
	F461	☐	☐			
	F462	☐	☐			
	F463	☐	☐			
	F464	☐	☐			
	F465	☐	☐			
	F466	☐	☐			

☐ tick off the box when the setting is done

Sepam 2000 Generator (cont'd)

function	identification	setting		
RTD (cont'd)		Ts1		Ts2
	F471	☐	☐	☐
	F472	☐	☐	☐
	F473	☐	☐	☐
	F474	☐	☐	☐
	F475	☐	☐	☐
	F476	☐	☐	☐
synchro-check	F181	dUs	dFs	dφs
		☐	☐	☐
		Us high	Us low	mode
		☐	☐	☐
		Ta		
		☐		
restricted earth fault		Iso		
	F641	☐		
	F651	☐		
generator differential		Is		
	F621	☐		

☐ tick off the box when the setting is done

Settings made on: __/__/__ by:	Signature	Signature

Comments:

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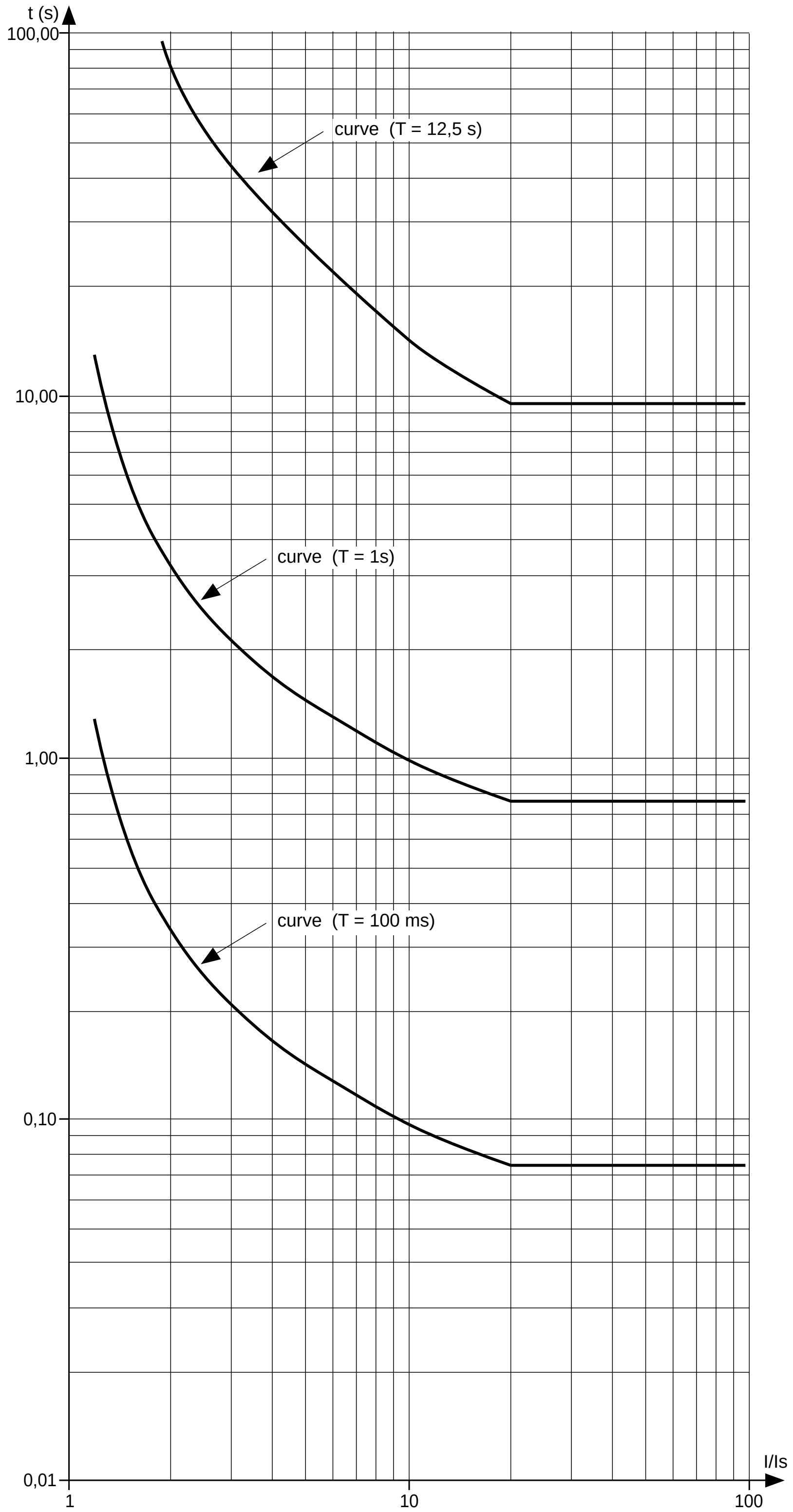
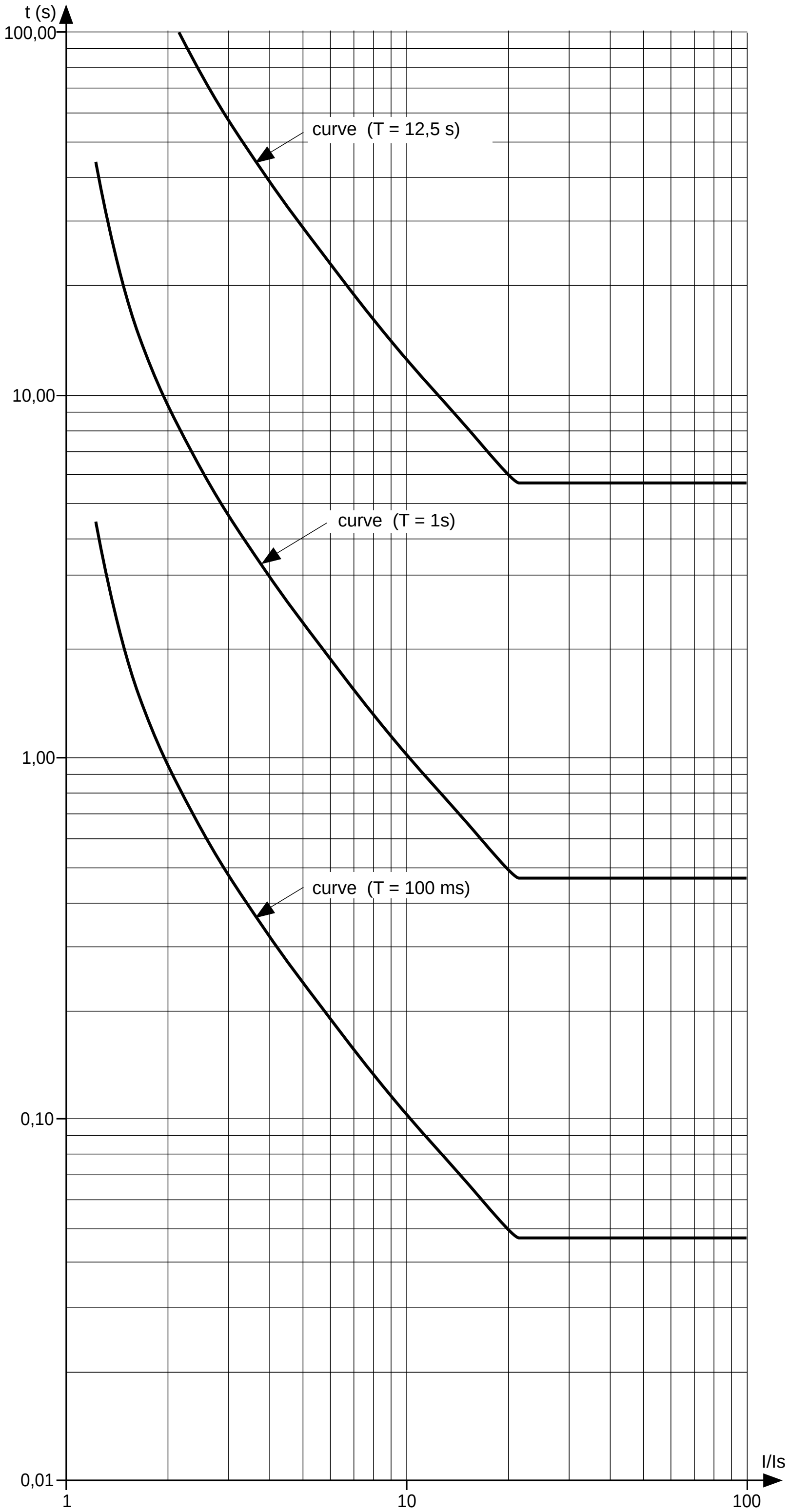
negative sequence/unbalance protection curve	**4**/6

IDMT protection curves

Standard inverse time SIT curve

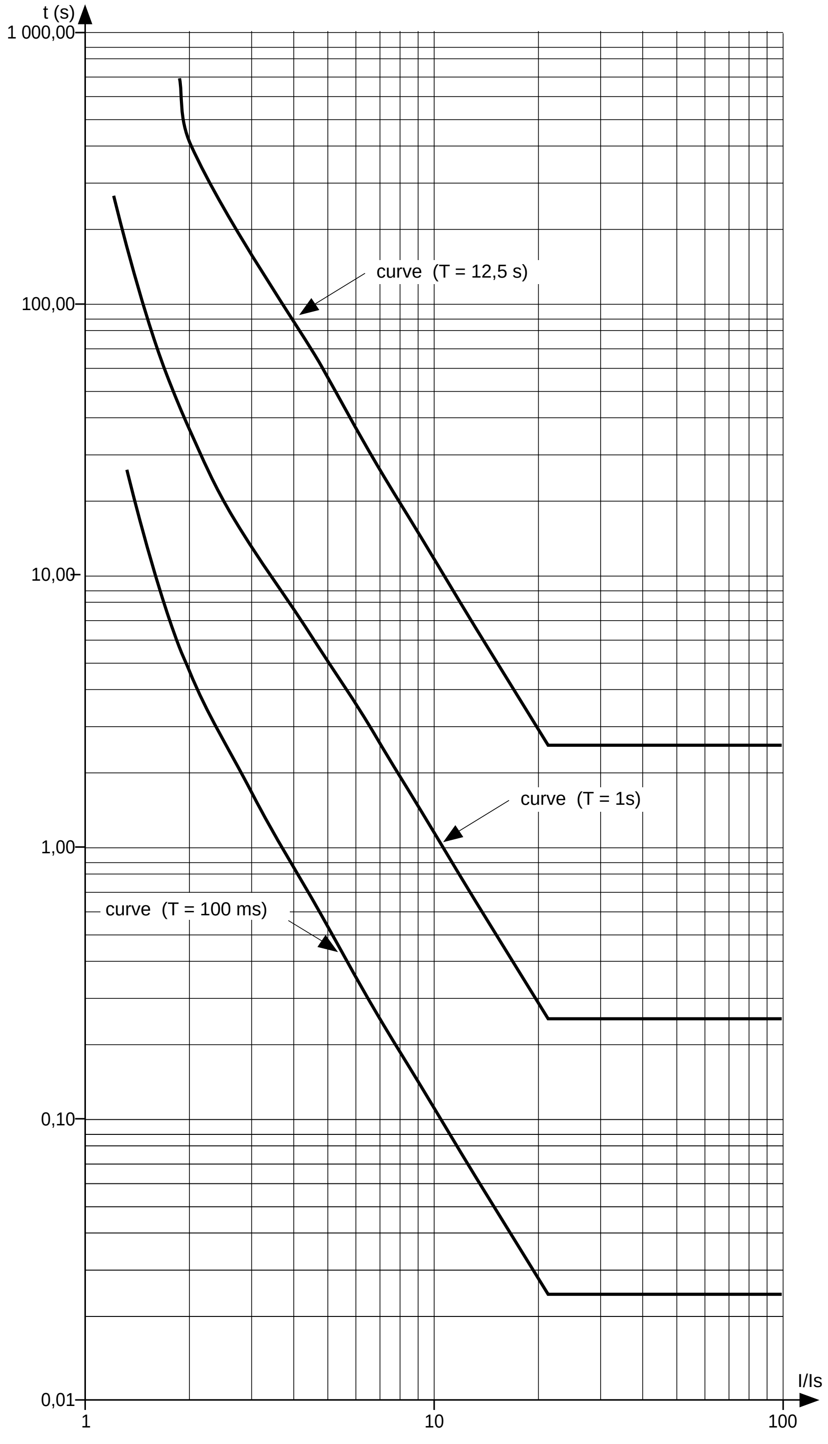


Very inverse time VIT or LTI curve

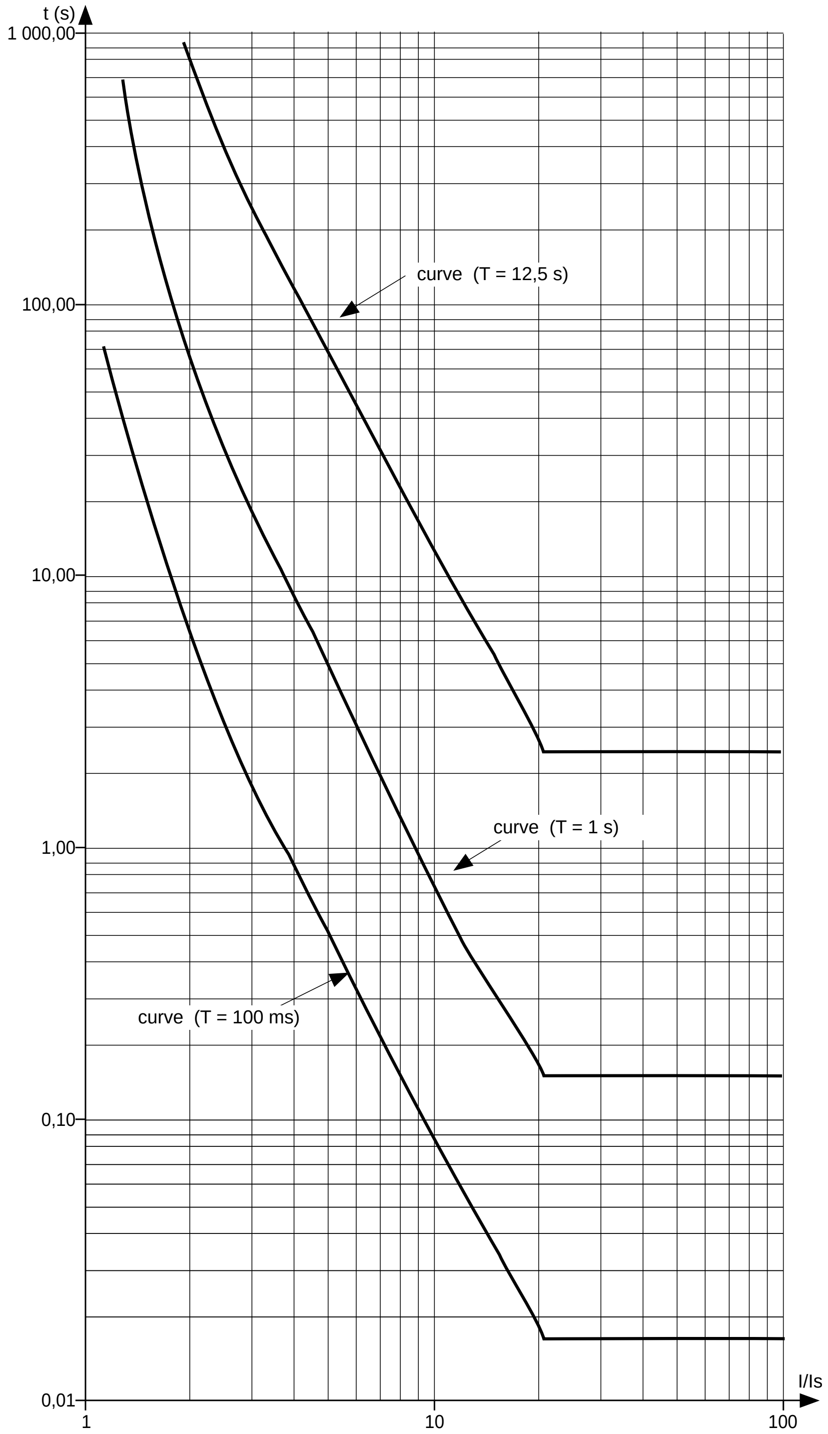


IDMT protection curves (cont'd)

Extremely inverse time EIT curve

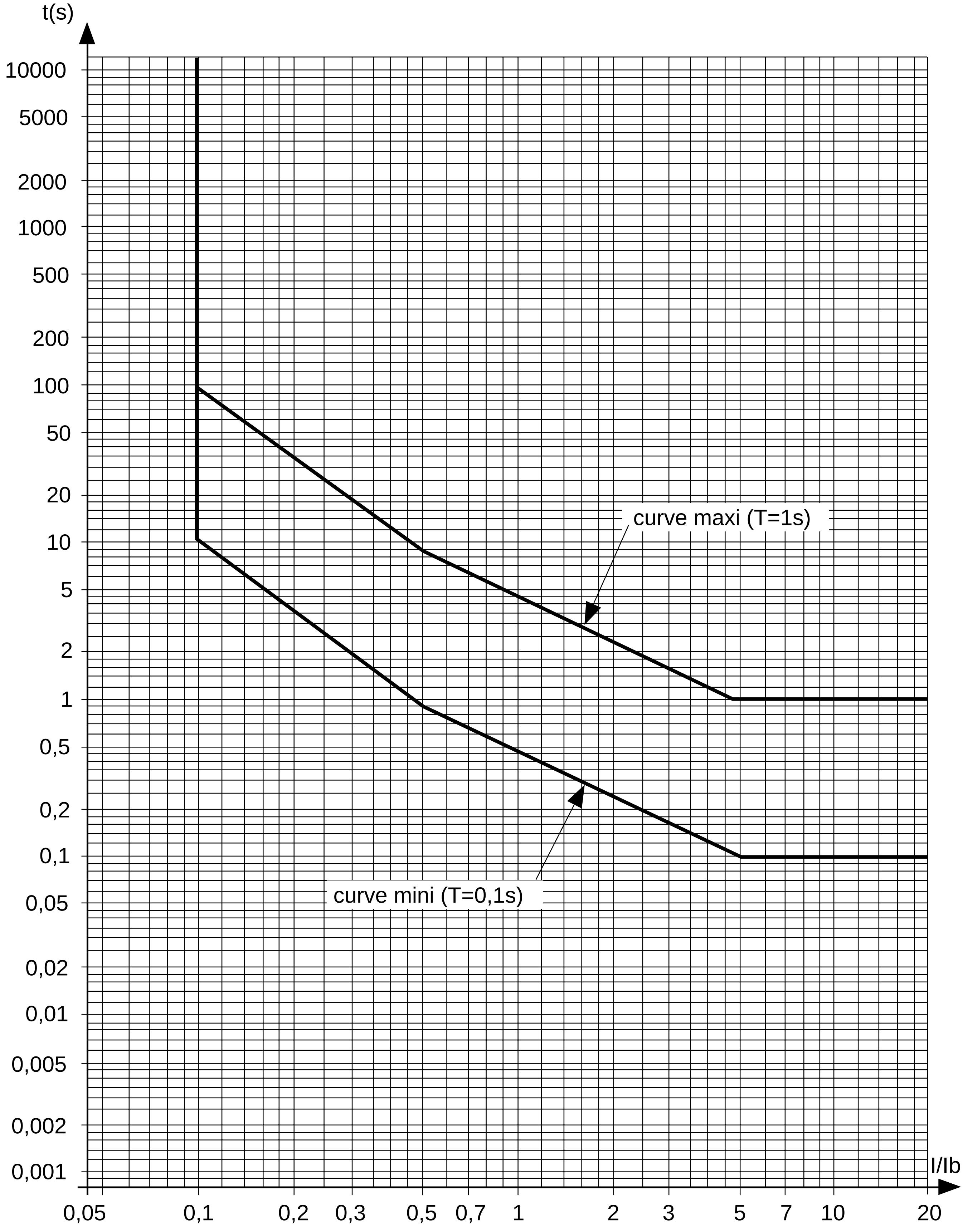


Ultra inverse time UIT curve



Negative sequence/unbalance protection curve

IDMT tripping curve



Notes

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As standards, specifications and designs change from time to time, please ask for confirmation of the information given in this publication.

Publishing : Schneider Electric
Design, production : Schneider Electric
Printing :

This document has been printed on ecological paper.

3140746A-E
ART.75733

12 / 1999