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**Test Report Procedures For DIFF (7SD522) Relay**

**TEST REPORT PROCEDURE FOR  
DIFFERENTIAL PROTECTION  
SIPROTEC RELAY  
(7SD522)**

**Prepared By**

A.I

ISCOSA ID: 90-3435



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## Test Report Procedures For DIFF (7SD522) Relay

### 1- Visual and Mechanical check:

	<b>Tick</b>
Check Name Plate data according to drawing and specifications	
Check For Transportation and correct positioning	
Verify tightness of external wiring	

### 2- Electrical checks:

	<b>Tick</b>
All connections checked according to the wiring diagram	
Auxiliary power supply checked for rating and polarity	
Casing earthing checked	
CT shorting checked	
LED`s checked	
Test switch function checked	

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## Test Report Procedures For DIFF (7SD522) Relay

### 3-Operational Measured Values:

- To check the operational measured values it is necessary to inject a 3phase symmetrical current and voltage system (but with different amplitudes)
- Inject current amplitudes of  $I_A = 0.5 I_{nom}$ ,  $I_B = 0.4 I_{nom}$ ,  $I_C = 0.3 I_{nom}$  (with balanced angles of  $120^\circ$ )
- Inject voltage amplitudes of  $U_{AN} = 0.5 U_{nom}$ ,  $U_{BN} = 0.4 U_{nom}$ ,  $U_{CN} = 0.3 U_{nom}$  (with balanced angles of  $120^\circ$ )
- Depending on the protection / supervision settings the relay might pick up or give an Alarm, but this does not affect the test (readings are possible to take)
- The actual measurement values can be read via DIGSI or the relay display.

Measured values		Tested and O.K.
Primary values	Operational values primary	-
Secondary values	Operational values secondary	-
Percent values	Operational percent	-

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## Test Report Procedures For DIFF (7SD522) Relay

### **4- Monitoring Functions:**

#### **I- Current Balance Monitor:**

- Inject a symmetrical balanced voltage and current system (the test may interfere with the operation of protection functions)
- The current amplitudes must be higher than the setting "Current Balance Monitor"(address 2904A)
- Slowly reduce one phase current value until annunciation "Fail I balance" (no. 0163) is coming (spontaneous log)

#### **II- Voltage Balance Monitor:**

- Inject a symmetrical balanced voltage and current system (the test may interfere with the operation of protection functions)
- The voltage amplitudes must be higher than the setting "Voltage Threshold for Balance Monitoring" (address 2902A)
- Slowly reduce one phase voltage value until annunciation "Fail U balance" (no. 0167) is coming (spontaneous log)

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A.I

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### III- Broken wires Monitor:

- During steady-state operation the broken wire monitoring registers interruptions in the Secondary circuit of the current transformers. In addition to the hazard potential Caused by high voltages in the secondary circuit, this kind of interruptions simulates Differential currents to the differential protection, such as those evoked by faults in the Protected object.
- The broken-wire monitor scans the current of each phase and picks up when the current Drops abruptly to 0 (from  $> 0.1 \cdot I_N$ ), while no corresponding drop appears in the Earth current.
- The differential protection is blocked immediately in the relevant phase. This blocking has an impact on all ends of the protected object. The device issues the Message "Broken Wire" indicating also the affected phase.
- The blocking is cancelled as soon as the device is again supplied with current in the Relevant phase. It is also suppressed as long as a high fault current ( $> 2.5 \cdot I_N$ ) is registered By any device of the differential protection system.
  - Inject a symmetrical balanced voltage and current system (the test may interfere with the operation of protection functions)
  - Make sure that the current does not flow back via the earth current circuit
  - Suddenly remove ph (A) current wire (or reduce ph (A) current to zero
  - Check that the diff will block and will not trip
  - Check the respective annunciation "Broken I wire" (no. 0290) in the spontaneous log

**Note: The broken-wire monitor only operates if the earth current of a separate earth current Transformer of the protected line is connected to the fourth current input (I4) of the relay, Or if no earth current is connected to this input.**

Monitoring function	Spontaneous log	Tested and o.k.
Current Balance Monitor:	"Fail I balance" (no. 0163)	-
Voltage Balance Monitor:	"Fail U balance" (no. 0167)	-
Broken wires Monitor:	"Broken I wire" (no. 0290,1,2)	-

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### Test Report Procedures For DIFF (7SD522) Relay

#### 5- DIFFERENTIAL PROTECTIONS:

##### I-DIFF PROTECTION 1<sup>ST</sup> STAGE I>DIFF

###### i-Setting:

- o 0112: 87 Diff Protections: ENABLE
- o 1201: State Of Diff Protection: ON
- o 1210: 87-1 pick up: 0.3A
- o 1213: I-DIFF>SWITCH ON: 1.0A
- o 1233: 87-2 pick up: 2.0A
- o 1217A: 87\_1 Trip Time Delay: 0.00 sec
- o 1218A: 87\_2 Trip Time Delay: 0.00 sec
- o 1132A: SI TIME ALL CLOSES: 0.1 sec

###### ii-Test Procedure

###### 1- Pickup/Drop off test

The following procedure checks the function pickup and drop off by single-phase operation.

- 1-Inject a single-phase current at a level below the set pickup threshold
- 2-Slowly increase the current until pick up LED goes on; write down the pickup value
- 3-Slowly reduce the current until the pickup LED1 goes out; write down the drop off value

###### 2-Timing test

The following procedure checks the time characteristic for the protection stage (trip Command must be connected with the time stop trigger):

- 1- Inject a current of 1.2 times the set pickup threshold according to the TRS (the stage Must pickup –watch the LED – and trip after the delay time; the trip command stops the Time measurement of the test equipment)
- 2- Check the measured time against the expected trip time and write down the result
- 3- Preset the injection level to the next test current and repeats the test according to the TRS

**Notes\*\*\* to get expected result you should make this address 1132:0.0 sec**

PH	P.U	D.O	TIME @ 2Id>	TIME @ 4Id>	REMARK
A					
B					
C					

##### II-DIFF PROTECTION 2<sup>ST</sup> STAGE I>>DIFF

###### i-Test Procedure

- See the above steps for Id>

PH	P.U	D.O	TIME @ 2Id>>	TIME @ 4Id>>	REMARK
A					
B					
C					

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## Test Report Procedures For DIFF (7SD522) Relay

### III-Diff Protection Under Switch On to Fault Condition

- When switching on long, unloaded cables, overhead lines and arc-compensated lines, Pronounced higher-frequency transient reactions may take place. Although these are Damped considerably by means of digital filters in the differential protection,
- A pickup value (**I-DIF>SWITCH ON**) (address 1213) can be set to reliably prevent single-sided Pick up of the protection.
- This pickup value is always active when a device has recognized the connection of a dead line at its end. For the duration of the seal-in time **SI Time all close. Which** was set with the general protection data under address 1132A.

#### i-Test Procedure

Note\*\*\* we will use Freja 3rd page (sequence page)

1. On the sequence page, you will generate the settings from 1ST and 2ND state.
2. The sequence page is useful for relays, which require a pre-fault condition before fault condition, to "reset the relay".
3. Define the number of cycles for each state. The cycles in 2ND state must be more than The trip time, a normal value is 200 cycles. Freja will normally not generate all cycles, it Will stop after the trip with the number of "Off-delay" cycles

- The following procedure checks the protection function by single-phase operation.

#### 1<sup>st</sup> test

- 1- Inject a current of 1.2 times the set pickup threshold using Freja page (2) Only
- 2- Check the measured time against the expected trip time and write down the result

#### 2<sup>nd</sup> test

- 1- Set Freja page (1) At value below the ID> setting
- 2- Set Freja page (2) 1.2 times the set pickup threshold using
- 3- Inject using freja page (3)
- 4- Check the measured time against the expected trip time and write down the result

PH	Time when inject (1.2*Id) suddenly		Time when inject (1.2*Id) after pre-fault stage		REMARK
	Exp.	Meas.	Exp.	Meas.	
A					-
B					-
C					-

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## Test Report Procedures For DIFF (7SD522) Relay

### 6- Direct LOCALTRIP:

#### i-Setting

- 0122 Direct Trip: ENABLE
- 2201 Direct Trip: ON
- 2202 Trip Time Delay: 0. 0 sec

Note\*\*\*we have also to assign also binary input/out put/led

- BI: >DTT Trip ABC
- BO: DTT Trip L123

#### ii-Test Procedure

- 1- Inject a DC voltage (80v) direct at the binary input which we assign for this function
- 2- Check the measured time against the expected trip time and write down the result

Function check	Measured Tripping Time PH ABC

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A.I

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## Test Report Procedures For DIFF (7SD522) Relay

### 7- Instantaneous High-Current Switch-onto-Fault Protection:

#### i-Setting

- 0124 50HS INS. High Speed SOTF: ENABLE
- 2401 50HS INS. High Speed SOTF: ON
- 2404 50HS INS. SOTF-O/C P.U:
- 2405A 50-4 switch into fault pick up:
- 1150A Seal in time after M.CL:

Note\*\*\*we have also to assign also binary input/out put/led

BI5 >MANUAL CLOSE (Fno 0356)

BIO 50HS TRIP ØABC

#### ii-Test Procedure

##### 1- 50HS INS. SOTF-O/C P.U:

- 1- DISABLES ALL THE OTHER FUNCTION
- 2- Check the trip time with manual close command functionality
- 3- Activate the logic input of the manual close (e.g. the respective binary input); in parallel Inject a fault current above the respective pickup threshold
- 4- Check the measured time against the expected trip time and write down the result  
The trip time must be instantaneously, not delayed (only the inherent delay time of Approx 45ms applies)

PH	Function check	Measured Time
A		
B		
C		

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A.I

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## Test Report Procedures For DIFF (7SD522) Relay

### II- 50-4 switch into fault pick up

#### 1- Pickup/Drop off test

The following procedure checks the function pickup and drop off by single-phase operation.

- 1- DISABLES ALL THE OTHER FUNCTION
- 2- Inject a single-phase current at a level below the set pickup threshold
- 3- Slowly increase the current until pick up LED goes on; write down the pickup value
- 4- Slowly reduce the current until the pickup LED1 goes out; write down the drop off value

#### 2-Timing test

- 1- Inject a current of 1.2 times the set pickup threshold
- 2- Check the measured time against the expected trip time and write down the result

Ph	PICK UP I>>>>	TRIPING TIME
A		
B		
C		

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Test Report Procedures For DIFF (7SD522) Relay

8- RELAY FUNCTION CHECK:

i- RELAY ANNUNCIATION CHECK

- **\*Event Log Checked:** .....

(\*Operation Messages Contain Information That The Device Generates During Operation and About The Operation)

- **\*\*Trip Log Checked:** .....

(\*\*It can be divided into

1. Spontaneous Messages:(Which Appear Automatically In The Display After A General Pick Up Of The Device)
2. Retrieved Messages: (The messages For Last 8 Network Faults)

- **\*\*\*General Interrogation Checked:** .....

(\*\*\*General Interrogation: The Present Condition Of The SIPROTEC Device)

- **\*\*\*\*Spontaneous Annunciation Checked:** .....

(\*\*\*\*Show The Data about The fault and Relay Behavior & Its Appear Auto. After A general Pick Up Of The Device)

- **\*\*\*\*\*Switching Statistics Checked:** .....

(\*\*\*\*\*The Messages In Switching Statistics are Counters for The Accumulations Of the Interrupted currents & the number of trip issued by the device)

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## Test Report Procedures For DIFF (7SD522) Relay

### ii- Fault Recording Check:

#### i-Setting

- 0402A Waveform Capture: Save With Pick UP
- 0403A Scope Of Waveform Data: fault event
- 0410 Max Length Of Waveform Capture Records:
- 0411 Captured Waveform Prior to Trigger:
- 0412 Captured Waveform After Event:

#### ii-Test Procedure

1. Generate any type of fault (Diff or O/C...etc)
2. Use DIGSI to read the trip log: “Online” -> “Annunciation” -> “Trip Log” -> double click the latest trip log.
3. Check the plausibility of the trip log.

## Test Report Procedures For DIFF (7SD522) Relay

### 9-Relay Binary Inputs& Outputs Checked

#### Item1:

i-To check the actual status of the binary inputs use DIGSI 4, steps are:

- 1- Open the device with DIGSI in "direct" mode
- 2- Choose "Test" in the Online-tree
- 3- Double click "Hardware Test" (takes several seconds)
- 4- The actual status of all BI, BA and LED's is shown

ii- Another option to visualize the actual status of BI is to use the relay menu; Steps are:

Menu, Settings (enter), Masking (I/O) (enter), Binary Inputs (enter)

-> The current status is shown

#### Item2

- Energize and deactivate all used binary inputs via applying a test voltage on the "terminal strip" or via "test switch"
- Check the respective actual status of the binary inputs by using "Hardware Test" of DIGSI 4; steps as given above

#### Item3

- Check the binary outputs by using "Hardware Test" of DIGSI 4
- Change the status of the BO (energize the BO) by making a click in the "nominal" column at the respective BO row
- Check the BO closing at the respective destination (remote interface) of the BO circuit
- Deactivate the BO via a click at the same position

#### Item4

- Test the LED's by using "Hardware Test" of DIGSI 4
- Change the status of the LED's by making a click in the "nominal" column at the Respective LED row
- Close the "Hardware Test" of DIGSI 4, this may last several seconds (the relay performs a reset)



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### Test Report Procedures For DIFF (7SD522) Relay

<b>NO</b>	<b>CHECKE</b>	<b>NO</b>	<b>CHECKE</b>	<b>NO</b>	<b>CHECKE</b>
BI1		BO1		BO25	
BI2		BO2		BO26	
BI3		BO3		BO27	
BI4		BO4		BO28	
BI5		BO5		BO29	
BI6		BO6		BO30	
BI7		BO7		BO31	
BI8		BO8		LED1	
BI9		BO9		LED2	
BI10		BO10		LED3	
BI11		BO11		LED4	
BI12		BO12		LED5	
BI13		BO13		LED6	
BI14		BO14		LED7	
BI15		BO15		LED8	
BI16		BO16		LED9	
BI17		BO17		LED10	
BI18		BO18		LED11	
BI19		BO19		LED12	
BI20		BO20		LED13	
BI21		BO21		LED14	
BI22		BO22			
BI23		BO23			
BI24		BO24			

**Prepared By**

A.I

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## Test Report Procedures For DIFF (7SD522) Relay

### 10-CHECKING THE COMMUNICATION TOPOLOGY

- Setting1: PROTECTION INTERFACE1

- 0115 Protection Interface1 (port D): ENABLE
- 0143 Numbers Of Relays: 2 Relays
- 1501 State Of Protection Interface1:ON
- 1502 Connection 1 Over: Communication Converter With Kbit/s
- 1505A Prot1: Maximal permissible delay time:
- 1506A Prot1: Diff in send and receive time:
- 1513A Prot1: Maximal permissible Error rate:
- 1515A Prot1: Block. Due to unsym. Delay time: YES
- 1509 Time Delay For Data Disturbance Alarm:
- 1510 Time Delay For Transmission Failure Alarm:
- 1512 Remote Signal Reset delay for Comm. Fail:

- Setting2: Differential Topology:

- 1701 Identification Number of relay 1: 1
- 1702 Identification Number of relay 2: 2
- 1710 Local Relay is: Relay 1

- Checking the communication topology

#### I- Checking a Connection Via A Communication Converter

1. Loop Test For the converter & device .....
2. Configurations of the communication Converter cc-1: .....
3. Both Devices at the links Ends are switched on: .....
4. Check the communication net work: .....
5. Check The Event log or Spontaneous annunciations for next message:
  - i. (PI1 Data Reflection ON): .....

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Consistency of topology and parametization:

1. Check The Event log or Spontaneous annunciations for the next messages:

- (3243 PI1 With)
(3463 Chain topology)
(3464 Topol complete)
(3231 PI1 Data Fault) will disappear

2. Check the next announcing inconsistency:

- \*Device Table Inconsistent (3233 DT inconsistent)
\*\*Device Table Unequal (3234 DT unequal)
\*\*\*Parameterization different (3235 Par. Different)

Availability of the protection interface:

Check The Event log or Spontaneous annunciations for the next messages:

- (7753 PI1 A/m = > 99.85%) After 2 minutes.
(7754 PI1 A/h => 99.85%) After one hour.
\*\*\*\*(7751 PI1 TD)

NOTES

- \* The Indexing of the devices is inconsistent (missing numbers or one number used twice)
\*\* The ID numbers of the Devices are unequal
\*\*\* Different function parameters
\*\*\*\* Indicate the transmission time via PI1

Table with 2 columns: Prepared By, A.I, ISCOsa ID: 90-3435





## Test Report Procedures For DIFF (7SD522) Relay

- End (1)-to-End (2) Check:

Item	Description	Remarks
1	<ul style="list-style-type: none"><li>• Inject a symmetrical balanced voltage and current system and check the Reading at the remote end (and versa)</li></ul>	-
2	<ul style="list-style-type: none"><li>• Generate fault at the relay (1) and check there is Trip in the other end Check the annunciation of both relays (and versa)</li></ul>	-
3	<ul style="list-style-type: none"><li>• Set relay (1) at log out and check the behavior of relay (2)</li><li>• Also at this mode inject fault current and check the behavior of relay (2)(And versa)</li></ul>	-
4	<ul style="list-style-type: none"><li>• Set relay (1) at test diff and check the behavior of relay (2)</li><li>• Also at this mode inject fault current and check the behavior of relay (2)(And versa)</li></ul>	-

**Prepared By**

A.I

ISCOSA ID: 90-3435

## Test Report Procedures For DIFF (7SD522) Relay

### Important Notes:

#### 1. Transmission fault and Transmission failure

- **The communication** is continuously monitored by the devices.
- **Single faulty** data telegrams are not a direct risk if they occur only occasionally. They are recognized and counted in the device which detects the disturbance and can be read out per unit interval as statistical information. You can define a limit for the permissible rate of faulty data telegrams when during operation this limit is exceeded an alarm is given (PI1 Error Fno 03258).
- **If several faulty** telegrams or no data telegrams at all are received, this is regarded as a **data fault** as soon as a time delay for data disturbance alarm (default setting 100 ms, can be altered) is exceeded. A corresponding alarm is output (PI1 Data Fault Fno03229)
- If the system offers no alternative way of communication (as ring topologies would do), the differential protection will stop operating. All devices are affected by the disturbance, since the formation of differential currents and restraint currents is no longer possible at any of the ends.
- If the backup over current protection is configured, it will be the only short circuit protection still active.
- As soon as the data communication works fault-free again, the devices will automatically switch back to differential protection operation.
- **If the communication is interrupted** for a permanent period (which is longer than a settable time period), this is regarded as a transmission **failure**. A corresponding alarm is output (PI1 Data Failure Fno 03230) the same reactions apply as for the data fault.
- **Transmission time jumps** that, for example, can occur in case of switchover in the communication network are recognized (PI1 jump Fno 03254) and corrected by the devices. The differential protection system continues to operate without interruption. The transmission times are measured again and actualized within less than 2 seconds.

## Test Report Procedures For DIFF (7SD522) Relay

### 2. Change over of operating mode

Its possible to change the operating mode of the relay in order to perform any work without effect on Running operation

The following modes are available

- Log out device:  
Logging out a device from the diff. Protection system with the circuit breaker being switched off  
The diff. Protection continues to be active at the other ends, which may remain switch on  
This mode can also be set via binary input (Fno 03451<log out)
- Test mode:  
All current from the other devices are set to zero in the local device thus the local device has been isolated from the diff protection system and can be checked.  
If the device has been logged out before all the other devices can operate normally otherwise  
The diff protection system is blocked in all linked devices. Emergency operation with time over current protection feasible.
- Commissioning mode:  
All tripping commands of the diff. Protection system are blocked. The diff. System as an entity  
Can be checked using primary or secondary value.

\*\*\*The above modes can be set via DIGSI or the relay front keys, steps are:

1) For setting via DIGSI:

- Open the device in DIGSI via "direct" mode
- Choose "control" -> "tagging" ->

2) For setting via relay keys:

- The setting are located under: menu, control (enter), tagging (enter)

### 3. Blocking/Inter blocking

- The **differential protection** can be blocked via a binary input (>diff block Fno 3525). The blocking at one end of a protected object affects all ends via the communications link (inter blocking). If the Overcurrent protection is configured as an emergency function, all devices will automatically Switch over to this emergency operation mode. (See manual page 6-31)

### 4. Breaker Intertrip and Remote Tripping

- **7SD52** allows transmitting a tripping command created by the local differential protection To the other end or ends of the protected object (inter tripping). Likewise, any desired Command of another internal protection function or of an external protection, Monitoring or control equipment can be transmitted for remote tripping.  
The reaction when such a command is received can be set individually for each device.



## Test Report Procedures For DIFF (7SD522) Relay

Commands are transmitted separately for each phase, so that a simultaneous single pole Auto-reclosure is always possible, provided that devices and circuit breakers are Designed for single-pole tripping. (See manual page 6-38)

### 5. Direct remote trip & Transmission of binary information

- **7SD52** allows the transmission of up to 28 items of binary information of any type from One device to the others via the communications links provided for protection tasks.
- Four of them are transmitted like protection signals with high priority, i.e. very fast, and Are therefore especially suitable for the transmission of external protection and trip signals Which are generated outside of 7SD52.
- The other 24 are transmitted in the background And are therefore suitable for any information that does not depend on high speed Transmission, such as information on the events taking place in a substation (See manual page 6-56)

### 6. Read out information

- The device provides a great deal of information that can be obtained on-site or from data transfer:
  - 1– Messages,
  - 2–Operating measurement and metered values,
  - 3– Waveform data in oscillographic fault records.
- Methods for viewing, retrieving, acknowledging, And storing this information on a PC (See manual page 7-2)