

AFDD/ AFCI Performance Testing

The program includes tests of required tripping in case of a serial arc fault and tests of required missing when switching the electrical loads without an arc fault. The tests were done according to the new standard IEC 62606 for arc fault protection devices. Standard tests with purely resistive loads were supplemented with tests with brush motors, what much increased their practical weight.

As the discharger (gap) we used prepared fragment of NYM cable (p. 9.9.2.6) and the arc generator with adjustable copper-graphite (p. 9.9.2.7) or copper-copper (n. 9.9.2.7*) electrodes.

Test Stand.

Fig. 1 is a schematic diagram of the universal test bench (Fig. 2) for performance testing on AFDD/AFCI devices of serial arc fault in single-phase or three-phase AC power. When testing for single-phase power the line wire is connected to the L1 input terminal.

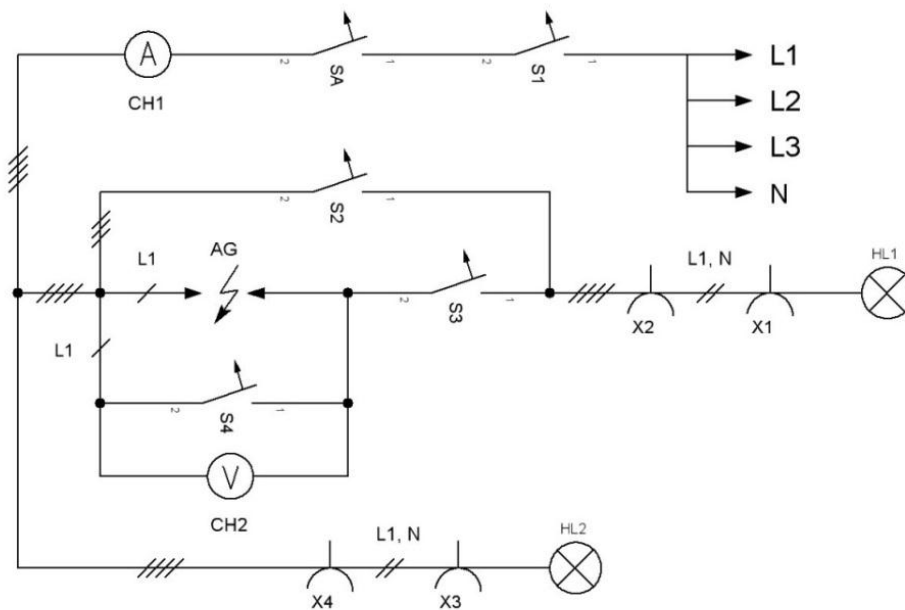


Fig. 1. The schematic diagram.

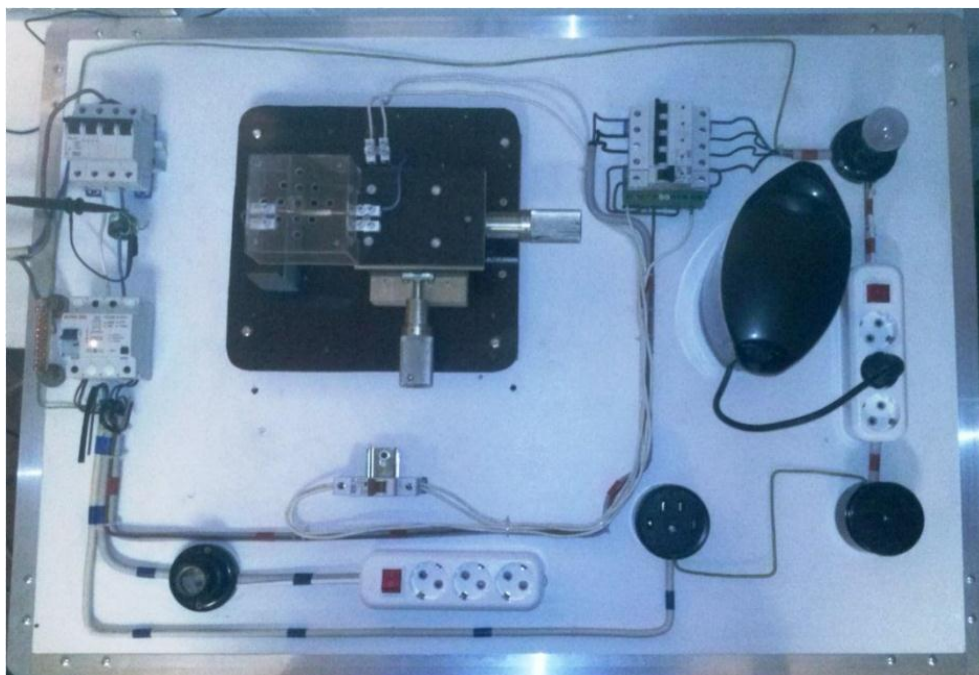


Fig. 2. The universal test bench.

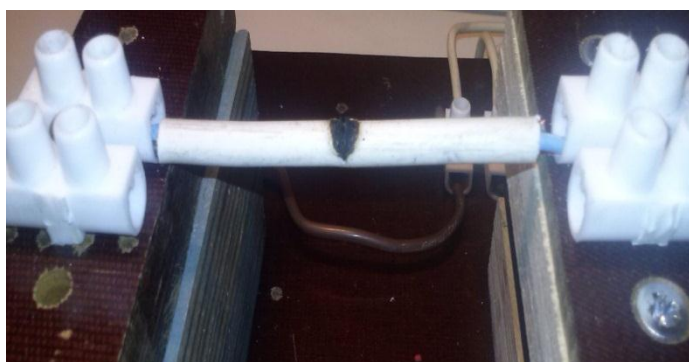
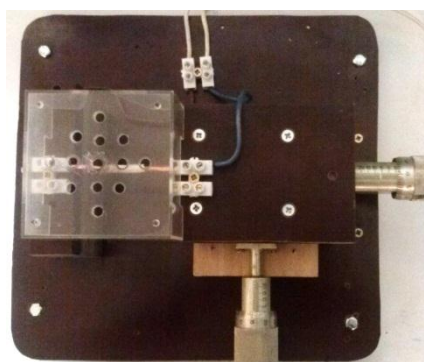


Fig. 3. The discharger (gap).



Fig. 4. Tektronix TDS 1002B oscilloscope.

Table 1. Description of symbols on diagram.

Symbol	Function	Description
S1	Input switch	4-pole 63 A overcurrent circuit breaker (type BA 47-63)
S2	Discharger switch	3-pole 63 A overcurrent circuit breaker (type BA 47-63)
S3	Discharger switch	1-pole 63 A overcurrent circuit breaker (type BA 47-63)
S4	Discharger switch	1-pole 63 A overcurrent circuit breaker (type BA 47-63)
SA	Testing device (AFDD/AFCI)	
X1	Single-phase power sockets of arc load	Type E (C3) or F (C2)
X2	Three-phase power sockets of arc load	Type PШ-30
X3	Single-phase power sockets of background load	Type E (C3) or F (C2)
X4	Three-phase power sockets of background load	Type PШ-30
HL1	Arc load current indicator	Neon lamp
HL2	Background load current indicator	Neon lamp
AG	Discharger (gap)	Cable fragment (p. 9.9.2.6) or arc generator with adjustable copper-graphite (p. 9.9.2.7) or copper-

		copper (n. 9.9.2.7*) electrodes
CH1	Summary current indicator	Oscilloscope (channel 1)
CH2	Discharger voltage indicator	Oscilloscope (channel 2)

Oscilloscope: digital, dual channel, 60 MHz bandwidth, maximum sampling rate - 1 Gsm/s (Tektronix TDS 1002B).

Tested products.

The following AFDD/AFCI models were selected for testing:

- Astro-UZO F-9311 (220-240 VAC, 50 Hz, 40 A) – AFDD+RCD
- Siemens 5SM6 + 5SU1354 (230 VAC, 50 Hz, 16 A) – AFDD+RCD
- Murray MP115AFC (120 VAC, 50/60 Hz, 15 A) – AFCI (combination type)
- Eaton CH120CAF (120 VAC, 50/60 Hz, 15 A) – AFCI (combination type)



a



b

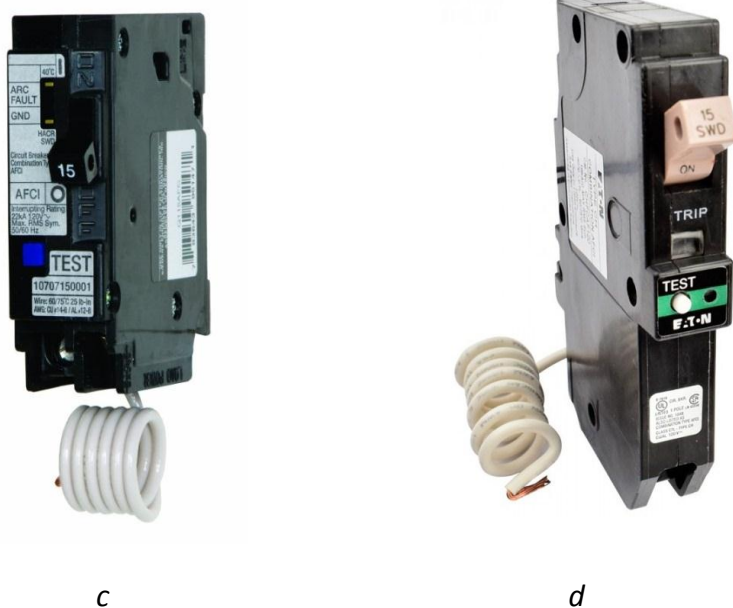


Fig. 5. The tested products:

a – Astro-UZO F-9311, b – Siemens 5SM6 + 5SU1354,

c – AFCI Murray MP115AFC, d – Eaton CH120CAF.

List of Tests.

A. The Required Tripping Tests:

1. Resistive load (p. 9.9.2):
 - 1.1. 2.5 A RMS
 - 1.2. 5 A RMS
 - 1.3. 10 A RMS
 - 1.4. 16 A RMS
2. Inductive pulse load (brush motors):
 - 2.1. 420 W
 - 2.2. 950 W

The response time measurement for each arc current value does for three times. The test is considered passed if in each of the three samples the response time does not exceed the value specified in Table 2.

Table 2. Response time of AFDD/AFCI at different arc current values.

Arc current, A (RMS)	2,5	5,0	10,0	16,0	32,0	63,0
Maximum allowable tripping time, ms (discharger – cable fragment)	1000	500	250	150	120	120
Maximum allowable tripping time, ms (discharger – arc generator)	2500	1250	625	375	300	300

B. The Required Missing Tests:

1. Resistive load 16 A
2. Inductive pulse load (brush motor) 2200 W
3. Dimmer controlling the incandescent lamps, 5x150 W (n. 9.9.5.4.d)
4. Dimmer controlling the brush motor, 750 W (n. 9.9.5.4.g)

The S2 switch closes and wait 5 seconds. The sample probe was repeated 5 times for each load. The test is considered passed if there are no tripping in each of the 5 samples.

Results of the Testing.

The results of product tests are in the summary table 3. If the test was passed, the corresponding cell contains "yes", otherwise - "no".

Table 3. Results of testing the products.

Test \ Product		Astro-UZO F-9311	Siemens 5SM6+5SU1354	Murray MP115AFC	Eaton CH120CAF
Required Tripping	Resistive Load 2.5 A	yes	yes	yes	no
	Resistive Load 5 A	yes	yes	yes	yes
	Resistive Load 10 A	yes	yes	yes	yes
	Resistive Load 16 A	yes	yes	yes	yes
	Brush Motor 420 W	yes	no	no	no
	Brush Motor 950 W	yes	no	no	no
Required Missing	Resistive Load 16 A	yes	yes	yes	yes
	Brush Motor 2200 W	yes	yes	yes	yes
	Dimmer + Bulbs 5x150W	yes	yes	yes	yes
	Dimmer + Brush Motor 750W	yes	yes	yes	yes

Conclusions:

1. AFCI Eaton CH120CAF has exceeding the value of the minimum recognizable arc fault current - 3.5 A with the norm of 2.5 A.
2. The reliability of recognition serial arc fault of Siemens 5SM6+5SU1354, Murray MP115AFC and Eaton CH120CAF much reduces (by 2-5 times) when using the non-resistive load such as brush motors.
3. The AFDD Astro-UZO F-9311 is devoid of these shortcomings. The reliability of recognition of an arc fault is high for a wide range of loads using in practice.

Remarks:

- The modification of Astro-UZO F-9311 and F-9312 for North American AC lines (120 V, 60 Hz) is planned.
- The universal modification of Astro-UZO F-9311 and F-9312 for all types of AC lines (110-240 V, 50/60 Hz) is expected.