



SIPROTEC 5 Compact Ground fault supervision of 4 feeders APN – C.012

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Ground fault supervision of 4 feeders with 7SX800 with 4x I, 4x V

SIPROTEC 5 Compact Application Ground fault supervision of 4 feeders

APN-C.012, Edition 1

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Ground fault supervision of 4 feeders with 7SX800 with 4x I, 4x V

1 Ground fault supervision of 4 feeders with 7SX800 with 4x I, 4x V

1.1 Introduction

The application describes the ground fault supervision of 4 feeders with one SIPROTEC 7SX800 with 4 current and 4 voltage inputs. The sensitive ground fault supervision is the only function that is carried out per feeder. The setting of the function itself is not dealt with in this APN, as these are described in detail among others in APN-C.014.

With this "ground fault supervision" function, it must be taken into account that it is **only about "supervision"** of ground faults and that it is **not possible to trip an ground fault** with the application described here.

The focus is on the detection and reporting of a ground fault. For tripping, it is necessary to configure a "circuit breaker" function group for each feeder, which must have a connection to a 3-phase current measuring group, which is not possible with the hardware options of the 7SX800.

1.2 Application overview and device selection

A SIPROTEC 5 Compact device 7SJX800 with 4x I and 4x U and 40 function points (for voltage-based protective functions) is selected.

The required sensitivity of the earth current measurement determines whether a 7SX800 is suitable for this application. If a secondary earth current of less than 30 mA is to be measured, the 7SJ85 must be used with a current terminal with 4 sensitive inputs.

The application overview with the connection of the device to the CTs and VTs and the functional device structure (measuring points, function groups and functions) is shown in the following figure.



Fig. 1: Device overview with function groups, measuring points and functions

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1.3 DIGSI settings

1.3.1 Function Groups

The function groups (FG) shown in Figure 1 must be configured in the device. If you create a 75X800 in DIGSI 5 it does not matter which application template is used, since adaptations must be made for this application anyway. Additional function groups (FG) must be added in the parameter tree and the superfluous function groups (FG) must be deleted.

The new required functional groups are:

- 4 x VI 1ph and
 - \circ therein the required function "67Ns Dir.sens GFP" see Figure 2.
- 1 x V 3ph,

We recommend adding the function group VI 1ph for the first feeder, adapting the name and then adding the protection function "67Ns Dir.sens GFP1" and then copy the entire function group 3 times and adapt the names.

Function groups that are not required must be deleted (red background color in Figure 2):

- VI 3ph (is replaced by 4 x VI 1ph and 1 x V 3ph)
- Circuit breaker (must be deleted because a connection to a measuring point I 3ph is mandatory)
- Disconnector (can be deleted if not required but does not have to)



Fig. 2: Creating (and deleting) function groups and functions

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1.3.2 Measuring points

In the Measuring-points routing, the additional measuring points must then be added, and the not needed measuring points must be deleted. Open the "Measuring-points routing" editor in the project tree by double-clicking (see Fig. 3)

▼ 📑 APN								
📑 Add new device								
📅 Devices and networks								
 TSX800_4Feeder 								
🔚 Device information								
📝 Hardware and protocols								
🏸 Measuring-points routing								
Function-group connections								
🗱 Information routing								
🔻 👆 Settings								

Fig. 3: Measuring-points routing in the project tree

In Figure 4 you can see the standard measuring points for current and voltage - created by the selected application template.

In the current measuring points, the measuring point I-3ph 1 with a red background is to be deleted and 4 new single-phase measuring points I-1ph are to be added using the "Add new" button; these can be renamed to provide a better overview.

The standard V-3ph 1 measuring point is retained in the voltage measuring points, as it can be used to measure the system frequency. In addition, a single-phase voltage measuring point must be created using the "Add new" button.

~	Current-measuring points		~	Voltage-measuring po	ints				
-		Base module					Base module		
		▶1A					▶ 1B		
		1A1-1A2 1A3-1A4	1A5-1A6 1A7-1A8				1C10-1C9	1C12-1C9 1C14-1C9	1C13-1C11
	Measuring point Connection type	LP1A1 LP1A2	I P 1A3 I P 1A4		Measuring point	Connection type	V 1.1	V 1.2 V 1.3	V 1.4
	(All) (All)	(All) 🔻 (All)	▼ (AII) ▼ (AII)	-	(All)	(All)	(AII)	(All) 🔻 (All)	💌 (All) 💌
	Meas.point I-3ph 1 3-phase + IN-separate	IA IB	I C IN		😂 Meas.point V-3ph 1	3 ph-to-gnd voltages 💌	VA	VB VC	
	Add new				Add new				

Fig. 4: current and voltage measuring points (before)

In the next step, the currents (zero sequence currents, here with Ix) and the voltage (zero sequence voltage, with UN) must be routed to the terminals as shown in Figure 5.

irrent-measuring	poin	its							~	Voltage-measuring po	oints	s												
► Base module												Base modul	le					_						
				▶ 1A										▶ 18										
				1A1-1A2	1A3-1A4	1A5-1A6	1A7-1A8							1C10-1C9		1C12-1C9	1C14-1C9		1013-1011					
easuring point		Connection type		P 1A1	I P 1A2	IP1A3	IP1A4			Measuring point	Co	onnection type		V 1.1	-	V 1.2	V 1.3		V 1.4	-				
(IL	-	(All)	-	(All)	 (All) 	(AII)	(All)	-		(AII)	- (4		5	(AII)		(AID)			(40)	-				
Feeder1 I-1ph 1				Ix							- (^	NI)	2	(41)	_	((1))		-	(((()))	-				
Feeder2 I-1ph 2					Ix					weas.point v-sph i	3	pn-to-gnd voitages	-	VA	_	VB	νc			_				
Feeder3 I-1ph 3						lx				Meas.point V-1ph 1	_		_		_				VN	_				
Feeder4 I-1ph 4							lx.			Add new	-													
Add new																								
	rrent-measuring esuring point II) Feeder1 I-1ph 1 Feeder2 I-1ph 2 Feeder3 I-1ph 3 Feeder4 I-1ph 4 Add new	suring point U Feeder1 I-1ph 1 Feeder2 I-1ph 2 Feeder3 I-1ph 3 Feeder4 I-1ph 4 Add new	suring point Connection type ()	sturing point Connection type (4) (b) (a) (4) (4) (4) Feeder1 - 1-ph 1 Feeder3 - 1-ph 2 Feeder3 - 1-ph 4 Add new	rrent-measuring points > Base modul > 1A 1A-11A2 ssuring point Connection type IP 1A1 I) (All) (All) Feeder2 I+1ph 1 IX Feeder3 I+1ph 3 Feeder4 I+1ph 4 Add new IX	rrent-measuring points	rrent-measuring points	rrent-measuring points	rrent-measuring points	sear module > Base module > Pase mo	rrent-measuring points	rrent-measuring points	Fase mode Voltage-measuring points 1A1-1A2 1A3-1A4 1A5-1A6 1A7-1A8 ssuring point Connection type IP1A1 IP1A2 IP1A3 IP1A4 Ib (All) (All) (All) (All) (All) (All) (All) (All) Feeder2 Hiph 3 Ix Ix Ix Ix Ix IX Add new Intervention Intervention Intervention Intervention Intervention Intervention Intervention	sessem noule Voltage-measuring points iA 1A 1A 1A3-1A4 1A 1A3-1A4 1A 1A3-1A4 iA IP1A3 iA IP1A3 iA IP1A iA IP1A3 iA IP1A4 ib<	rrent-measuring points > Base module > Base module <th< td=""><td>search No <th< td=""><td>Pase mode > Base mode</td><td>V Voltage-measuring points Passe module > Base module</td><td>Passe module > Base mo</td><td>rrent-measuring points Voltage-measuring points Sase module Sase module I A3-1A4 1A3-1A6 IA7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I P1A2 I P1A3 I P1A4 ID IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IS IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IA IA IA IA IA IA IA IA IA IA IA IA <th <="" colspan="4" td=""></th></td></th<></td></th<>	search No No <th< td=""><td>Pase mode > Base mode</td><td>V Voltage-measuring points Passe module > Base module</td><td>Passe module > Base mo</td><td>rrent-measuring points Voltage-measuring points Sase module Sase module I A3-1A4 1A3-1A6 IA7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I P1A2 I P1A3 I P1A4 ID IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IS IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IA IA IA IA IA IA IA IA IA IA IA IA <th <="" colspan="4" td=""></th></td></th<>	Pase mode > Base mode	V Voltage-measuring points Passe module > Base module	Passe module > Base mo	rrent-measuring points Voltage-measuring points Sase module Sase module I A3-1A4 1A3-1A6 IA7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I A3-1A4 I A7-1A8 I A1-1A2 I P1A2 I P1A3 I P1A4 ID IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IS IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IC10-1C9 IC12-1C9 IC14-1C9 IC13-1C11 IA IA IA IA IA IA IA IA IA IA IA IA <th <="" colspan="4" td=""></th>				

Fig. 5: Current and voltage measuring points (after)

1.3.3 Connection of the measuring points with the function groups

The editor / menu item "Function-group connections" is displayed (normally hidden because this editor is only required in special cases such as here).

Since new function groups were created and function groups that existed by default were deleted, the connections that were automatically created with the application template are no longer available and the editor, which is normally hidden, is displayed and shows an inconsistency in the project tree and light red fields in the work area where a connection must be configured (see Fig. 6).

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Duelout two	m 4											
Project tree		APN > 75X800_4reeder > FL	inction-gro	oup connections							/	
Devices						Measur	ing points <-> Function g	Function g	roup <-> Circuit-brea	ak Protec	tion-FG <-> P	rotection-FG
19	11 T											
		✓ Connect measuring points to	function	group								
🔻 🛅 APN			VI 1ph Fe	eeder1	VI 1p	n Feeder2	VI 1ph Feed	er3	VI 1ph Feed	er4		V 3ph 1
💕 Add new device		Measuring point	V	l 1ph	V	I 1p	h V	I 1ph	V	I 1ph	1	V 3ph
Devices and networks		(All)	 (All) 	(All)	(All)	💌 (All)) 🔻 (All)	(AII)	(AII)	💌 (All)	-	(All)
 TSX800_4Feeder 	8	Meas.point V-3ph 1[ID 2]										
Device information		Feeder1 I-1ph 1[ID 1]										
Hardware and protocols		Feeder2 I-1ph 2[ID 3]										
Measuring-points routing		Feeder3 I-1ph 3[ID 4]										
Function-group connections	8	Feeder4 I-1ph 4[ID 5]										
🗰 Information routing		Meas.point V-1ph 1[ID 6]										
Settings												

Fig. 6: Connection of the current and voltage measuring points to the function groups (before)

The measuring points must now be connected to the respective function groups (see Figure 7). The adjustments are only to be made for the "Measuring points <-> Function groups", the other two groups are irrelevant for this application.

- The measuring point V-3ph (only for measuring the system frequency) must be connected to the **FG** function group V 3ph
- The measuring point V-1ph must be connected to **all FG** function groups VI 1ph Feeder1 (2/3/4)
- The measuring points Feeder1(2/3/4) I-1ph must be connected to the appropriate **FG** function group VI 1ph Feeder1(2/3/4)

APN → 7SX800_4Feeder → Fun	PN > 7\$X800_4Feeder → Function-group connections _ PN > 7\$X800_4Feeder → Function-group connections											
				Measuring points <-> Function g			Function group <	> Circuit-break	Protection-FG <-> Protection-FG			
Y									-			
✓ Connect measuring points to f	Connect measuring points to function group											
	VI 1ph Feeder1		VI 1ph Feeder2		1	/I 1ph Feeder3		VI 1ph Feeder4		V 3ph 1		
Measuring point	V	l 1ph	V	I 1ph	N	/	l 1ph	V	I 1ph	V 3ph		
(All)	(All) 💌	(AII)	(AII)	💌 (AII)	- ((All)	(All)	💌 (AII)	 (All) 	(All)		
Meas.point V-3ph 1[ID 2]										х		
😺 Feeder1 I-1ph 1[ID 1]		х										
Feeder2 I-1ph 2[ID 3]					х							
Feeder3 I-1ph 3[ID 4]							X					
😺 Feeder4 I-1ph 4[ID 5]									х			
Meas.point V-1ph 1[ID 6]	х		Х			Х		х				

Fig. 7: Connection of the current and voltage measuring points to the function groups (after)

1.3.4 Ground fault & Operate (trip) indication

Often a ground fault should only be reported, for this purpose the message "ground fault" of the respective function "67Ns Dir.sens GFP" e.g. "310> cos/sin φ 1" is used. In this application description for the SIPROTEC 5 Compact universal device 7SX800 it is assumed that only ground fault supervision is required, i.e. a ground fault should only be reported but not tripped.

For **tripping**, it must be ensured that a circuit breaker function group is configured in the device via which a trip must be issued, and that **is not possible** within the here described application (the needed amount of terminals for 3ph current measuring points cannot be configured in a compact SIP5 device – FG Circuit Breaker must be mapped always to a 3ph current measuring point).

More detailed information on the setting recommendations for directional ground fault functions is not dealt with in this APN; there are additional application descriptions (e.g. APN-C.014).

To ensure that no trip messages (operate signal) are generated, setting adjustments (as shown in Fig. 8 and Fig. 9) within the used stages of the protection function "67Ns Dir.sens GFP" must be made.

Open the settings for the protection functions "67Ns Dir.sens GFP" and select the network topology of your network (radial; ring/meshed) and enable the earth fault function (s) suitable for your network and philosophy via the "mode" (which function may fits best, can be seen e.g. in the APN-C.014) and set "Operate & flt.rec. blocked" to "Yes"(Fig. 8).

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Project tree 🔲 🗉		APN ▶ 7SX800_4Feeder ▶ Settings	s → VI 1ph Feeder1 → 67Ns	Dir.sens GFP1	_ # = X (
Devices	Г				9
۲ ۲		🗗 Edit mode: secondary	ctive: settings group 1 🛛 🔶 י	→ ∞ ∞ 🗉 2 🗉	Tas
					× 8
T APN		General			
💕 Add new device					L L
Devices and networks		1151 1861 2311 121	Network topology:	ring/meshed	i i i i i i i i i i i i i i i i i i i
 TSX800_4Feeder 	8		in the second se	ring/meshed	ar.
bevice information		1151.1861.2311.101	Decay time VU:	radial	s.
Hardware and protocols		1151.1861.2311.102	Dropout delay:	1.00 s	
Measuring-points routing		1151.1861.2311.103	Core balance CT- current 1:	0.050 A	
Function-group connections		1151.1861.2311.104	Core balance CT- current 2:	1.000 A	
🗱 Information routing		1151 1961 2211 105	CT angle error at 11.		
 Settings 		1151.1001.2511.105	Crangle enoratit:	0.0	
Device settings		1151.1861.2311.106	CT angle error at I2:	0.0	
Time settings		1151.1861.2311.119	Block. group indications:	no	
 Power system 					
Recording					
✓ ¥ VI 1ph Feeder1		Add new stage	Delete stage		
Seneral					
G/Ns Dir.sens GFP1					
Circuit-breaker interaction		310> cos/sinφ1			
N 1/ Viphreeder4		1151.1861.12601.1	Mode:	on	
P up Charte		1151.1861.12601.2	Operate & fit.rec. blocked:	yes 🔻	
Display pages	0	1151.1861.12601.10	Blk. by measvolt. failure :	yes 💌	
Safety and security	~	1151.1861.12601.111	Blk.by interm.and.flt.:	no	
Test sequences		1151 1861 12601 110	Rik, after fault extinction:	uar 💌	
Process data		115111661112601110	bik. alter laut extinction.	jes i	
Charts - Trend/dynamic display & forc		1151.1861.12601.108	Directional mode:	forward	
▶ 🛄 75X800 basic	26	1151.1861.12601.109	Dir. measuring method:	cos φ	
75X800_4Felder	%	1151.1861.12601.107	φ correction:	0 0	
Load configuration to devices		1151 1861 12601 102	Min polar 310> for dir det :	0.030 A	
🐓 Load firmware to devices		1151 1961 13601 105	et adustice d'		
Upgrade project devices		1151.1861.12601.105	d i reduction dir. area:	2	
 Import project 		1151.1861.12601.106	a2 reduction dir. area:	2 °	~
Documentation settings		<			>

Fig. 8: Block trip-indication (operate)

Each protection function generates its own " operate indication (trip-indication)". The minimum operation time for the "operate indication" can be set using the parameter shown in Figure 9. The default setting is 0 s, as this setting is normally not required (when using a circuit breaker function group). The setting should be adjusted to a common value of approx. 100 ms.

Project tree	APN → 7SX800_4Fee	eder 🕨 Settii	ngs 🕨 Device settings				_ # i	$\equiv \times$	1
Devices									
1	Edit mode: seconda	ary 🗗	Active: settings group 1 🛛 🗲	→ 🕺 😿 🗉					Tas
	General							^	ŝ
T APN	Device								=
Add new device	Device								끹
Devices and networks		91 101	Rated frequency:	50 Hz	-	P- 🕄			ii i
▼ 🧾 75X800_4Feeder 🤅	3								E.
Device information		91.102	Minimum operate time:	0.00	s	AG			S
Hardware and protocols		91.115	Set. format residu. comp.:	Kr, Kx		AS			
Measuring-points routing		91.138	Block monitoring dir.:	off		A			
Function-group connections			<u> </u>						
🗱 Information routing	Chatter blocking								
🔻 👆 Settings	chatter bioching								
📝 Device settings		91.123	No. permis.state changes:	0		P			
🎔 Time settings					-				
		91.127	initial test time:	<u> </u>	s	L2 A0			
Recording		91.124	No. of chatter tests:	0		🔁 🔊			
🕨 🍕 VI 1ph Feeder1		91.125	Chatter idle time:	1	min	🔁 🔊			
VI 1ph Feeder2		91 137	Subsequent test time:	2					
🕨 🙀 VI 1ph Feeder3		51.157	subsequent test time.	*		40			

Fig. 9: Parameter for the minimum duration of the "operate indication"

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1.4 Resolving inconsistencies

As can be seen in Figure 10 (circled in red) there are still inconsistencies.

The reason for this is that with the originally used application template (which later was adapted for the application described here) measured values from originally existing measuring points were linked to the display pages. These values are no longer available (after deletion of the measuring group VI 3ph).

Such measured values are displayed both in the display page "Bay1" and in the display page for the measured values "Measurement" in the standard application template (and that assignment fits normally, but not in this case)

Project tree		APN ►	7SX800_4Feed	ler 🕨 Display pages 🕨	Bay1 🗕	∎≡×∢
Devices						•
		▓ #	Α ### 🖄 🔬 ,	🖊 🗖 Default	•	Sigr
		Bav1		1/2		lals
- APN						
Add new device						9
Devices and networks	6					5
 TSX800_4Feeder 	₿	X				sks
Device information			Iph:A	####.#####		
Hardware and protocols		ې ا				
Eusction-group connections			lph:B	####.#####		÷
Information routing		L O				ran
Settings			ipn:C	####.####		<u>s</u>
Charts						
L CFC cross-reference list		T				
🔺 Add new chart			10000			
🖸 Group warning			v pp:AB	####.####		
D. Interlocking			VaniDO			
Process mode inactive			vpp:BC	#### . ####		
 Display pages 	8		1/00.04			
Add new display page			v pp:CA	####.####		
Bay1	(8)	Ť				
Measurement	6					
Fault-display configuration						

Fig. 10: Inconsistencies (measured values no longer available in the display pages)

To eliminate the inconsistencies in the display pages, either simply delete the display pages, or adapt them in replacing the no longer available values with values that are meaningful for our application described here (example see Fig. 11)



Fig. 11: Inconsistencies corrected with existing measured values in the display pages

There are other inconsistencies that are not immediately apparent. These come from the CFC plans that are predefined (and useful) in the application template. The inconsistencies become visible when "Charts" is selected in the project tree and the charts are **compiled** (start with the button that is circled in red).

Since for our application measuring points were deleted and replaced by others, there are now missing input values in the prefabricated CFC plan "Group warning" (Fig. 12); simply delete these red marked inputs in the CFC chart.

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The predefined interlocking conditions (circuit breaker and disconnector) are also no longer valid, since the "Circuit breaker" function group and possibly also the FG disconnectors have been deleted. This CFC chart "Interlocking" can be completely deleted because it does not make sense in this application.

The third CFC chart "Process mode inactive" is not affected by the changes and does not have to be adapted.

After the adjustments have been made (deleting the "Interlocking" chart and deleting the red marked (missing) inputs in the CFC "Group warning" chart, compile the charts and all inconsistencies are then solved.



Fig. 12: Inconsistencies in the CFC charts

1.5 Summary

The expandability of function groups "FG VI 1ph", as well as the flexible and simple connection with the measuring points enables the ground fault supervision of 4 feeder with a SIPROTEC 7SX800 with 4 current and 4 voltage inputs.

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