

Performance TEST REPORT



Project No.: L13-70639
Equipment Under Test: Measuring relay for frequency protection
Model/Type: PB22-AAAB-AAA **Rated Value:** Uaux:48-230Vac/dc
S/N: 211-00022
Manufacturer: PISHTAZ SANAT NAM ASHNA(ESFA)
Address: No. 5/1, North Kargar Street, Science and Technology Park, University of Tehran, Tehran
Applicant: PISHTAZ SANAT NAM ASHNA(ESFA)
Address: No. 5/1, North Kargar Street, Science and Technology Park, University of Tehran, Tehran
Tested According to: IEC60255-181:2019(Clauses :6.2&6.3&6.4)-Client Request
Testing Laboratory: Energy & Power Industries Laboratories Co.
Date of Sample Reception: 1404/01/20
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Tested by: Technical Expert

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The statement of conformity decision on the measured values is made based on guard band $w=U, r=1$ rule (ILAC-G8: 09/2019). The specific False Accept Risk is up to 2.5%.

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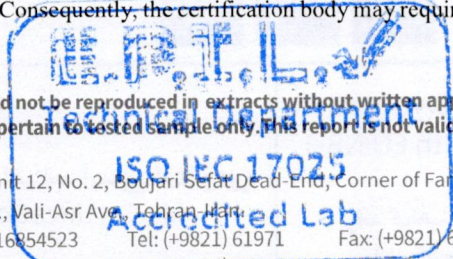
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1. General information

1.1. Product information

Equipment under test:	Measuring relay for frequency protection
Manufacturer:	PISHTAZ SANAT NAM ASHNA(ESFA)
Model:	PB22-AAAB-AAA
Normative documents:	IEC 60255-181:2019

1.2. Client information

Applicant:	PISHTAZ SANAT NAM ASHNA(ESFA)
Contact:	Dr. Ahmadreza Darabi
Fax:	02144524383
Telephone:	+989186254616

1.3. Test Results

Determination of steady-state errors related to the characteristic quantity

- Accuracy of the start value
 - Under/over frequency
 - Rate of change of frequency
- Reset hysteresis or reset ratio determination
 - Under/over frequency
 - Rate of change of frequency

Determination of the start time

- Under/over frequency
- Rate of change of frequency

Determination of the accuracy of the operate time delay

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2. PERFORMANCE AND RESULTS OF TEST: MEASURING RELAYS AND PROTECTION EQUIPMENT – IEC60255 PART 181: FUNCTIONAL REQUIREMENTS FOR FREQUENCY PROTECTION

2.1. Determination of Steady State Errors Related to the Characteristic Quantity

2.1.1. Accuracy of the start value

2.1.1.1. Under/over frequency

2.1.1.1.1. Test procedure:

The test method shall be based on a pseudo-continuous frequency ramp. The ramp starts at the initial frequency $f_{initial}$. The initial frequency shall be above/under the expected start value G_s for under/over frequency function, with a minimum difference equal to 5 times the declared frequency accuracy (example: for the over frequency function, with a declared accuracy of ± 10 mHz, the initial frequency is equal to $G_s - 0,05$ Hz).

The ramp can be interrupted after the activation of the start signal. The activation of the start signal shall be a "solid activation"; this means no chattering of the signal with several transitions high – low–high during the injection of the step. The only chattering allowed in the signal is by the output contact, which has a reasonable bouncing time of less than 4 ms. If the start signal oscillates for more than 4 ms, the start activation shall not be considered, and the ramps shall continue to the next step. For other output media, such as IEC 61850 GOOSE or static output, no chattering at all shall be present in the transition of the start signal, in order to be considered valid.

The test method is illustrated in Figure 1, which is applicable to an overfrequency function.

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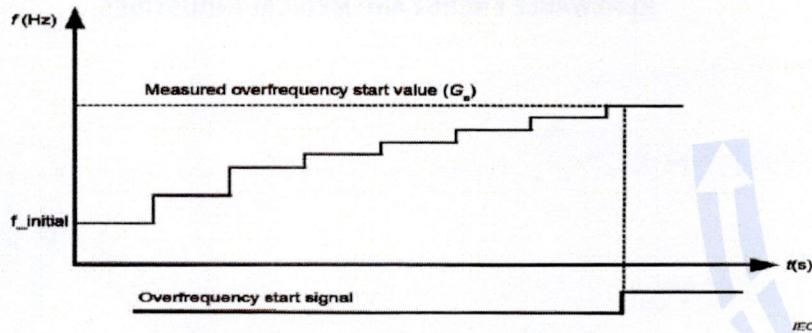


Figure 1: Example of test method for overfrequency

2.1.1.1.2. Acceptance conditions of test:

The start of the protection function shall occur within the frequency band around the expected start value (G_s). The band has the following borders:
 higher accepted value = ($G_s +$ declared frequency accuracy) ;
 lower accepted value = ($G_s -$ declared frequency accuracy) .

2.1.1.1.3. Test result:

Table 1- Test point for over/under frequency function

Test point value X	Frequency setting (start threshold, G_s Hz)	Voltage magnitude	Test 1 Hz	Test 2 Hz	Test 3 Hz	Test 4 Hz	Test 5 Hz	Acceptance criteria	
								$G_s \pm f$ -accuracy	Manufacturer claim= ± 10 Hz
-100% (min. setting)	45.0	Min. U	45.01	45.01	45.00	45.01	45.00	≤ 10 m Hz	passed
-100%	45.0	Max. U	45.01	45.00	45.01	45.01	45.01	≤ 10 m Hz	passed
-100%	45.0	U_n	45.00	45.01	45.01	45.00	45.01	≤ 10 m Hz	passed
-10%	49.5	U_n	49.51	49.51	49.50	49.51	49.51	≤ 10 m Hz	passed

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-5%	49.75	U _n	49.74	49.75	49.75	49.74	49.74	≤10m Hz	passed
-2.5%	49.88	U _n	49.87	49.87	49.87	49.88	49.87	≤10m Hz	passed
-1%	49.95	U _n	49.95	49.94	49.95	49.94	49.95	≤10m Hz	passed
0% F _R =50 Hz,	50.00	U _n	50.01	50.00	50.01	50.01	50.00	≤10m Hz	passed
+1%	50.05	U _n	50.06	50.05	50.06	50.06	50.06	≤10m Hz	passed
+2.5%	50.13	U _n	50.14	50.14	50.13	50.13	50.14	≤10m Hz	passed
+5%	50.25	U _n	50.26	50.25	50.26	50.26	50.26	≤10m Hz	passed
+10%	50.50	U _n	50.50	50.51	50.51	50.50	50.51	≤10m Hz	passed
+100%	55.00	U _n	55.01	55.01	55.00	55.01	55.00	≤10m Hz	passed
+100%	55.00	Min. U	55.01	55.00	55.01	55.01	55.01	≤10m Hz	passed
+100% (max. setting)	55.00	Max. U	55.00	55.01	55.01	55.01	55.01	≤10m Hz	passed

Table 2- Reporting of the frequency accuracy

Over/Under frequency protection	
Frequency accuracy	±10mHz

2.1.1.2. Rate of change of frequency

2.1.1.2.1. Test procedure:

The accuracy of the ROCOF setting (Gs) is assessed with a sequence of frequency ramps where the frequency increases or decreases from the nominal value depending on the sign of the frequency derivative ("+" or "-"). The test method is illustrated in Figure 2, applicable for a positive ROCOF function.

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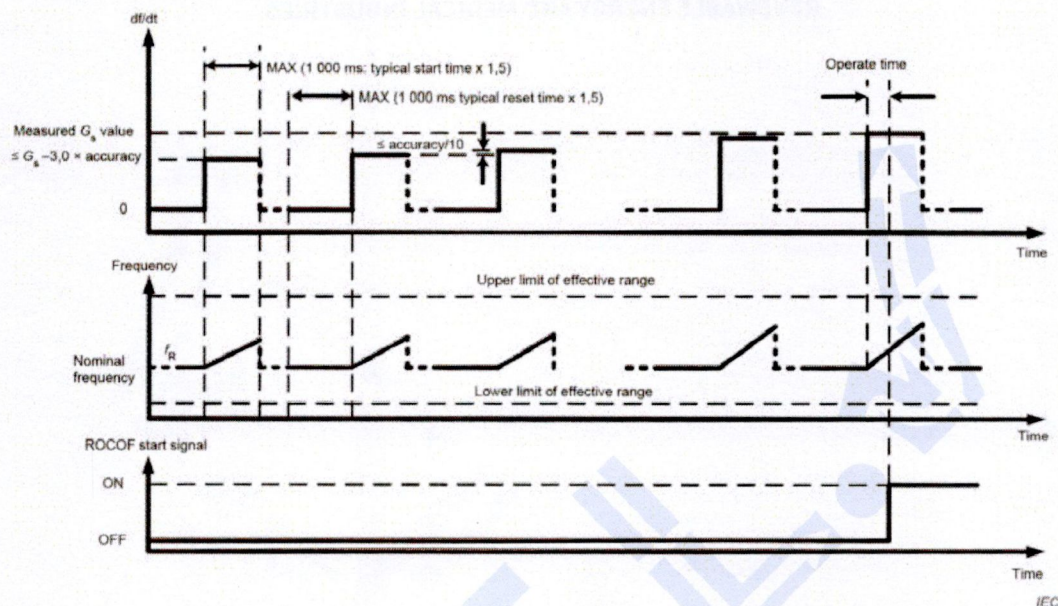


Figure 2. Example of test method for positive ROCOF function

To reduce the length of the test, the frequency increment can be higher at the beginning of the test, with the following rules:

- For the overfrequency function, this increment can be equal to G_s minus 3 times the "declared frequency accuracy."
- For the underfrequency function, this increment can be equal to G_s plus 3 times the "declared frequency accuracy."

The declared frequency rate of change accuracy is based on the requirements specified in 5.3.

Once the above value is reached the increment in the rate of change of frequency will be less than or equal to 10% of the declared frequency rate of change accuracy until the end of the ramps caused by the operation of the start signal.

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2.1.1.2.2. Acceptance conditions of test:

The start of the protection function shall occur within the error band a round the expected start value (G_s). The band has the following borders:
 higher accepted value = ($G_s + \text{declared frequency rate of change accuracy}$);
 lower accepted value = ($G_s - \text{declared frequency rate of change accuracy}$).

2.1.1.2.3. Test result:

Table 3- Test points for ROCOF function

Test point value X	ROCOF setting (start threshold, G_s) Df/dt Hz/S	Voltage magnitude	Test 1 Df/dt Hz/S	Test 2 Df/dt Hz/S	Test 3 Df/dt Hz/S	Test 4 Df/dt Hz/S	Test 5 Df/dt Hz/S	Acceptance criteria mHz/S ($G_s \pm f'$ accuracy) Manufacturer claim = $\pm 10 \text{ mHz/S}$	
								Error	Result
Minimum (0%)	0.1	Min. U	0.100	0.099	0.099	0.099	0.098	<2	passed
0%	0.1	Max. U	0.098	0.099	0.099	0.100	0.099	<2	passed
0%	0.1	U_n	0.100	0.100	0.099	0.099	0.099	<1	passed
5%	0.6	U_n	0.594	0.594	0.595	0.595	0.594	<6	passed
10%	1.1	U_n	1.093	1.094	1.094	1.093	1.094	<7	passed
30%	3.1	U_n	3.098	3.095	3.093	3.098	3.095	<7	passed
60%	6.0	U_n	5.996	5.999	5.998	5.996	5.998	<4	passed
+100%	10	U_n	9.999	9.999	9.998	9.999	9.999	<2	passed
+100%	10	Min. U	9.998	9.997	9.998	9.997	9.998	<2	passed
Maximum (100%)	10	Max. U	9.999	9.999	9.999	9.999	9.998	<2	passed

Table 4- Reporting of ROCOF accuracy

ROCOF protection	
Rate of Change of Frequency accuracy	$\pm 10 \text{ mHz/S}$

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2.1.2. Reset hysteresis or reset ratio determination

2.1.2.1. Under/over frequency

2.1.2.1.1. Test procedure:

The first frequency ramp (increasing ramp for over frequency functions and decreasing ramp for underfrequency functions) will start from the nominal power frequency value (or at any frequency where the protection function is stable in the non-starting condition to reduce the testing time); the START signal of the protection function is monitored. When the protection START signal operates:

- The value of the injected frequency is registered as "START frequency value", and
- the second ramp (decreasing ramp for over frequency, increasing for under frequency functions), will start.

The second ramp starts from the registered "START frequency value" and will stop when the START signal of the protection function resets. At that point, the injected frequency will be registered as "RESET frequency value".

The activation of the start signal shall be a "solid activation"; this means no chattering of the signal with several transitions high-low-high during the injection of the ramp. The only chattering allowed in the signal is by the output contact, which has a reasonable bouncing time of less than 4 ms. If the start signal oscillates for more than 4 ms, the start activation shall not be considered and the ramp shall continue with the next step.

During the transition between successive frequency steps, the injected signal shall be continuous, with no step change in its phase angle or magnitude, except in its frequency.

The frequency variation will be equal to the variation of the last step of the first ramp (immediately prior to the protection START). The second ramp will proceed until the START signal of the protection function resets, allowing the registration of the "RESET frequency value" and the final calculation of the reset hysteresis.

2.1.2.1.2. Acceptance conditions of test:

Each test is repeated 5 times and the test results are reported as shown in Table 5.

The measured reset hysteresis is calculated in the following way:

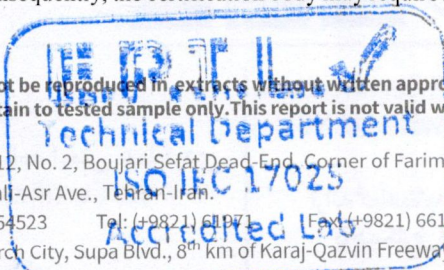
- reset hysteresis = " START frequency value" - " RESET frequency value ", for overfrequency functions ;

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–reset hysteresis = " RESET frequency value " – " START frequency value ", for underfrequency functions .

For all the tests , the measured reset hysteresis shall be be low the declared res et hysteresis .

2.1.2.1.3. Test result:

Table 5- Test points of reset hysteresis for under/over frequency function

Test point value X	Frequency setting (start threshold, G _s) Hz	Voltage magnitude	Test 1 Hz	Test 2 Hz	Test 3 Hz	Test 4 Hz	Test 5 Hz	Acceptance criteria Manufacturer claim=±20mHz ≤Reset hysteresis	
								Error	Result
-100% (min. setting)	45.00	Min. U	44.980	45.980	45.980	45.980	45.980	≤20	passed
-100%	45.00	Max. U	44.980	45.980	45.980	45.980	45.980	≤20	passed
-100%	45.00	U _n	44.980	45.980	45.980	45.980	45.980	≤20	passed
-10%	49.50	U _n	49.480	49.480	49.480	49.480	49.480	≤20	passed
-5%	49.75	U _n	49.730	49.730	49.730	49.730	49.730	≤20	passed
-2.5%	49.88	U _n	49.860	49.860	49.860	49.860	49.860	≤20	passed
-1%	49.95	U _n	49.930	49.930	49.930	49.930	49.930	≤20	passed
0% (F _R =50 Hz)	50.00	U _n	49.980	49.980	49.980	49.980	49.980	≤20	passed
+1%	50.05	U _n	50.030	50.030	50.030	50.030	50.030	≤20	passed
+2.5%	50.13	U _n	50.110	50.110	50.110	50.110	50.110	≤20	passed
+5%	50.25	U _n	50.230	50.230	50.230	50.230	50.230	≤20	passed
+10%	50.50	U _n	50.480	50.480	50.480	50.480	50.480	≤20	passed
+100%	55.00	U _n	54.980	54.980	54.980	54.980	54.980	≤20	passed
+100%	55.00	Min. U	54.980	54.980	54.980	54.980	54.980	≤20	passed
+100% (max. setting)	55.00	Max. U	54.980	54.980	54.980	54.980	54.980	≤20	passed

Table 6- Reporting of the reset hysteresis for over/under frequency functions

Overfrequency protection	
Frequency accuracy	±20mHz

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2.1.2.2. Rate of change of frequency

2.1.2.2.1. Test procedure:

The tests are carried out according to the following procedure :

- The start value for df/dt (associate d to the protection function setting G_s , indicated also as df/dt setting) is detected with a succession of frequency ramps within creasing value of the frequency slope for positive ROCOF (for negative ROCOF the ramps will have a decreasing frequency slope) . The detected ROCOF start value is associated with the value df/dt start . See ramps S_1, S_2, \dots, S_{m-1} and S_m in Figure 3 (a), where the start operation is detected with the ramp S_m in the case of a positive error on start value.
- A frequency ramp with the value $1,2 \times df/dt$ start is generated, causing a definite start operation.

At the end of this frequency ramp, a frequency ramp with a lower frequency slope is generated (df/dt_1 , illustrated by ramp R1 in Figure 3 (b)). During this ramp, the protection function may or may not reset :

– If the function does not reset, then the initial ramp at $1, 2 \times df/dt$ start is generated again, following this, a ramp with an even lower frequency slope is generated (df/dt_2 , illustrated by ramp R2 in Figure 3 (b);

–This process continues until the protection function resets, which occurs at the ramp with the frequency derivative value of df/dt reset. See ramps R_1, R_2, \dots, R_{n-1} and R_n in Figure 3 (b), where the reset operation is detected with ramp $R_n - 1$ in the case of positive error on reset value or with ramp R_n in the case of negative error on reset value. When the protection function resets, the reset value can be calculated.

- The reset value is calculated based on the values $d f/dt$ start and df/dt_{reset} .

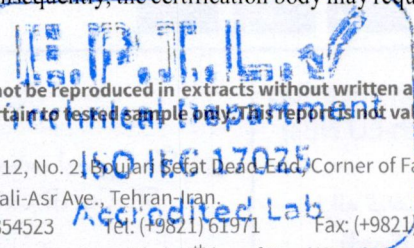
Figure 3 shows the test method for a ROCOF function.

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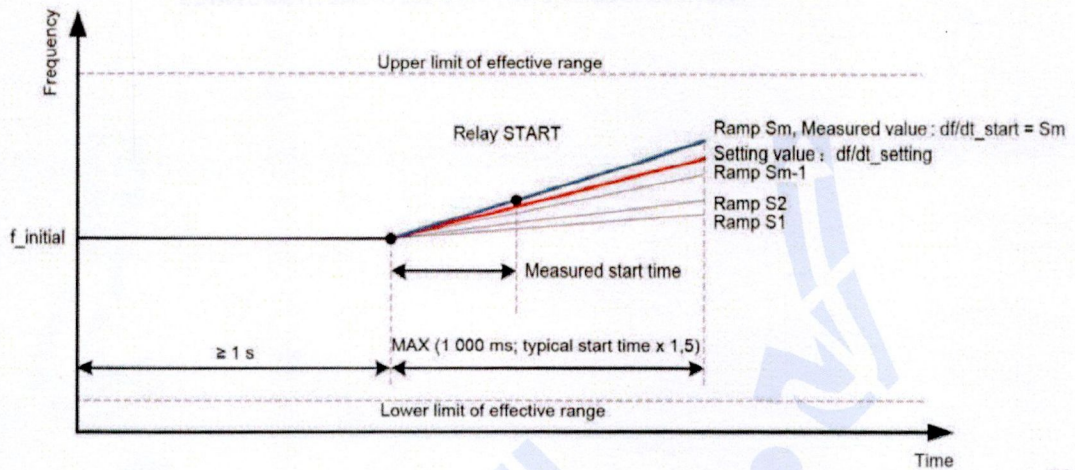
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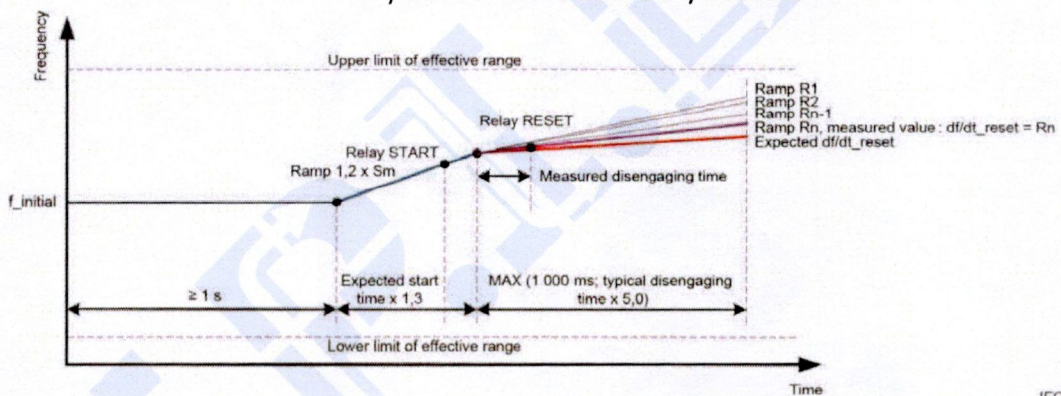


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a) Test to determine df/dt start



b) Test to determine df/dt reset

Figure 3 – Test method for measurement of reset value for ROCOF functions : example for positive ROCOF function

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2.1.2.2.2. Acceptance conditions of test:

The reset of the start signal is considered valid if there is no chattering at all, regardless of whether the output media is a contact, IEC61850 GOOSE or static output.

The reset ratio is calculated with the formula :

$$\text{Reset ratio} = (df/dt_{\text{reset}}/df/dt_{\text{start}}) \times 100 \%$$

If a minimum absolute reset hysteresis is declared, the reset hysteresis is calculated with the formula :

$$\text{Reset hysteresis} = df/dt_{\text{start}} - df/dt_{\text{reset}}$$

2.1.2.2.3. Test result:

Table 7- Test points of reset value for ROCOF function

Test point value X	ROCOF setting (start threshold, G _s) Df/dt Hz/S	Voltage magnitude	Test 1 result % or Hz/S	Test 2 result % or Hz/S	Test 3 result % or Hz/S	Test 4 result % or Hz/S	Test 5 result % or Hz/S	Acceptance criteria mHz/S	
								Manufacturer claim=±10mHz/S	≤Reset ratio (or hysteresis)
								Error	Result
0% Minimum	0.10	Min. U	0.100	0.099	0.099	0.099	0.098	≤2	passed
0%	0.10	Max. U	0.098	0.099	0.099	0.100	0.099	≤2	passed
0%	0.10	U _n	0.100	0.100	0.099	0.099	0.099	≤1	passed
5%	0.60	U _n	0.594	0.594	0.595	0.595	0.594	≤6	passed
10%	1.1	U _n	1.093	1.094	1.094	1.093	1.094	≤7	passed
30%	3.1	U _n	3.098	3.095	3.093	3.098	3.095	≤7	passed
60%	6.0	U _n	5.996	5.999	5.998	5.996	5.998	≤4	passed
+100%	10.00	U _n	9.999	9.999	9.998	9.999	9.999	≤2	passed
+100%	10.00	Min. U	9.998	9.997	9.998	9.997	9.998	≤3	passed
Maximum (100%)	10.00	Max. U	9.999	9.999	9.999	9.999	9.998	≤2	passed

Table 8- Reporting of the reset value for ROCOF function

ROCOF protection(Reset value)	
Rate of Change of Frequency accuracy	±10mHz/S

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2.2. Determination of the start time

2.2.1. Under/over frequency

2.2.1.1. Test procedure:

The test method based on a sudden change in frequency is illustrated in Figure 4 (for over frequency function).

During the transition of the sudden frequency change, the injected signal shall be managed without discontinuity in the voltage waveform, except in its frequency.

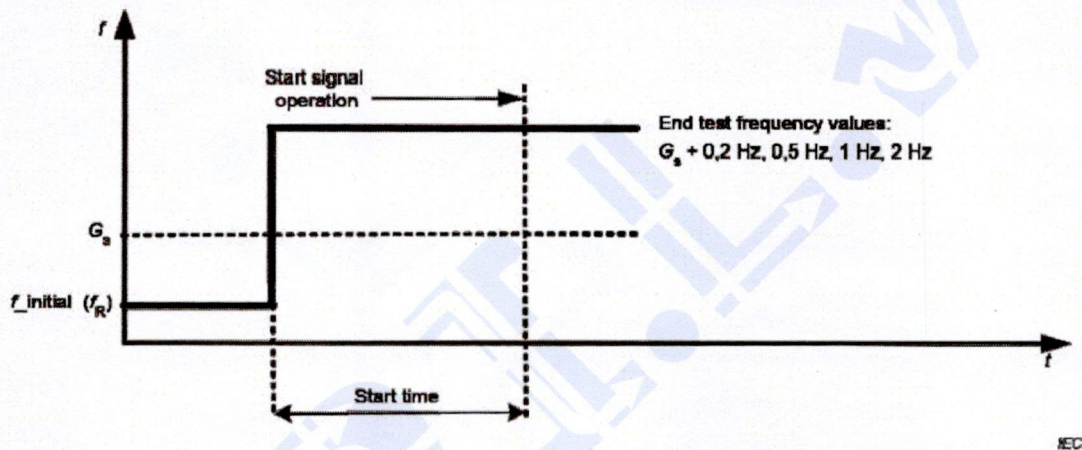


Figure 4: Start time measurement of overfrequency with sudden frequency change

These tests are based on tests points defined. These tests points are identified with a frequency slope equal to "infinity" (sudden change).

- The initial test frequency value is always equal to the tested nominal power frequency.
- The end test point value is equal to the G_s setting plus (for over frequency) or minus (for under frequency) different frequency values (0, 2 Hz, 0,5 Hz, 1 Hz, and 2 Hz) to measure the start time with different ratios between the threshold and frequency signal.
- The start time is measured between the instant when the frequency changes and the instant when the start signal is asserted.

The injected frequency shall always be within the operating range of the protection function. For lower/higher settings of under/over frequency functions, end test frequency value could be outside the operating range. In that case, the function cannot be tested with this method

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for that test point. The manufacturer shall declare this information in the type test report and the test shall be performed with the upper/lower limit of the declared operating range. The test method based on a finite constant frequency slope is illustrated in Figure 5 (for over frequency function).

During the transition in the frequency change, the injected signal shall be managed without discontinuity in the voltage waveform, except in its frequency.

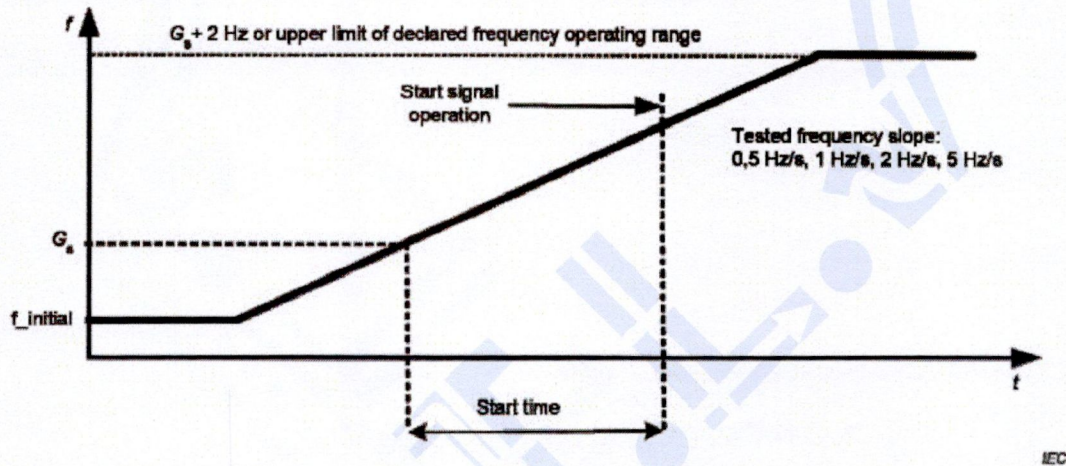


Figure 5: Start time measurement of overfrequency with constant slope frequency ramp

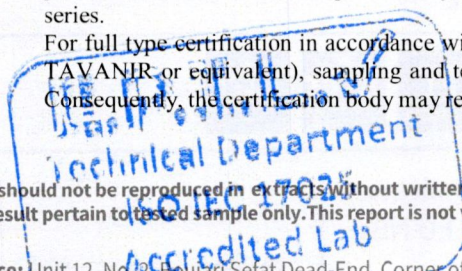
The start time is measured for the following test points. Each test is repeated 10 times. The tests are repeated for each nominal power frequency value of the protection function (typically 50 Hz and 60 Hz).

2.2.1.2. Acceptance conditions of test:

The test results are reported in tabular form as shown in Table 9, where the minimum, average (mean) and maximum values are calculated. In addition, the test results are reported in graphical form, as shown in Figure 14. The results shown in Table 15 and in Figure 14 are provided by way of example.

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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2.2.1.3. Test result:

Table 9– Reporting of start time for over frequency functions

Over frequency protection start times 50 Hz nominal frequency				
Velocity of frequency change	Frequency jump (sudden change)	Minimum START time	Maximum START time	Average START time
0.5 Hz/s	N/A	62.80	69.60	67.78
1 Hz/s	N/A	65.20	71.20	69.29
2 Hz/s	N/A	65.60	70.80	69.51
5 Hz/s	N/A	66.40	70.80	68.79
Sudden change	0.2 Hz	57.20	95.20	76.04
Sudden change	0.5 Hz	50.00	89.20	68.26
Sudden change	1 Hz	46.00	83.20	62.50
Sudden change	2 Hz	42.40	80.00	58.00

Table 10– Reporting of start time for under frequency functions

Under frequency protection start times 50 Hz nominal frequency				
Velocity of frequency change	Frequency jump (sudden change)	Minimum START time	Maximum START time	Average START time
0.5 Hz/s	N/A	69.20	72.80	71.23
0.5 Hz/s	N/A	68.40	70.80	69.93
0.5 Hz/s	N/A	67.20	70.80	69.48
0.5 Hz/s	N/A	67.20	70.80	68.99
Sudden change	-0.2 Hz	57.20	94.80	75.99
Sudden change	-0.5 Hz	50.40	89.20	68.29
Sudden change	-1 Hz	46.00	83.60	62.57
Sudden change	-2 Hz	42.80	79.60	58.14

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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2.2.2. Rate of change of frequency

2.2.2.1. Test procedure:

The start time measurement is assessed using a test method based upon a constant frequency slope. The method is illustrated in Figure 6 (for positive ROCOF function).

During the transition in the frequency change, the injected signal shall be managed without discontinuity in the voltage waveform, except in its frequency.

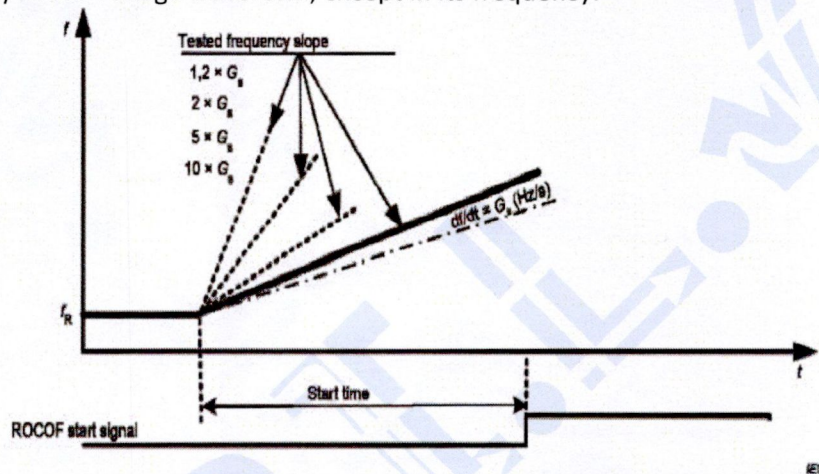


Figure 6: Start time measurement of positive ROCOF function

Each test shot is determined by the test points defined in Table 11.

- The initial test frequency value is always equal to the tested nominal power frequency.
- The frequency is increased with different values of frequency slope, to measure the start time with different test conditions.
- The injection can be interrupted when the protection start signal operates.
- The start time measurement is initiated when the frequency variation starts and stops when the protection start signal operates.

The injected frequency shall always be within the operating range of the protection function, if an operating frequency range is declared for the ROCOF function. This condition may require a limited duration of the frequency ramp. For higher ROCOF settings, if the injected frequency is outside the declared operating range before the start signal operation, the function cannot be tested for that setting based on the standardized test conditions. In that case, the manufacturer shall declare this information and shall declare the appropriate test method to be used to measure the start time for these settings.

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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The start time is calculated for the test cases shown in Table 11. Each test is repeated 10 times. The tests are repeated for each nominal power frequency value of the protection function (typically 50 Hz and 60 Hz).

2.2.2.2. Acceptance conditions of test:

If some of the test points required in Table 16 lead to a frequency derivative outside of the operating range declared by the manufacturer, these particular test points shall be ignored and the test result shall be reported as "not tested – outside of df/dt operating range and the test shall be performed with the maximum value of the frequency derivative, defined by the declared operating range.

2.2.2.3. Test result:

Table 11 – Test points of start time for positive ROCOF function(81R)

Test point value X	ROCOF setting (start threshold,Gs) Hz/s	Frequency slope value Hz/s
Minimum (0%)	Gs	0.10
5%	1.2*Gs	0.60
10%	2*Gs	1.1
30%	3*Gs	3.1
60%	5*Gs	6.0
Maximum (100%)	10*Gs	10.00

Table 12 – Reporting of typical start time for positive ROCOF function

Typical start time for ROCOF protection	
Min value	58.00
Mean value	99.77
Max value	198.40

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2.3. Determination of the accuracy of the operate time delay

2.3.1 Test procedure:

The operate time delay is defined as the time difference between the activation of the start (pick-up) signal and the operate (trip) signal.

The test method shall be based on the same principles than the start time measurement tests:

- for under/over frequency function, test method based on a sudden change in frequency;
- For ROCOF function, test method based on a finite constant slope.

These two test methods are illustrated in Figure 7 (for over frequency and positive ROCOF).

During the transition in the frequency change, the injected signal shall be managed without discontinuity in the voltage waveform, except in its frequency.

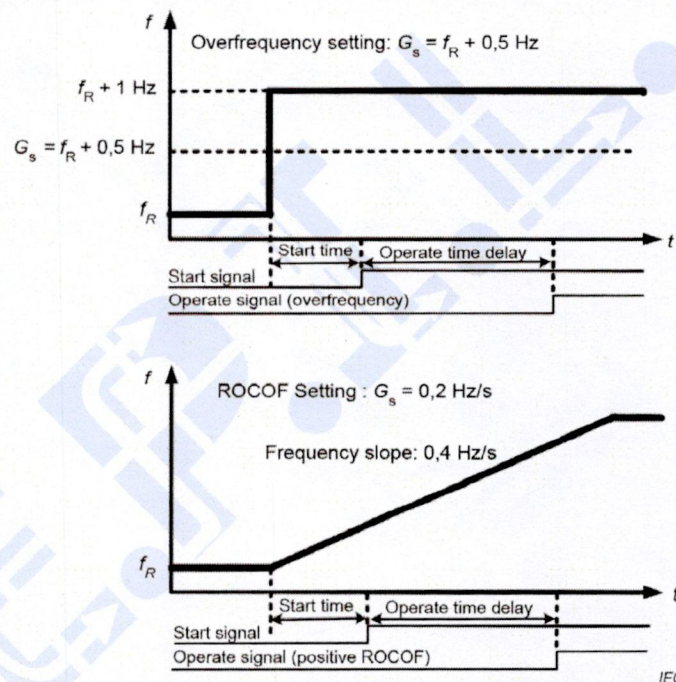


Figure 7– Operate time delay measurement of over-frequency and positive ROCOF

At least 5 settings (i.e., 10 %, 20 %, 30 %, 50 % and 100 %) of the time delay setting range shall be tested. The tested time delay settings are expressed as a percentage of the maximum time delay setting.

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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These tests are based on tests points defined .

- The initial test frequency value is always equal to the tested nominal power frequency.
- For over frequency, the threshold G_s is set to the nominal frequency plus 0, 5 Hz and the end test frequency value is equal to the nominal frequency + 1 Hz.
- For underfrequency, the threshold G_s is set to the nominal frequency - 0,5 Hz and the end test frequency value is equal to the nominal frequency - 1 Hz.
- For ROCOF, the threshold G_s is to 0, 2 Hz (with positive or negative thresholds if applicable) and the frequency is increased with a constant frequency slope equal to 0, 4 Hz.
- The test can be stopped when the frequency function operates. The operate time delay is measured between the instant when the start signal is asserted and the instant when the operate signal is asserted.

At least 5 settings (i.e., 1 0 %, 20 %, 30 %, 50 % and 1 00 %) of the time delay setting range shall be tested. The tested time delay settings are expressed as a percentage of the maximum time delay setting.

The operate time delay shall be tested at least with the test points defined in below table.

Table 13 – Test points to measure operate time delay

Frequency function	Frequency or ROCOF setting (start threshold, G_s)	Initial test frequency value	End test frequency value
Overfrequency	$f_R + 0,5 \text{ Hz}$	f_R	$f_R + 1 \text{ Hz}$, with sudden change
Underfrequency	$f_R - 0,5 \text{ Hz}$	f_R	$f_R - 1 \text{ Hz}$, with sudden change
ROCOF	0,2 Hz/s (with positive or negative thresholds if applicable)	f_R	0,4 Hz/s with positive or negative ROCOF according to the tested threshold

The tests are repeated for each nominal power frequency value (f_R) of the protection function.

2.3.2 Acceptance conditions of test:

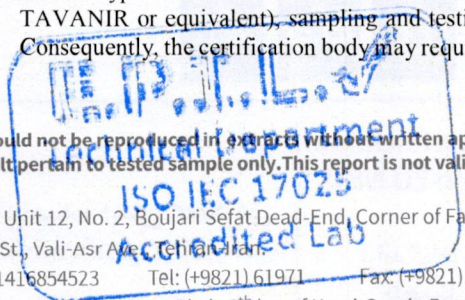
The accuracy of the operate time delay shall be reported by the manufacturer according to Tables 14 to 19, where an absolute error and a relative error are shown; the values are given.

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2.3.3 Test result:

Table 14 – Test points for the accuracy test of the **over-frequency** operate time delay

Operate time delay setting(t_{delay})	Test 1 s	Test 2 s	Test 3 s	Test 4 s	Test 5 s	Acceptance criteria ms
10%=30s	30.00	30.00	30.00	30.00	30.00	$t_{delay} \pm$ declared accuracy
50%=150s	149.80	149.80	149.80	149.80	149.80	$t_{delay} \pm$ declared accuracy
100%max(max)=300s	299.60	299.60	299.60	299.60	299.60	$t_{delay} \pm$ declared accuracy

Table 15 – Reporting of operate time delay accuracy
For **over-frequency** functions

Over-frequency protection Accuracy of the operate time delay	
Operate time delay accuracy	0.5% of the setting delay or ± 30 ms

Table 16 – Test points for the accuracy test of the **under-frequency** operate time delay

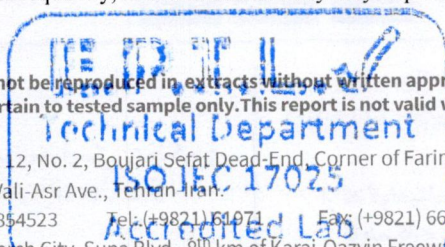
Operate time delay setting(t_{delay})	Test 1 s	Test 2 s	Test 3 s	Test 4 s	Test 5 s	Acceptance criteria ms
10%=30	30.00	30.00	30.00	30.00	30.00	$t_{delay} \pm$ declared accuracy
50%=150s	149.80	149.80	149.80	149.80	149.80	$t_{delay} \pm$ declared accuracy
100%max(max)=300s	299.60	299.60	299.60	299.60	299.60	$t_{delay} \pm$ declared accuracy

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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Table 17 – Reporting of operate time delay accuracy
For **under-frequency** functions

Under-frequency protection Accuracy of the operate time delay	
Operate time delay accuracy	0.5% of the setting delay or $\pm 30\text{ms}$

Table 18 – Test points for the accuracy test of the **positive ROCOF** operate time delay

Operate time delay setting (t_{delay})	Test 1 ms	Test 2 ms	Test 3 ms	Test 4 ms	Test 5 ms	Acceptance criteria ms
10%=1.6s	1.62	1.62	1.62	1.62	1.62	$t_{\text{delay}} \pm \text{declared accuracy}$
50%=8.1s	8.10	8.10	8.10	8.10	8.10	$t_{\text{delay}} \pm \text{declared accuracy}$
100%max(max)=16.2s	16.20	16.20	16.20	16.20	16.20	$t_{\text{delay}} \pm \text{declared accuracy}$

Table 19 – Reporting of operate time delay accuracy
For **Positive ROCOF** functions

Positive ROCOF protection Accuracy of the operate time delay	
Operate time delay accuracy	0.5% of the setting delay or $\pm 30\text{ms}$

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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Figure 8: Equipment under test

This function test has been performed on a single sample of the relay provided by the client. Sampling and selection were not conducted by the testing laboratory. Therefore, the test results in this report represent only the performance of the tested sample and may not be considered as evidence of type conformity for the entire product series.

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3. List of Critical Components					
Object/ Part no.	Manufacturer	Type/Model	Technical Data	Standard	Mark of Conformity
Enclosure	Pishgaman Metal	Galvanized Sheet	-	60255-1	-
LCD Display	CDtech	LCD Graphic 800*480 pixel	-	-	-
Relay Contacts	Schrack technik	RY613005	SPDT Relay	-	-
Current Transformers	Yuanxing	TA 200A/80mA	-	60255-1	-
Voltage Transformers	Yuanxing	TV 2mA/2mA	-	60255-1	-
Connectors	Phoneix Contact	7 position 8 position 12 position 14 position	-	60255-1	-
Capacitor	'Nippon Chemi-Con	'ELXS401VSN221MQ30S 220uF - Capacitor	-	-	-
Microcontroller	ST	STM32H743IIT	-	-	-
Supply Module	Meanwell	RS-25-5	-	-	-

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