TUMOV

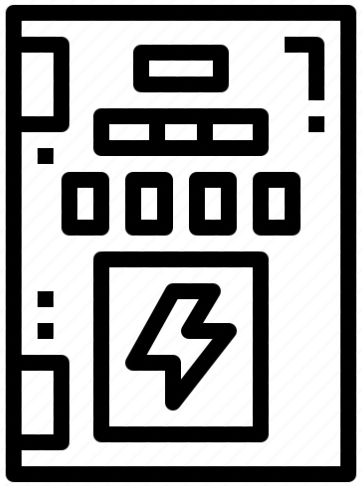
TUMOV.PRO

AFDD
Arc Fault Detection Device

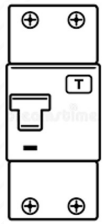
Prevent Fire
Save Live
Protect Property

STANDARD EQUIPMENT FOR ELECTRICAL CIRCUITS PROTECTION

2 types of circuit breakers installed in electrical distribution board at least



Miniature Circuit Breaker (MCB) is is an electrical safety device designed to protect an electrical circuit from damage caused by overcurrent. Its basic function is to interrupt current flow to protect equipment and to prevent the risk of fire.



Residual-current device (RCD), residual-current circuit breaker (RCB) is an electrical safety device that quickly breaks an electrical circuit with leakage current to ground. It is to protect equipment and to reduce the risk of serious harm from an ongoing electric shock.

Important

Both **MCB** and **RCD** have been used for decades around the world, but the number of fires caused by faulty electrical circuits and appliances is not decreasing, to say the least.

Bad news

Arc faults are a common cause of fires. It is not detected by both MCB and RCD in the most cases.

Good news

Arc Fault Detection Device (AFDD) is invented and available for installation into electrical distribution board. AFDD is the third step of safety, following MCB and RCD.

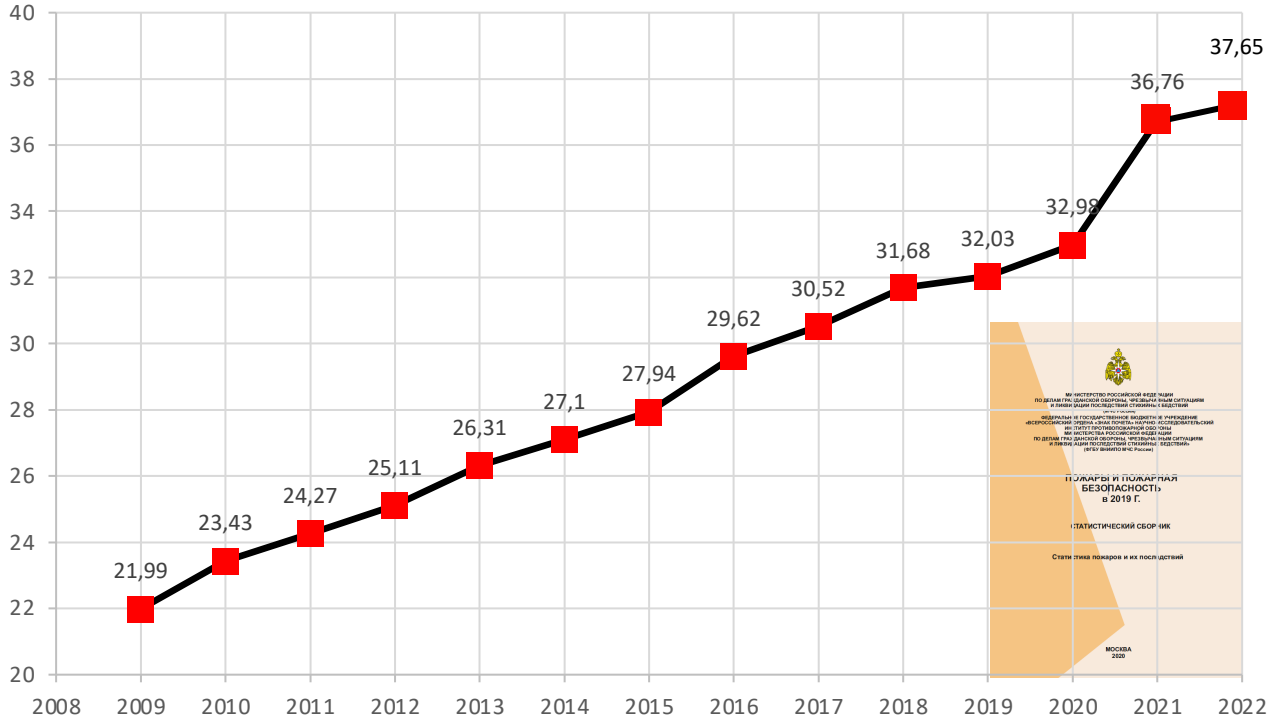
FIRE STATISTICS IN RUSSIA (EMERCOM* OF RUSSIA)

Share of fires due to issues in electrical circuits and electrical appliances is still increasing

Share of fires due to issues in electrical circuits and electrical appliances (EWEA) is still increasing, 2009-2022 (%%)

For the last 10 years:

- Share of fires due to issues with EWEA in total number of fires in Russia, 2009-2019 (%%) the death rate increased from 14% up to 24%
- the share of direct material damage increased from 29% up to 40%

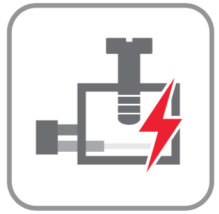


Approximately the same statistics holds true to the countries where the problem is not technically solved with the help of special technical devices

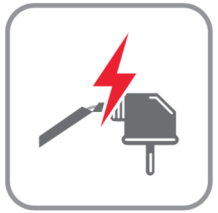
*Ministry of Civil Defense, Emergencies and Disaster Relief of the Russian Federation

ARC FAULT (ARCING) IS THE MAIN CAUSE OF FIRES DUE TO ISSUES WITH ELECTRICAL CIRCUITS AND ELECTRICAL APPLIANCES

Typical issues in electrical circuits and electrical appliances:

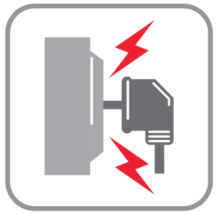


Loose connection

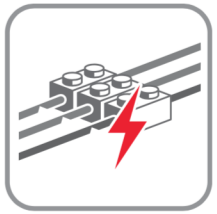


Power supply cord defective following inappropriate or excessively numerous operations

Power supply cord subjected to excessive forces (by furniture or a position)

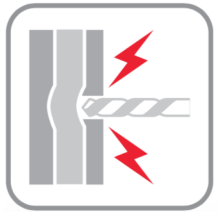


Power sockets in poor condition

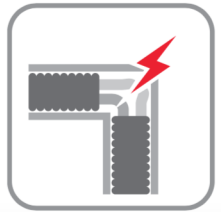


Cable weakened at connection

Cables damaged by their environment: UV, vibrations, moisture, rodents



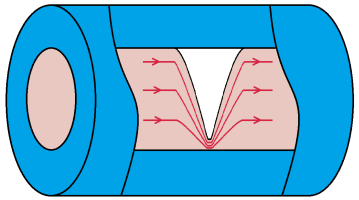
Accidental damage to a cable



Ageing of cable protective devices

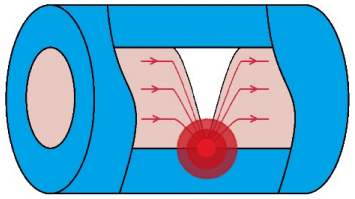
Aluminum-copper twist-on

How a serial arc fault in a wire occurs



①

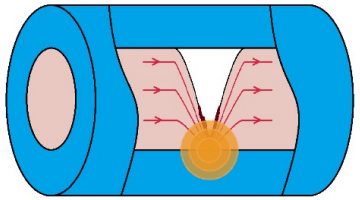
The conductor is damaged, but the circuit has not yet been broken. An area of increased resistance is formed due to a sharp decrease in the cross section of the wire.



②

Current flowing in the area of deformation causes the temperature at the defect to rise. The wire metal and the insulation nearby are heated. Carbonization of the insulation begins.

t > 220 °C

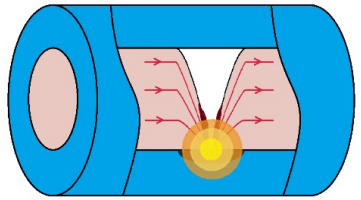


③

Severe heating causes oxidation of the copper, which leads to a further increase in resistance and a further rise in temperature.

t_{mlt}= 1083 °C

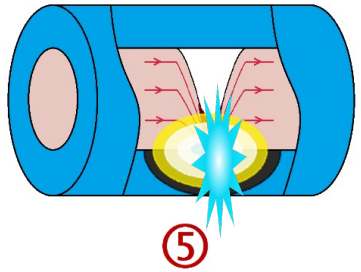
Copper melting point



④

Further heating leads to the melting of the copper. A gap is formed between the conductors. Arc fault through the carbonized insulation begins. Further charring of the insulation occurs.

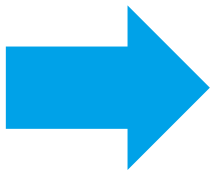
t > 2000 °C



⑤

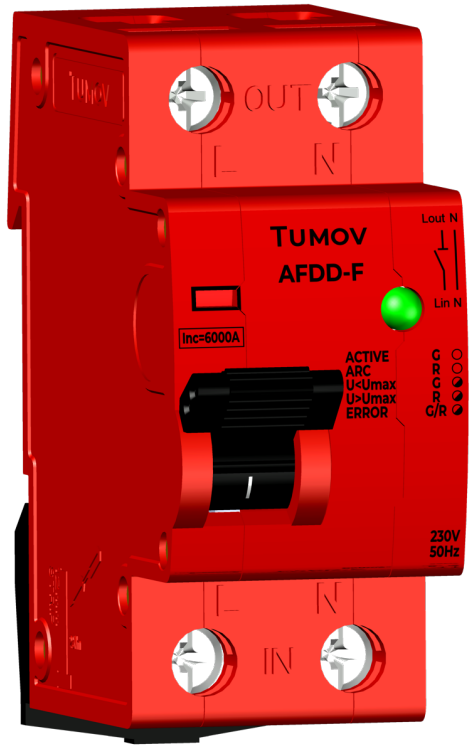
A steady arc will form through the carbonized insulation section. The risk of fire is greatly increased.

t = 2500-7000 °C

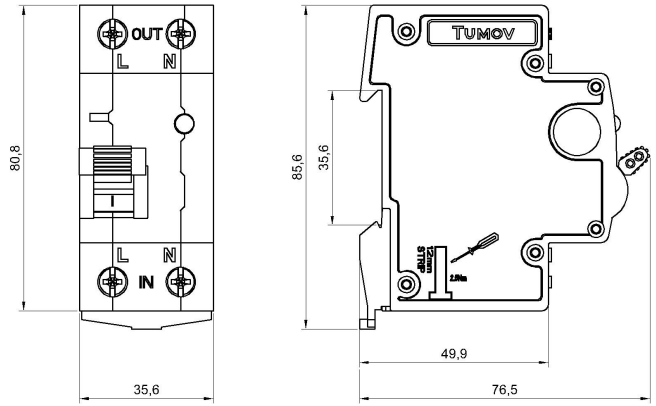


ARC FAULT DETECTION DEVICE (AFDD)

AFDD is the third stage of electrical circuits' safety tools, following MCB and RCD.



- DIN-rail mounted.
- TEST UNIT the operation area monitoring for and AFDD's testing is included.
- A fire-hazardous arc within the protected circuit is detected by AFDD. The protected circuit will be tripped off automatically after that.



The use of an AFDD will reduce the number of fires due to issues with wiring and electrical appliances by more than a factor of 2*.

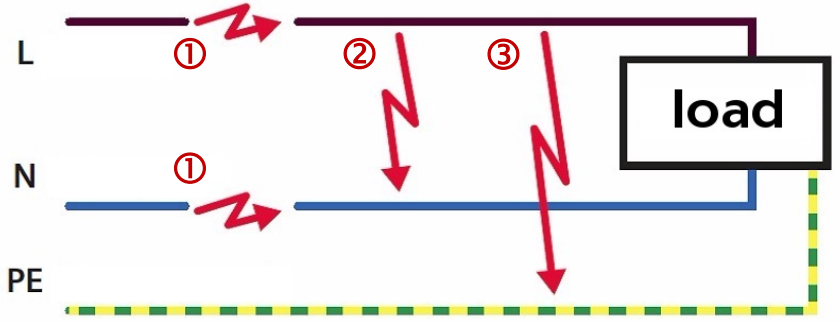
* based on data from the Consumer Product Safety Commission (US CPSC)

STANDARD EQUIPMENT FOR ELECTRICAL CIRCUITS PROTECTION

How do different types of circuit breakers react to arc fault

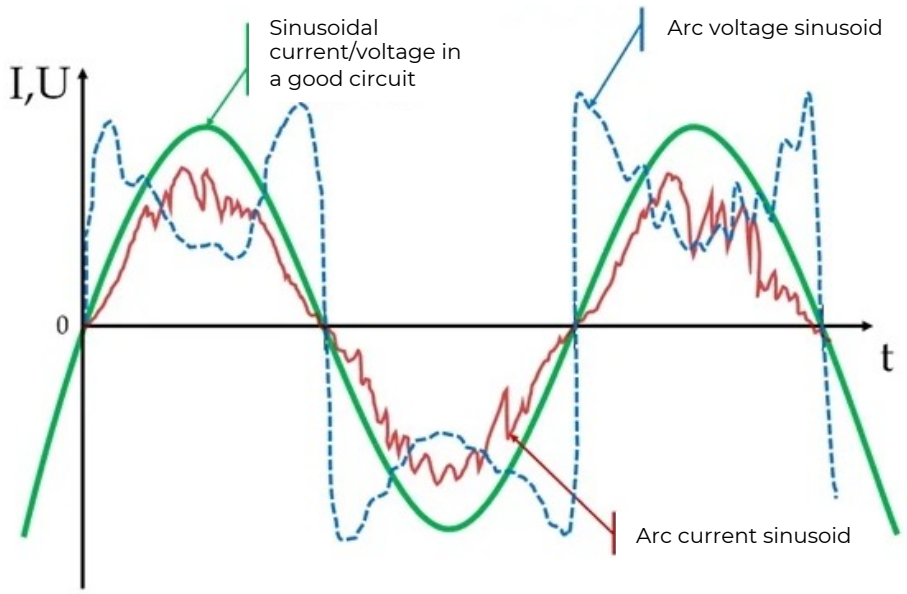
Protection device	Type of arcing		
	① Serial (BTR – poor contact)	② Parallel Phase - neutral	③ Parallel Phase - ground
 MCB	Doesn't detect at all	May trips too late (under a limited short-circuit current)	May trips too late (under a limited short-circuit current)
 RCD	Doesn't detect at all	Doesn't detect at all	May not detect (under pulsed nature of arcing)
 AFDD	The circuit is tripping off	The circuit is tripping off	The circuit is tripping off

An "electrical" fire will not be prevented by MCB and RCB in most cases!



How AFDD works

Current and voltage at the AFDD terminals in case of arc fault



1. The pulse at the start of the arc fault triggers the signal measurement procedure at the terminals of the device.
2. The HF component of the signal is evaluated, at a given level further measurements are started.
3. Events are supported by several current and voltage measurements:
   - The presence of a characteristic current jump at the initial half-period of the current sinusoid;
   - The current surge occurred in the protected circuit and not in the adjacent circuits;
   - The arc current is sufficient according to IEC 62606 standard criteria.
4. If at least one indication is missing - reset to the initial state.
5. If all signs are present (in the "AND" scheme), the "Single Arc Failure" counter is turned on.
6. When a critical number of single arc faults accumulate, the circuit is tripped off depending on the arc current strength.

STANDARDS AND REGULATIONS

AFCI – Arc Fault Circuit Interrupter, AFDD – Arc Fault Detection Device

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Mandatory use of AFDDs begins only after tragic events and human losses…

Grenfell Tower fire on June 14, 2017

STANDARDS AND REGULATIONS

AFCI – Arc Fault Circuit Interrupter, AFDD – Arc Fault Detection Device

USA , 2002
National Electric Code (NEC)

Canada, 2002
Canadian Electric Code (CEC)

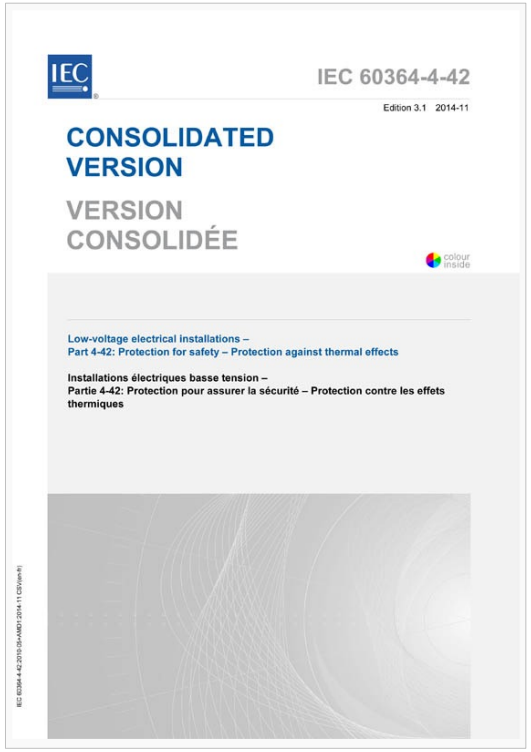
Germany, 2017
DIN VDE 0100-420:2019-10

Austria, 2017
OVE E 8101:2019-01-01

Slovakia 2018
STN 33 2000-4-42/A1

UK, 2022
BS 7671:2018, A2:2022

New Zealand, 2018
AU/NZS 3000:2018



International Standard IEC 60364-4-42:2014
AFDD is recommended, effective since 2014

STANDARDS AND REGULATIONS

AFCI – Arc Fault Circuit Interrupter, AFDD – Arc Fault Detection Device

IEC 62606:2016 applies to arc fault detection devices (AFDD) for household and similar uses in AC circuits.

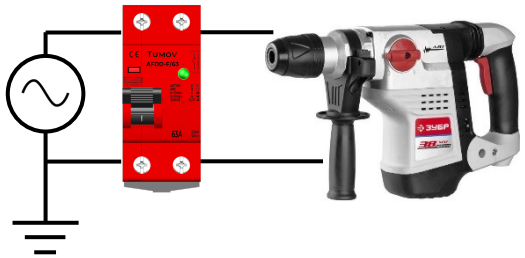
An AFDD is designed by the manufacturer:

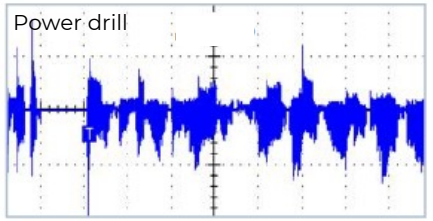
- either as a single device having opening means able to open the protected circuit in specified conditions; or
- as a single device integrating a protective device; or
- as a separate unit, according to Annex D assembled on site with a declared protective device.

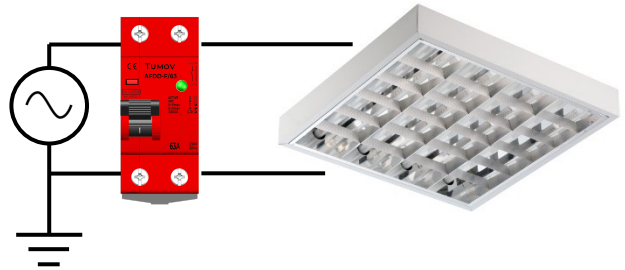
STANDARDS AND REGULATIONS

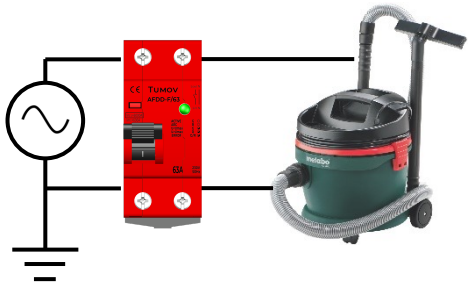
AFDD: false positive testing. IEC 62606:2013, point 9.9.5.4

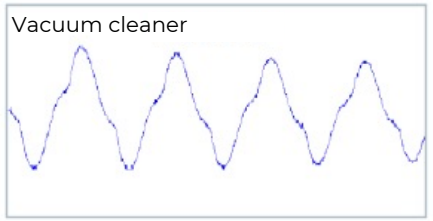
Passed

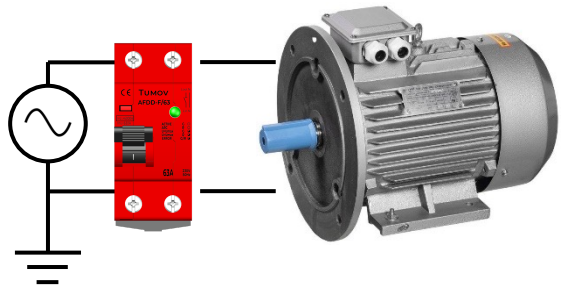


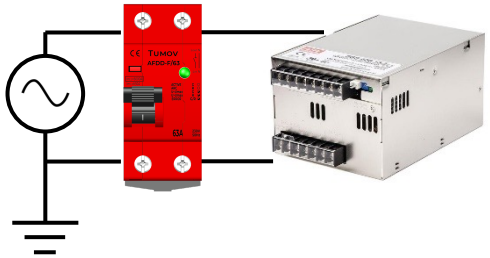


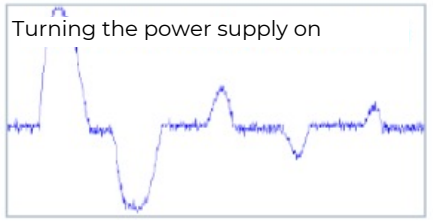


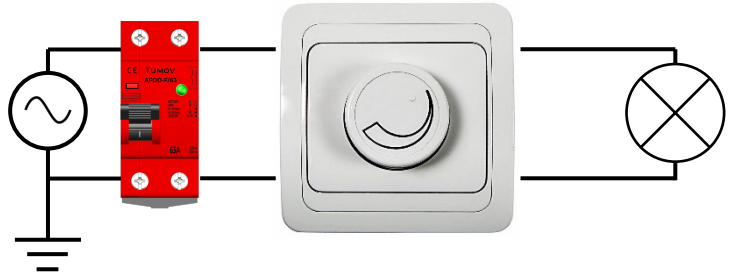








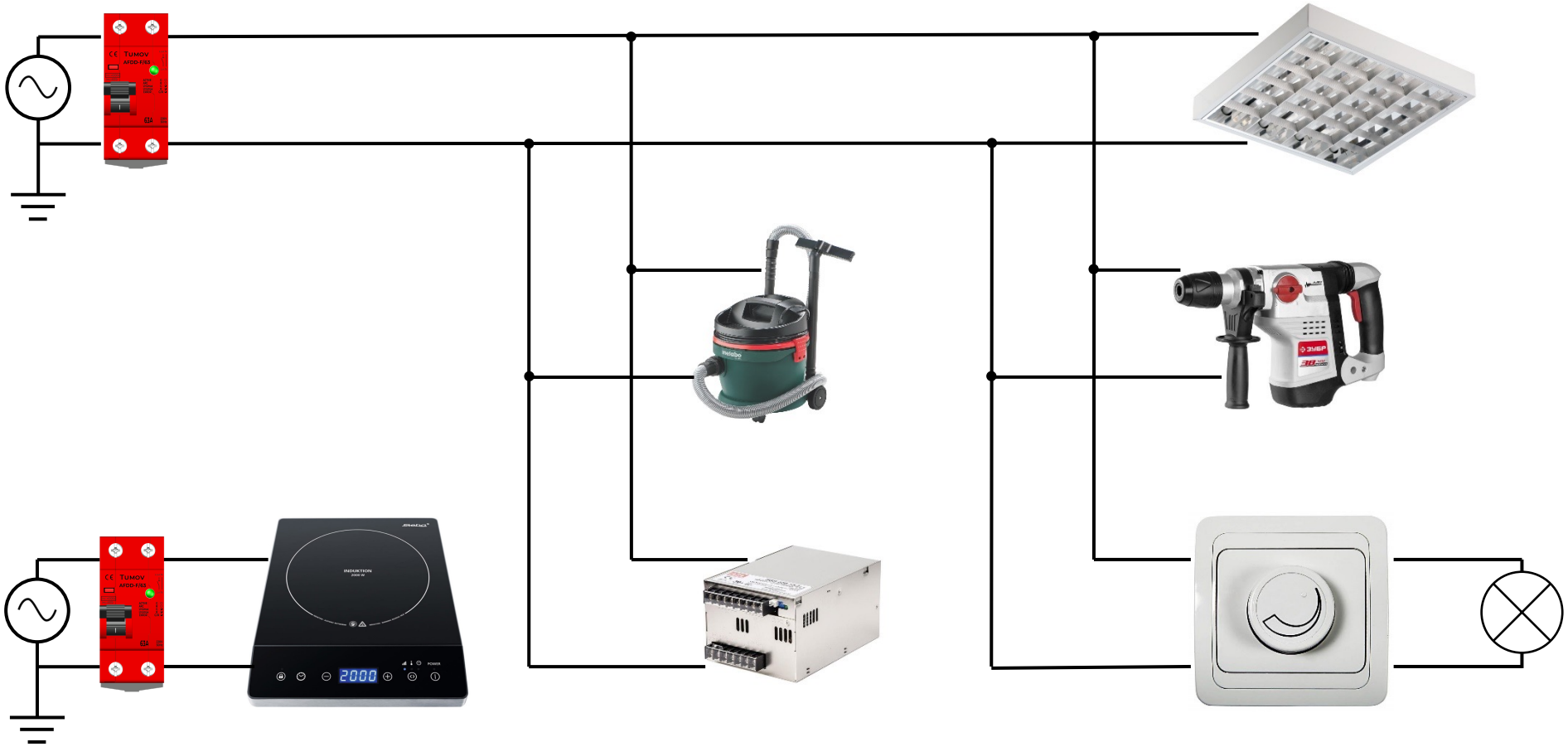




STANDARDS AND REGULATIONS

AFDD: false positive testing. IEC 62606:2013, point 9.9.5.4

Additional tests by the Ecolight experts were also conducted.
Passed ✅



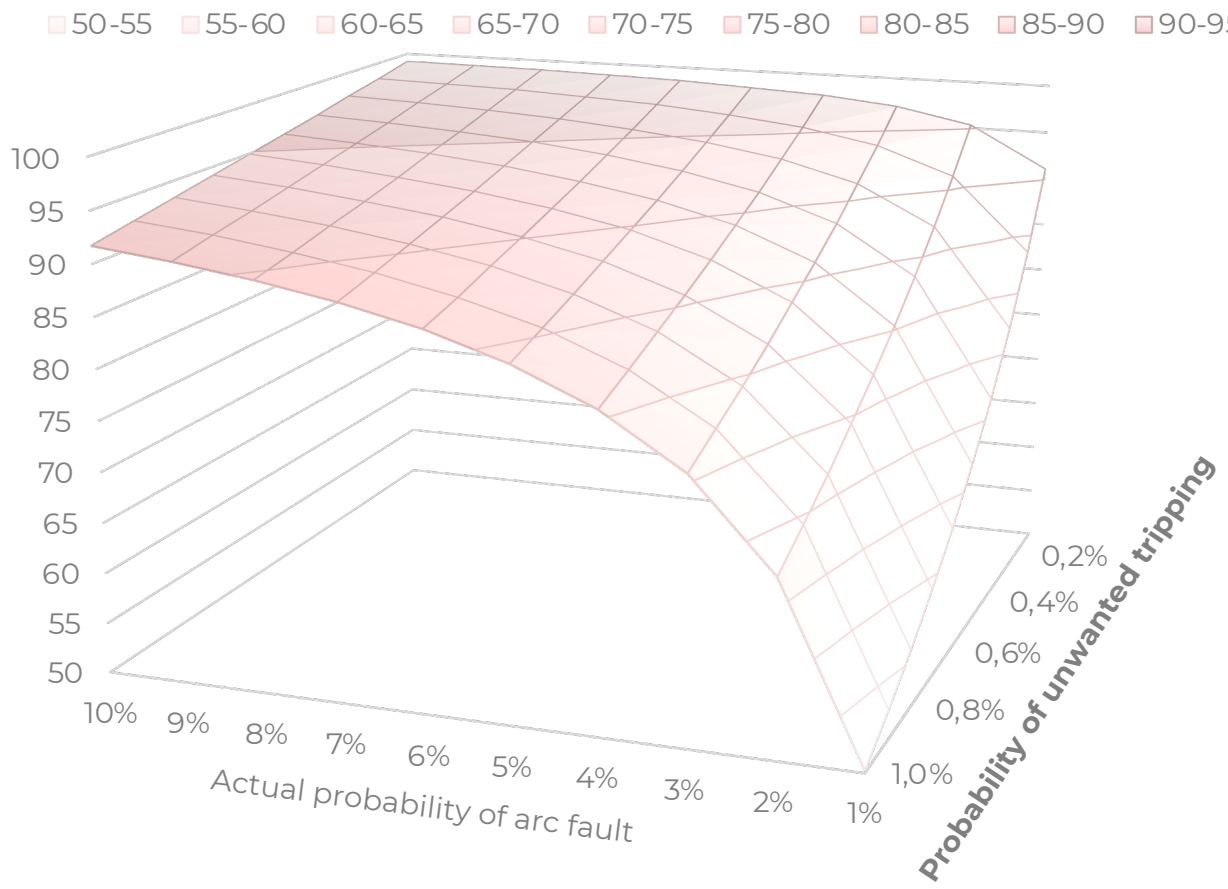
Criteria for AFDD successful operation

Probability of an arc fault detection

Signal analysis method	Accuracy of arc fault detection	Notes
Sparse representation Neural network with linear coefficients	88 %	High processing power is required
Chirplet Conversion (CZT transform)	97 %	A specialized chip is required
The Support Vector Method (SVM)	98 %	High processing power is required
Spectral analysis with Fourier transform	97 %	High processing power is required
Signal energy analysis in the high-frequency areas and fast Fourier transform	96 %	A separate signal processor is required
Selective analysis of signal energy in different spectrum areas (in-house original solution by Ecolight Ltd.)	**> 99 %**	

Criteria for AFDD successful operation

Influence of unwanted tripping on the accuracy of arc fault detection



Probability of an arc fault in case of AFDD tripping

Event A – arc fault
Event B – AFDD tripping

The 90% to 100% probability of arc fault detection has little or no effect on the success criterion for AFDD operation

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B|A) \cdot P(A) + P(B|NotA) \cdot P(NotA)}$$

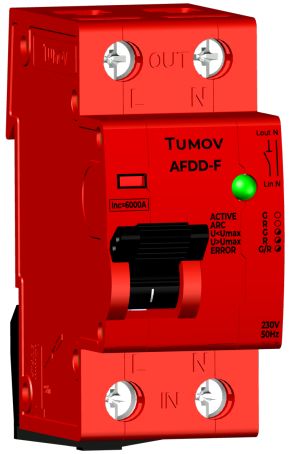
WORLD COMPETITORS

Overview of patents close to Ecolight Ltd. technology

Patent No., country	Features of the arc fault detection method All methods distinguish bands in the area of low and high frequencies, the presence of an arc fault is determined by signal changes in these frequency bands
098672, USA	LF – up to 1 kHz, HF – 10-100 kHz
158744, USA	LF – from 700 Hz up to 3 kHz, HF – no frequencies specified
6128169, USA	LF – no frequencies specified, HF – 500 kHz and high
149891, USA	LF – below 500 Hz, HF – 500 kHz and high
171085, USA	Single range both for LF and HF – from 200 Hz up to 18 kHz
5835321, USA	LF – not available, HF – from 3 Hz up to 20 kHz
628270, Australia	LF – 180 и 300 Hz (3^{rd} and 5^{th} harmonics), HF – from 2 Hz up to 20 kHz
Siemens, Germany	HF – from 24 MHz up to 30 MHz
Ecolight Ltd., Russia	HF – from 5 up to 15 kHz and from 5 up to 10 MHz

WORLD COMPETITORS

Tumov



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Price of 1 piece

115 USD

=

Price of 10 pieces of competitor's device
1500-2000 USD

Legrand

Schneider

Hager

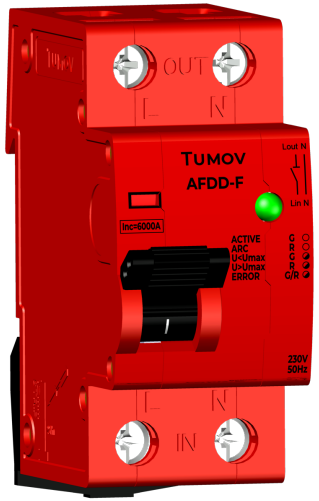
Eaton

ABB

Siemens

COMPETITIVE ADVANTAGES OF TUMOV AFDD

Made in Russia



Arcing detection is provided by multi-factor and multi-stage algorithm:

- Within distributed circuits
- Maximum rated current is 63 A
- The only AFDD is enough up to 150 sq.m. facilities
- Each phase of electrical circuit is covered by its own AFDD
- Zero level of false positives

Important for customers:

- Always ON tripping cause indicator, re-enabling is not required
- TEST UNIT for operation area monitoring is included
- Overvoltage shutdown threshold
- Competitive price

AFDD POSITIONING

1. AFDD is a mass product that is necessary for:
   - owners of all types of residential and non-residential buildings, outbuildings;
   - owners, tenants, managers, users of public buildings, some kinds of industrial facilities.

2. The closest analogue of AFDD by the type of market penetration,which are known to all consumers, are miniature circuit breakers (MCB) and residual current devices (RCD) but the only one who prevents electrical fire.

3. AFDD is the third stage of protection of electrical circuits following MCB and RCD.

4. The goal is to make the use of AFDD understandable and natural like MCB and RCD.

AFDD POSITIONING

Target audience and benefits

State officials
Improving citizen safety

Electrotechnical equipment manufacturers
Access to high-end technologies for the new equipment production

Building designers
Increasing the safety of buildings

Electrical distributor board manufacturers
Installing top-level devices for customers

Building Developers
Increasing the safety of buildings

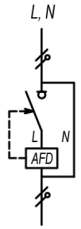
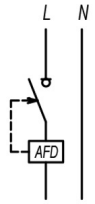
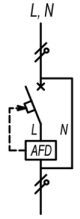
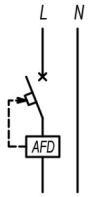
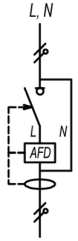
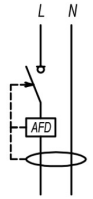
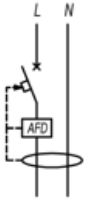
Electricians
Installing top-level devices for customers

Property management companies
Improving the safety of residents

Insurance companies
Reduction of insurance payments

IMPLEMENTING AFDD

Typical symbols

	Graphical symbols on single-line diagrams	Graphic symbols on circuit diagrams
Single-pole AFDD		
Single-pole MCB+AFDD		
Single-pole RCD+AFDD		
Single-pole RCBO+AFDD		

PATTERNS OF COOPERATION

Stage 1
Supply of finished devices

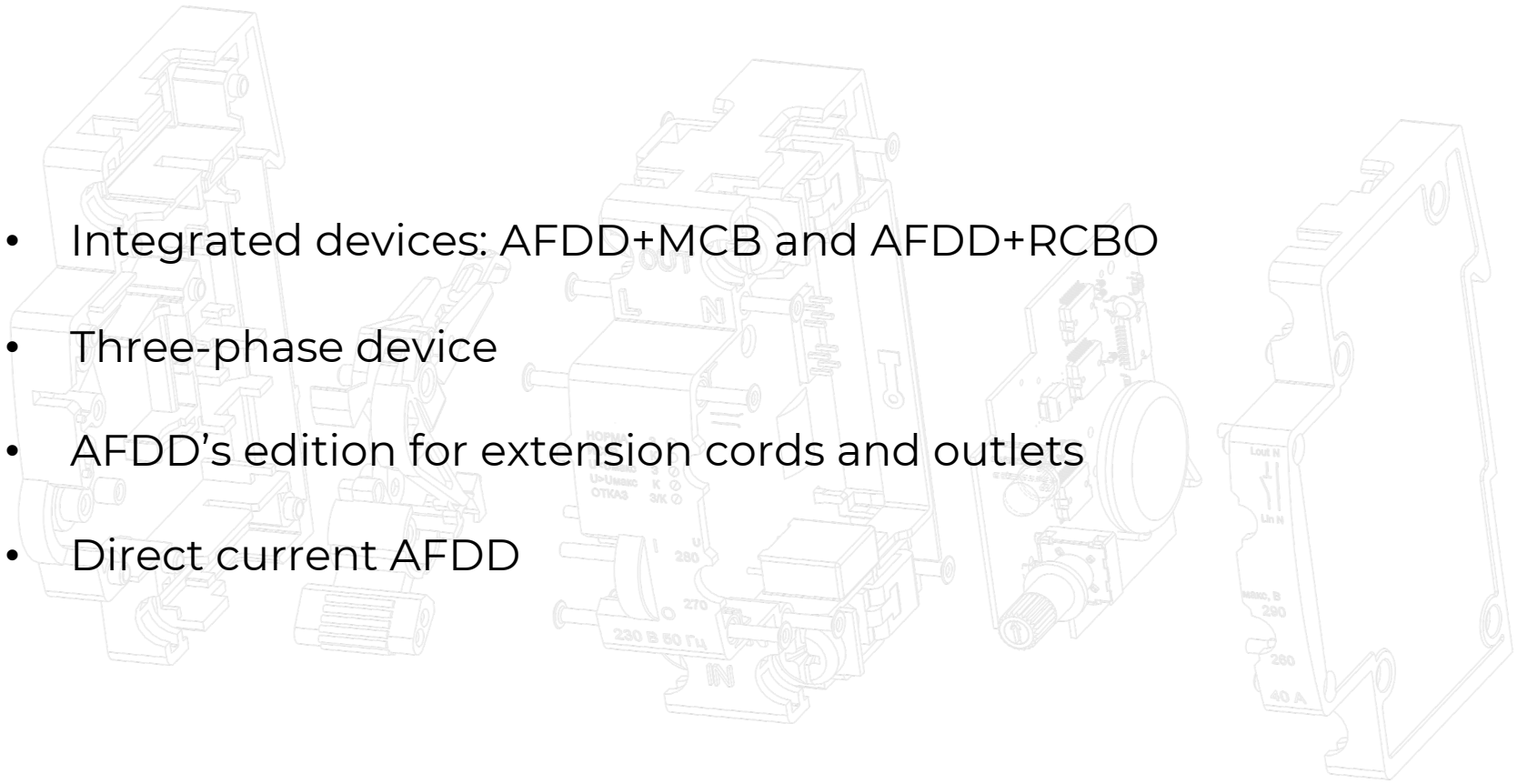
- Teaching events
- Agreement with a local partner
- Pilot project for initial AFDD testing
- Sales to local customers
- Warranty and post-warranty support

Stage 2
Joint venture

- Teaching events
- Agreement with a local partner
- Joint production facility for local brand devices *)

*) – The feasibility study will be sent upon special request

WHAT IS COMING SOON?



- Integrated devices: AFDD+MCB and AFDD+RCBO
- Three-phase device
- AFDD’s edition for extension cords and outlets
- Direct current AFDD

PREVENT FIRE
SAVE LIVE
PROTECT PROPERTY

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